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Team 303: Dual Wind and Solar Power Generator

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Abstract

Team 303 – Kinetic Aero-Solar Renewable Energy Nexus (KAREN)

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As global energy demands escalate and non-renewable resources dwindle, there is a pressing need to explore sustainable alternatives. Renewable energy, notably wind and solar power, emerges as pivotal solutions for future energy needs. Our team endeavors to integrate these resources into a cohesive system capable of generating power during periods of low solar or wind activity. Our primary goal is to design a compact renewable energy generator specifically tailored to meet the needs of farmers in remote rural areas where access to sufficient electricity for essential agricultural machinery is limited. By downsizing the project, we enhance its versatility, enabling users to deploy the device wherever it's needed most. Our strategy involves reducing the generator size to optimize energy output while minimizing costs and spatial requirements. The central objective of our endeavor is to create a dual solar and wind generator capable of generating a minimum of 100 W of power. It must be easily transportable by a single individual and resilient enough to withstand winds of up to 45 mph. To achieve this, we integrate a "sunflower" concept for the solar panels, allowing them to track the sun's

trajectory throughout the day to maximize power generation. Additionally, we utilize horizontal axis wind turbines, similar to those employed in large-scale wind farms, to effectively harness wind energy. By combining innovative design principles with proven renewable energy technologies, our project aims to empower rural communities with reliable, sustainable energy solutions while fostering environmental stewardship and technological advancement.

Acknowledgement

These remarks thanks those that helped you complete your senior design project. Especially those who have sponsored the project, provided mentorship advice, and materials. 4

- Paragraph 1 thank sponsor!
- Paragraph 2 thank advisors.
- Paragraph 3 thank those that provided you materials and resources.
- Paragraph 4 thank anyone else who helped you.

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Notation

A17	Steering Column Angle
A27	Pan Angle
A40	Back Angle
A42	Hip Angle
AAA	American Automobile Association
AARP	American Association of Retired Persons
AHP	Accelerator Heel Point
ANOVA	Analysis of Variance
AOTA	American Occupational Therapy Association
ASA	American Society on Aging
BA	Back Angle
BOF	Ball of Foot
BOFRP	Ball of Foot Reference Point
CAD	Computer Aided Design
CDC	Centers for Disease Control and Prevention
CU-ICAR	Clemson University - International Center for Automotive Research
DDI	Driver Death per Involvement Ratio
DIT	Driver Involvement per Vehicle Mile Traveled
Difference	Difference between the calculated and measured BOFRP to H-point

DRR	Death Rate Ratio
DRS	Driving Rehabilitation Specialist
EMM	Estimated Marginal Means
FARS	Fatality Analysis Reporting System
FMVSS	Federal Motor Vehicle Safety Standard
GES	General Estimates System
GHS	Greenville Health System
H13	Steering Wheel Thigh Clearance
H17	Wheel Center to Heel Pont
H30	H-point to accelerator heel point
HPD	H-point Design Tool
HPM	H-point Machine
HPM-II	H-point Machine II
HT	H-point Travel
HX	H-point to Accelerator Heel Point
HZ	H-point to Accelerator Heel Point
IIHS	Insurance Institute for Highway Safety
L6	BFRP to Steering Wheel Center

Chapter One: EML 4551C

1.1 Project Scope

Project Description

The Dual Solar Wind Generator project aims to focus on the integration of power collection from solar and wind sources with the goal of efficient energy generation and storage in a dedicated battery system.

Key Goals

The key objective is to seamlessly combine the outputs of solar and wind generators into a unified package aimed toward use in farming application and rural areas. By harmonizing these power sources, the project aims to optimize energy utilization and enhance overall system reliability. This integration not only increases the resilience of the power supply but also contributes to a sustainable and versatile energy solution. The project involves careful engineering to ensure the compatibility and synergy of the two generators, ultimately creating a robust and unified system for reliable power storage.

Primary Market

- Renewable energy companies
- Farmers
- Farming supply companies
- Power grid companies
- **Secondary Market**

- Hobbyists
- Construction companies
- Federal/State/Local Governments

Assumptions

For this project it is assumed that the final product should produce at least 100 W of power, be easily portable, utilize both solar and wind power simultaneously and have fail safes to prevent damage to the structure. It is assumed that the user will have access to alternate power sources in cases where the system has zero charge, the user will also be able to complete initial set up. The user will also have their own method of transport if the device is decided to be attached to a vehicle for transport. Devices that are utilizing the generated power will be provided by the user. Proper placement and usage of the device is also assumed from the user.

Stakeholders

- FAMU-FSU College of Engineering
- Dr. Shayne McConomy
- Dr. Jerris Hooker
- Mr. Bruce Morrison

1.2 Customer Needs

To identify the key requirements for the project design, we devised a series of questions aimed at interviewing the project stakeholders. The purpose of these questions was to gather detailed information and also to gain insight regarding their expectations, preferences, and also their priorities. By conducting these questions, we were able to gain a better understanding of the project scope and goals, as well as their needs and their concerns of the client and stakeholders. The same information was then used to guide the design process, ensuring that the final product would meet the expectations of the consumer. Table (1) below shows the questions that were asked to the client, as well as their respective answer and interpreted needs.

Table 1: *Customer Needs Q&A*

Customer Needs Q&A			
	Question	**Customer Statement**	**Needs Interpretation**
1	What type of environment would the project be expected to work in?	The device will be outside all the time, so expect it to be exposed to the elements.	The device will need to be durable enough to withstand natural forces.
2	Are solar panels the desired method to utilize solar energy?	Any method can be used to capture solar energy.	All methods for capturing solar energy are acceptable.
3	Are traditional turbines the desired method to harness wind power?	Any method can be used to capture wind power.	All methods for capturing wind energy are acceptable.
4	Does the design need to be on the ground, or could it function on water or in the air?	Yes, we need the generator to be based on the ground for reliable conditions.	The device needs to be ground based to meet customer desires.
5	What is the desired life span of the device?	We would expect the device to be able to supply power for over five years.	The device needs to be able to last for a minimum of 5 years without having significant failure.
6	Do you need the device to scale for different water variations?	The device does not need to be scalable.	The design only has to reach the desired targets and metrics.

7	Would disassembling the design for transport be accessible?	Yes, disassembly for transport would be accessible.	The customer needs the assembly to be transportable, however how that is accomplished is up to the team.

Results

The team identified important customer desires to determine needs and later determine a design that can accomplish these goals. Furthermore, the team found that the desired design does not have to utilize solely solar panels and traditional turbines. The design should have a reasonable longevity and be functional in various environments while consistently functionable outdoors. The design should also be planted on the ground as well as being relatively collapsible so that it can be transported around with ease.

1.3 Functional Decomposition

The functional decomposition is a chart used to determine the functions necessary to successfully complete and meet the requirements of the project. For this project the major functions were determined to be safety, wind power, solar power, and energy storage. These major functions were then broken down into smaller functions to determine how the major functions would need to be accomplished. The subfunctions can be found in Appendix B.

1.4 Target Summary

Overview

The main objectives of this project are to generate 100W of electricity, design a device that is portable within 50 meters, and design fail safes for the device. For this design, there will be many targets that will be achieved for sufficient functionality of the device. These targets were determined based on the design requirements for the design. These functions relate to the general environmental conditions the team expects the device to encounter when used such as wind speeds, solar irradiance, and erosion of material. For the power generation elements of the device the team will need to account for positioning of the solar collector and turbine, energy lost in transfer to storage, and total energy capacity. With the design using multiple power sources, analysis will need to be done to ensure both methods are being captured and stored efficiently in a battery of a proper size based on approximate power output. When designing the device's structure, the team will need to assess materials and structural design options to ensure the structure can withstand the applied forces. All these targets must be considered for a successful design outcome as they will be necessary for the project's implementation.

Targets, Metrics and Derivation

A wide range of objectives have been set to accomplish these goals, all of which are essential to the device's operation in a variety of environmental settings. These targets include variables that are expected to occur during the device's operation, such as wind speeds, solar irradiance, and material erosion. When it comes to producing electricity, careful consideration will be given to the best locations for the solar collector and turbine, reducing energy loss during the transfer to storage, and figuring out the overall energy capacity. Considering the use of several power sources, a careful examination will be carried out to effectively capture and store energy, guaranteeing the selection of a battery size according to the anticipated power output. The team will also evaluate different structural options and materials to ensure that the device can withstand applied forces. The accomplishment of these goals, each of which is essential to the project's success, will determine how well it is carried out. The measures employed to assess these goals' success will be crucial indictors of the project's development and success. These metrics will be refined through a rigorous derivation process, guaranteeing a meticulous approach to every aspect of the design, and leading to a highly functional and dependable portable electricity generation device.

Critical Targets

For the Dual Solar Wind generator, it will need to harness both wind and solar energy to use or store that energy for future use. The relays planned are being designed in a way so that the current energy storage of the device is displayed within five percent of the amount stored. With the collection of the power through solar and wind energy, it is planned to have a maximum power loss of twenty percent. This is important because we want the amount of power stored in the device to not have a huge margin of error, because it can allow for charging uses or malfunctions with the device. It is also essential to not minimize the amount of power lost, so that the storage mechanism can be as efficient as possible. The electrical conversion of the wind and solar will have a maximum power loss of ten percent and the battery will be able to store a minimum of one and a half KWh of electricity. The device will be able to withstand a constant solar irradiance of one thousand three hundred and sixty W/m^2 for an average of around twelve hours a day, for five years. The device will also be able to withstand wind speeds of up to 45mph. This is essential for proper operation of the device so it can output sufficient power and not break in the process. The device will be portable enough so that a single person can transport it around fifty meters with relative ease and the structure will have a safety factor of two, to account for natural forces which will be impacting the device. The carry weight of the system will have a factor of safety of one and a half to ensure the device can support its own weight. The materials used will also be weatherproof to prevent corrosion for at least five years to ensure that the device can remain operational and does not need any heavy-duty maintenance. The device will be able to track the location of the sun as well as determining where the wind is blowing from to determine the optimal position at which to place the wind and solar devices. There will be a temperature gauge to determine if the device is overheating or not. This is essential because if the device overheats it won't be able to operate properly, or it might break entirely. If the device senses that something is wrong, it will react within ten seconds of sensing the issue.

Validation Tests

In order to ensure that our Dual Solar Wind generator aligns with our desired critical targets, a comprehensive variety of validation tests must be conducted to maximize its performance. First and foremost, an examination of energy storage is imperative, in which this entails measuring the actual energy storage capacity of the battery and comparing it to the predefined target, with a strict tolerance of no more than a 5% margin of error. Subsequently, the battery's ability to retain its charge over an extended period, affirming long-term stability, will also be assessed. Energy collection from both solar and wind sources will undergo great scrutiny, with a focus on ensuring that power loss does not exceed 20% of the energy collected. This necessitates an evaluation of the electrical conversion efficiency for both wind and solar systems, with the aim of not exceeding a 10% power loss. The battery's capacity, holding a minimum of 1.5 KWh of electricity, will be confirmed through rigorous testing, inclusive of assessing its cycle life and capacity retention under diverse operational conditions. Environmental endurance tests will also be paramount, where we will expose the generator to constant solar irradiance of 1360 W/m^2 for 12 hours a day, emulating a five-year period, as well as subjected to wind speeds of up to 45 mph without incurring structural damage. A lengthy exposure to environmental conditions will be carried out to validate the weatherproofing and corrosion resistance over a span of five years. The device's portability will also be assessed, ensuring that a single person can transport it up to 50 meters with ease, and that it remains stable during transit without incurring any harm. Subsequently, the structural integrity will be confirmed through load testing, featuring a safety factor of 2, as well as evaluating its capacity to support its own weight with a safety factor of 1.5 under varying environmental conditions and forces. The precision and dependability of the sun-tracking and wind-direction-detection mechanisms will be evaluated to guarantee that the device optimally positions the solar and wind components to maximize energy collection. The accuracy of the temperature gauge and the device's capacity to avert overheating will be tested, including simulations of overheating scenarios to validate its ability to respond within a mere ten seconds. Finally, controlled tests featuring faults and malfunctions will be introduced to evaluate the device's response and safety mechanisms, ensuring its ability to continue functioning even under degraded conditions. It is of paramount importance to meticulously document and analyze the results of these tests, addressing and rectifying any deviations from the specified targets in the design and manufacturing processes. Ongoing maintenance and monitoring should be duly considered to ensure sustained functionality over time.

Measurement Resources

1. Efficiency Testing: Perform efficiency tests to assess the overall efficiency of the energy conversion process. Measure the energy output relative to the energy input to determine how effectively the device converts wind and solar energy into electricity. This can help in optimizing the design for better energy conversion.
2. Battery Performance in Extreme Conditions: Test the battery's performance under extreme conditions such as very low or very high temperatures, to ensure that it can operate reliably in a wide range of environmental settings. This will validate its ability to store and release energy under different conditions.
3. Environmental Impact Testing: Conduct environmental impact assessments to ensure that the device does not harm the local ecosystem. This includes assessing the impact on wildlife, plant life, and the immediate environment where the device is deployed.
4. Long-Term Durability Testing: Beyond the five-year endurance tests, you can conduct longer-term durability testing to see how well the device holds up over a more extended period, simulating a decade or more of operation to assess long-term performance and reliability.
5. Extreme Weather Testing: Subject the device to extreme weather conditions, such as heavy rain, snow, or sandstorms, to validate its resilience under adverse weather scenarios. This will ensure it can function in a variety of climates and still meet performance targets.

6. Remote Control and Monitoring Testing: Assess the device's ability to be controlled and monitored remotely. Ensure that the remote control systems and sensors work reliably, and the device can be shut down or started up remotely if needed.
7. Redundancy and Backup System Testing: Test the device's backup systems and redundancy mechanisms to ensure they function as intended. This includes redundant power sources, fail-safes, and emergency shutdown procedures.
8. Transportation and Deployment Testing: Verify the device's ease of transportation within 50 meters and its stability during deployment. Consider tests like setting up and dismantling the device in different terrains and weather conditions.
9. Load Testing with Variable Wind and Solar Conditions: Subject the device to variable wind and solar conditions to ensure that it can adapt to changing environmental factors while maintaining its power generation efficiency.
10. Remote Monitoring and Troubleshooting: Test the remote monitoring and troubleshooting capabilities of the device. Ensure that it can detect issues, diagnose problems, and provide notifications or implement corrective actions as needed.
11. Safety Testing with Fault Simulations: Perform safety tests with various fault simulations to ensure the device's safety mechanisms work effectively under different fault scenarios. This is crucial for preventing accidents and malfunctions.
12. Lifecycle Testing: Conduct tests that simulate the entire lifecycle of the device, including manufacturing, transportation, deployment, operation, and maintenance, to identify any potential issues at different stages of its use.

1.5 Concept Generation

Initial Random Ideas, No Specific Tools Used
No techniques used, just random ideas we have.

Biomimicry
Utilizes things in nature to produce solutions.

Anti-Problem
Identify specific problem then solve the opposite of the problem.

"Crap Shoot"
Produce random items under these categories people involved, common activities, and potential resources then randomly select and generate concepts that include those items.

Forced Analogy
Choose random objects/things list some attributes use different combos of those attributes to generate ideas.

Morphological Charts
Break functions into subfunctions generate solutions to these functions.

Medium Fidelity Concepts

1. A pipe system with a mirror that follows the pipe and heats the fluid inside of it. The fluid then flows through a generator. To generate Wind energy the system can then be connected to an oscillating wind generator that is connected to the system.
2. Create fish shaped structures that are slightly flexible and allow wind flow to move them have a field of them which then lessens the friction on subsequent wind turbines. Could connect solar panels to these that move with the structure.
3. Oscillating bladeless wind generator with small horizontal axis windmills going up and down the structure and wrapped in flexible solar panels. As the wind blows to the structure the HAWTs are collecting wind energy, and the oscillating wind generator is as well. The solar panels are also collecting energy from the sun the entire time.
4. Design wind turbine in the fashion of a turtle's neck, allowing the extension and retraction of the wind turbines to maximize wind exposure like a turtle's neck
5. The design's structure can be shaped like a car which directs the flow of wind to turbines in the shape of trash can placed holes of that structure. This shape can then be covered in glass or made of glass to capture solar radiation and heat which can be used to generate more electricity in the solar panels.

While these designs are all good ideas, they don't fall under our final vision due to their own few flaws. For #1 we see our design using solar photovoltaic rather than solar thermal therefore eliminating this idea. For #2 the design does not seem quite feasible due to the mechanics of the structure that would need to be constructed and maintained over time. For #3 while it's a neat design it doesn't seem to be as efficient in collecting wind and solar as our high-fidelity designs. For #4 we don't believe this structure would sustain its integrity. For #5 this design appears to be too heavy and would be difficult to transport.

High Fidelity Concepts

1. Setting up the solar panel array in a parallel orientation to enhance and protect the solar generation and maximize current.
2. Box shaped design has battery in it that is not touching edges with turbine going up through the top.
3. Solar panels on device in the shape of sunflower heads, allowing tracking of the sun's path to maximizes solar energy collection

For these concepts we took the most prevalent concepts that we came up with, as these concepts are the most feasible for the team's design and will allow for the team to accomplish their design within a manageable budget. As for the solar arrays set up, we will have them oriented in parallel for the circuit design as this protects against losses in the system along with generating the most current possible through the design. Along with this we would like for our concept to have some type of sun tracking system where the panels can generate their peak power throughout the day, along with assisting in curbing the effect of weather and climate on the panels. For this solar system we see the design encompassing a box-like shape with the battery in the bottom with space around it to prohibit overheating, along with a turbine that will be above the box vertically generating wind power to the system. This will allow for a solar Panell system to fold out from the box to generate power whilst also maintaining portability.

Concept Generation: 100 Ideas

Initial Random Ideas, No Specific Tools Used

1. You can use a system that concentrates heat onto a closed cylinder which will then drive a piston which connects to a generator and also has a water wheel type shape to capture wind flow.
2. A pipe system with a mirror that follows the pipe and heats the fluid inside of it. The fluid then flows through a generator. To generate wind energy the system can then be connected to an oscillating wind generator that is connected to the system.
3. To generate wind energy an ionic wind generator could be used. This could be placed in a funnel to increase wind flow velocity, on the outside of this funnel flexible solar panels could be placed.
4. Create a pivoting system where wind turbines and solar panels adjust their angles based on prevailing weather conditions.
5. Use lightweight materials and small-scale wind turbines combined with flexible solar cells for a portable, efficient energy solution.
6. Box shaped design has battery in it that is not touching edges with turbine going up through the top.
7. Horizontal-Axis Windmill tower with solar panels on the structure
8. Kite that goes into air with solar panels as wind raises and lowers it wire connected to something on ground that pulls generator
9. Base pulley system with solar panels and a kite to absorb wind energy

10. Base solar panel design with kite attached containing turbines for higher windspeeds at higher altitudes
11. Vertical axis windmill with Solar panels attached to the base
12. Vertical axis windmill with solar panels that fold out above the windmill
13. Vertical Axis Wind turbine (Darrius Turbine) using lift to rotate it, with the solar panels sitting on top the shaft
14. Darrius Turbine with solar Pannels attached to the struts and blades
15. Savonius Turbine using drag to rotate it with flexible solar panels attached to the wind turbine itself
16. Oscillating bladeless wind generator with small horizontal axis windmills going up and down the structure
17. Spiral shaped wind turbines alongside curved solar panels to maximize wind and solar efficiency
18. Wind wall, install vertical wind turbines to the sides of solar panel diamond shaped structure so when wind hits wall it deflects into the wind turbine's location
19. Linear Concentrator system that utilizes mirrors to heat liquid which then turns water to steam and utilizes turbine to generate energy. A wind turbine can then be connected to the system.
20. Dish system that utilizes satellite shaped mirrors to utilize solar energy to transfer to a generator. Then connect a wind turbine to the structure of the mirror system.
21. The power tower system utilizes sun following field of mirrors to heat a receiver on a top of a tower which generates steam and powers a conventional turbine. Can connect a turbine to the top or sides of this tower to utilize wind energy.
22. Construct a sustainable fountain in the fashion of a waterfall to help power the wind turbines and solar panels of the device
23. A grounding system that can be applied to the base protecting the device and storage from any prevalent surges that occur to the system.
24. A balloon could be used to keep a series of solar panels and wind turbines in the air.

Generation Using Biomimicry

25. Solar panels on device in the shape of sunflower heads, allowing tracking of the sun's path to maximizes solar energy collection
26. Solar panels in a hexagonal structure of a honeycomb, allowing maximum surface area for solar energy generation
27. Solar panels spread out from the device's sides in fashion of wings, allowing maximum surface area for solar energy generation.
28. Wind turbine's blades designed as a bird's wings, allowing for efficient low-wind-speed energy generation
29. Imitate the wing patterns of butterflies on the solar panels to maximize sunlight absorption for our device
30. Could use cells that act similarly to chloroplast to generate energy such as producing a chemical that can then be used to charge a battery. Can then utilize wing shaped turbine to generate movement then use that movement to generate energy.

31. Create fish shaped structures that are slightly flexible and allow wind flow to move them have a field of them which then lessens the friction on subsequent wind turbines. Could connect solar panels to these that move with the structure.
32. Design wind turbine blades with a shape inspired by the streamlined fins of whales for greater energy capture.
33. Develop self-cleaning solar panels inspired by the hydrophobic properties of lotus leaves, allowing for greater energy generation in harsher weather environments.
34. Model the wind turbine's structure on the device after the structure of an octopus's tentacles, allowing for flexibility in high winds.
35. Create the design of our solar panels to mimic leaves on rainforest trees, imitating photosynthesis for solar energy production.
36. Implement insulation techniques on our device inspired by the temperature moderation capabilities of polar bear fur, allowing maintenance of the generator's efficiency in extreme weather patterns.
37. Design device with water-repellent surfaces inspired by the desert beetle to enhance solar panel functionality.
38. Design a serpentine shaped structure utilizing organic polymer solar panels as they are flexible along the device's curves to maximize solar energy generation
39. Design wind turbine in the fashion of a turtle's neck, allowing the extension and retraction of the wind turbines to maximize wind exposure like a turtle's neck.
40. Design device's structure in the vein of a spider, in which the turbine will be at the head and tail of the "body" and solar panels extending along its legs to maximize energy generation.
41. Use an elephant-inspired footprint foundation design to distribute the weight of the generator and reduce environmental impact.
42. Create a wind funnel design inspired by bird nests to channel and concentrate wind energy.
43. Imitate the way cacti store water in solar thermal tubes to smooth out energy production during low-wind periods
44. Implement a system inspired by bat echolocation to detect and optimize wind direction.
45. Develop a cooling system inspired by termite mounds to prevent solar panels from overheating.
46. Design the generator structure to mimic the aerodynamic principles of bat flight.
47. Use a beehive-inspired ventilation system to cool and maintain optimal operating temperatures for solar panels.
48. Create a network of wind turbines that mimic the flocking behavior of birds to improve wind capture.

Generation Using Anti-Problem

49. Shape the wind turbine and solar panels to account for changing conditions and structural movement that can account for them too.
50. Shape device to use the wind turbine's location to help repel debris from interrupting the device's functionality, minimizing the need for maintenance

51. Utilize lightweight materials and a structural design that can hold the weight as well as utilizing the shape of the wind turbines to uphold the structure.
52. Have a system that allows for movements of parts on itself to place the device in a better position for solar and wind capture.
53. The device is designed to be compact with extendable solar panels and wind turbines, maximizing transportability without loss of device energy generation efficiency.
54. Optimize the design of the wind turbine, allowing for the generation of significant wind energy even at low wind speeds.
55. Structure the design of the solar panels to optimize the capture and conversion of light energy even on overcast or rainy days.
56. Structure of the design is minimal using nonsolid metal supports to create a light portable design.
57. Creating a structure using solid metal components as supports enhancing the resilience of the design.
58. Using an array of batteries as our storage to enhance the system's storage capabilities, allowing multiple batteries to be charged or used for power at the same time.
59. Setting up the solar panel array in a parallel orientation to enhance and protect the solar generation and maximize current.
60. Setting up the power transmission to the battery from the generators using a singular cable input to the battery.
61. Creating a collapsible design that can collapse into a portable size for easy transportation.
62. Having a separated battery bank allows for easier portability for the design along with easier access to the power generated.
63. Using a drag based vertical axis turbine to inhibit the spinning velocity in high wind environments.
64. Using a water turbine in a river system will generate power from the stream's flow, connected to a battery base with solar panels on shore.
65. A river-based turbine design where the system floats above the water turbine with solar panels attached in which battery storage can be charged and offloaded for usage.
66. Designing a turbine system with drag based components in a wind tunnel that allows for energy to be captured at low wind speed where other systems would not generate any power.
67. Applying film to the solar panels maintains cleanliness and reduces buildup decreasing necessary maintenance on the design.

Generation Using "Crap Shoot"

68. A design that floats on the flow of irrigation water that can be moved by the farmer or wind turbine and sends energy back to a battery within the system's structure.
69. Wind generators and solar generators can connect to the outside of a building and send power to a battery that can be stored within the building to be utilized.
70. Within the structure of the system create a system that can analyze the integrity of the structure and let users know that a problem exists.
71. The farmer can utilize solar energy to power lights and can then utilize those lights to further create energy.

72. The farmer could utilize irrigation and the flow of the water to analyze structural integrity of the system, the wind and solar collectors would then control the flow of that water.
73. An audible buzzer that can be heard at least 100 feet away to allow for the farmer to hear if the system is in emergency mode.
74. Creating a wind turbine system with a bearing treated with black oxide that protects the component from outside degradation leading to less routine maintenance for the system.
75. Installing an advanced monitoring system for the turbine that can accurately predict how soon maintenance will need to occur and will relay this information to the maintenance man.

Generation Using Forced Analogy

76. You can use field of fish shaped structures that direct the flow of wind into a whirlpool shape that increases the speed of flow to turn a turbine at the center of the whirlpool. Mirrors in the shape of elephant ears can then direct sunlight onto the outer shell of the whirlpool which heats liquid in a cavity of the material and directs the gas to a traditional generator.
77. The design's structure can be shaped like a car which directs the flow of wind to turbines in the shape of trash can placed holes of that structure. This shape can then be covered in glass or made of glass to capture solar radiation and heat which can be used to generate more electricity in the solar panels.
78. A trash can shaped structure collects solar radiation and heat that then concentrates these rays into a solar collector. The shape of the trash can utilize car geometry to direct wind flow into turbines.
79. Generate the structure of the device in the fashion of an elephant ear, where our device “dilates” or extends out its parts to keep the structure cool in the face of extreme temperatures.
80. Design our device in the fashion of a school of sardines, in which we coordinate the energy generation of the solar panels and wind turbines akin how the behavior school of sardines
81. Model the design of the device after coral reefs, where the structure of the grouping of “corals” or solar panels allows for great resilience and adaptability to multiple detrimental weather conditions.
82. A closed glass structure can capture solar heat and radiation which is then used to power a chemical process like photosynthesis, generating energy there could also be another clear box with holes in it and a turbine of some shape that utilizes the difference in temperatures to create air flow and cause rotation of the turbine.
83. A structure made of glass shaped like coral will break wind as it flows over it and causes more wind to flow through turbine that can be placed behind it. This same glass coral can direct solar energy to heat pipes filled with water which will create pipe flow and utilize a turbine to generate electricity.
84. Cellulose solar paper can be placed outside of a cylindrical shape which has throughout the structure shaped as whirlpools inside each connected to a tiny turbine generating energy.

85. Design the device in the structure of an umbrella, where the device “opens” up and extends the solar panels out the from its sides as well as have a wind turbine at the “ferrule" or on top of the device to help improve solar and wind energy generation
86. Device structure designed after a helicopter, in which the wind turbines are implemented in the fashion of helicopter blades where the turbine “hovers” in the air to generate wind energy.
87. Imitate the structure of a staircase for our devices' design, where we will be using an ascending design with helical wind turbines and solar panels on top of each ascending “step” to generate solar and wind energy.
88. A strcuture in the shape of an airship or Zepplin, where the solar panels are spread out along its length as well as turbines on the top and bottom to generate a combination of wind and solar energy.
89. Imitate the strcuture of a tree for our device’s design, where solar panels act as the “leaves” of the tree and solar panels are “branching” out from its sides to generate both wind and solar energy for our device.
90. Design the device in the structure of DNA, where we use helix wind turbines to act as the outer strands of the DNA as well as solar panels actin as the backbone of the DNA providing solar and wind energy generation
91. Design the device in the structure of a tornado, in which helical wind turbines surround the solar panels in the “eye” of the tornado, allowing the harnessing of wind and solar energy efficiently.
92. Design our device in the vein of a “wave rider“in which our device’s structure is akin to ocean waves, utilizing solar panels and a horizontal-axis wind turbine to harness solar and wind energy.
93. Design our device imitating the structure of a pyramid powerhouse, in which we will use layered solar panels along the sides of the pyramid and a wind turbine at its pinnacle to provide efficient solar and wind energy generation.

Generation Using Morphological Charts

94. To generate a condensable design, the system could be made of slightly flexible solar cells that can be folded like origami. This design can then, depending on weight, either be transported by a person or a wheel-based system.
95. The design can have parts that are easily separated and lifted by a single person.
96. To protect from solar and wind energy inputs the design can have a system that monitors wind speed and temperature of important system parts, such as sensors.
97. Creating a power output system that allows for DC or AC power to be drawn from the battery simultaneously if needed.
98. Creating a design where supports are driven into the ground to create extra structural support for the system.
99. Designing a system where movement is done through a caterpillar track thus prohibiting wind from creating unwanted movement and allowing the design to have a motorized system to help portability.
100. Creating a system where a kite is used to analyze wind direction and correctly orient the turbine to capture the energy at maximum efficiency.

1.6 Concept Selection

Binary Pairwise Comparison	1	2	3	4	5	6	7	8	Total
1. Needs to withstand environmental forces	-	0	1	1	1	0	0	0	3
2. Must generate solar/wind energy	1	-	1	1	1	1	1	1	7
3. The device needs to be ground based	0	0	-	0	1	0	0	0	1
4. Minimum 5 year durability	0	0	1	-	1	0	0	0	2
5. Design doesn't need to be scalable	0	0	0	0	-	0	0	0	0
6. Transportable by single person	1	0	1	1	1	-	1	0	5
7. Needs to be a single structure	1	0	1	1	1	0	-	0	4
8. Must be able to charge a battery simultaneously	1	0	1	1	1	1	1		6
									0
									0
Total	4	0	6	5	7	2	3	1	n-1 =7
Check	7	7	7	7	7	7	7	7	

Figure 1: Binary Pairwise Comparison

House Of Quality											
	Engineering Characteristics										
	Improvement Direction										
	Units	Wh	Wh	Wh	deg	m/s	Mpa/m^2	m	N/m	W/m^2	
Customer Needs	Priority	Energy stored	Energy Generated by Wind Turbine	generated by the solar	Solar position tracking	Wind speed	Structurally Sound	Altitude of wind turbine	Total force required to move	Solar Protection	
1. Needs to withstand environmental forces	3	0	1	1	0	9	9	3	0	9	
2. Must generate solar/wind energy	7	3	9	9	3	3	1	3	0	1	
3. The device needs to be ground based	1	0	0	0	0	0	3	0	3	0	
4. Minimum 5 year durability	2	1	1	1	1	3	9	0	3	3	
5. Design doesn't need to be scalable	0										
6. Transportable by single person	5	0	0	0	0	1	9	3	9	0	
7. Needs to be a single structure	4	0	0	0	0	0	1	3	3	0	
8. Must be able to charge a battery simultaneously	6	9	3	3	1	1	0	1	0	0	
Raw Score		77	86	86	29	65	104	63	66	40	Average
Relative Weight Percent		12.50%	13.96%	13.96%	4.71%	10.55%	16.88%	10.23%	10.71%	6.49%	11.11%
Rank Order		4	3	2	9	6	1	7	5	8	

Figure 2: House of Quality

			Concepts							
Selection Criteria	**Criteria Weight**	**Portable Solar/Wind 30' Light Tower**	Heat cyllinders	Fish Turbines	Solar Cyllinders	Turtle Neck	Car Spinner	Parrallel Solarness	Box Man	Sunflower
Structurally Sound	16.88%	Datum	+	+	+	-	+	-	+	S
Energy Generated By Solar	13.96%		-	-	-	+	S	+	S	+
Energy Generated By Wind	13.96%		-	-	+	-	-	S	S	-
Energy Storage	12.50%		S	S	S	S	S	S	S	S
Force Required to Move	10.71%		S	+	+	+	S	+	+	+
Wind Speed	10.55%		+	S	S	-	+	S	S	S
# of pluses			2	2	3	2	2	2	2	2
# of minuses			2	2	1	3	1	1	0	1

			Concepts			
Selection Criteria	**Criteria Weight**	**Turtle Neck**	Heat cyllinders	Fish Turbines	Solar Cyllinders	Sunflower
Structurally Sound	16.88%	Datum	+	S	+	S
Energy Generated By Solar	13.96%		-	S	S	+
Energy Generated By Wind	13.96%		-	-	+	-
Energy Storage	12.50%		+	+	+	S
Force Required to Move	10.71%		-	+	S	S
Wind Speed	10.55%		+	S	S	-
# of pluses			3	2	3	1
# of minuses			3	1	0	2

Figure 3: Pugh Chart

Figure 4: AHP Rating Matrix

Figure 5: Criteria Comparison and Normalized Criteria Matrix

Col>row

Criteria Comparison Matrix [C]						
Selection Criteria	#1	#2	#3	#4	#5	#6
1. Structurally Sound	1.00	1.00	1.00	3.00	3.00	3.00
2. Energy Generated By Solar	1.00	1.00	1.00	3.00	5.00	3.00
3. Energy Generated By Wind	1.00	1.00	1.00	3.00	5.00	1.00
4. Energy Storage	0.33	0.33	0.33	1.00	0.33	0.33
5. Force Required to Move	0.33	0.20	0.20	3.00	1.00	3.00
6. Wind Speed	0.33	0.33	1.00	3.00	0.33	1.00
SUM	4.00	3.87	4.53	16.00	14.67	11.33

Consistency Check		
{Ws} = [C]{W}	{W}	Cons = {Ws}./{W}
Weighted Sum Vector	Criteria Weights	Consistency Vector
1.582	0.231	6.848
1.815	0.254	7.154
1.586	0.224	7.069
0.373	0.060	6.258
0.812	0.117	6.967
0.718	0.115	6.259
	Random Index Values (RI)	
	LAMBDA	6.759
	RI	1.250
	CI	0.152
	CR	0.121

Normalized Criteria Comparison Matrix [NormC]							
Selection Criteria	#1	#2	#3	#4	#5	#6	Criteria Weights {W}
1. Structurally Sound	0.250	0.259	0.221	0.188	0.205	0.265	0.231
2. Energy Generated By Solar	0.250	0.259	0.221	0.188	0.341	0.265	0.254
3. Energy Generated By Wind	0.250	0.259	0.221	0.188	0.341	0.088	0.224
4. Energy Storage	0.083	0.086	0.074	0.063	0.023	0.029	0.060
5. Force Required to Move	0.083	0.052	0.044	0.188	0.068	0.265	0.117
6. Wind Speed	0.083	0.086	0.221	0.188	0.023	0.088	0.115
SUM	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Figure 6: Wind Speed Consistency Check

Wind Speed [C]			
Selection Criteria	#1	#2	#3
1. Fish Turbines	1.00	1.00	1.00
2. Solar Cylinders	1.00	1.00	0.20
3. Sunflower	1.00	5.00	1.00
SUM	3.00	7.00	2.20

Wind Speed [NormC]				
Selection Criteria	#1	#2	#3	Design Alternative Priorities {Pi}
1. Fish Turbines	0.333	0.143	0.455	0.310
2. Solar Cylinders	0.333	0.143	0.091	0.189
3. Sunflower	0.333	0.714	0.455	0.501
SUM	1.000	1.000	1.000	1.000

Consistency Check		
{Ws} = [C]{Pi}	{Pi}	Cons = {Ws}./{Pi}
Weighted Sum Vector	Criteria Weights	Consistency Vector
1.000	0.310	3.223
0.599	0.189	3.171
1.756	0.501	3.507
	Random Index Values (RI)	
	LAMBDA	3.300
	RI	0.520
	CI	0.507
	CR	0.976

Figure 7: Force Required Consistency Check

Force Required to Move [C]			
Selection Criteria	#1	#2	#3
1. Fish Turbines	1.00	3.00	5.00
2. Solar Cylinders	0.33	1.00	5.00
3. Sunflower	0.20	0.20	1.00
SUM	1.53	4.20	11.00

Force Required to Move [NormC]				
Selection Criteria	#1	#2	#3	Design Alternative Priorities {Pi}
1. Fish Turbines	0.652	0.714	0.455	0.607
2. Solar Cylinders	0.217	0.238	0.455	0.303
3. Sunflower	0.130	0.048	0.091	0.090
SUM	1.000	1.000	1.000	1.000

Consistency Check		
{Ws} = [C]{Pi}	{Pi}	Cons = {Ws}./{Pi}
Weighted Sum Vector	Criteria Weights	Consistency Vector
1.965	0.607	3.238
0.954	0.303	3.145
0.272	0.090	3.031
	Random Index Values (RI)	
	LAMBDA	3.138
	RI	0.520
	CI	0.478
	CR	0.919

Figure 8: Wind Generated Energy Consistency Check

Energy Storage [C]			
Selection Criteria	#1	#2	#3
1. Fish Turbines	1.00	1.00	1.00
2. Solar Cylinders	1.00	1.00	1.00
3. Sunflower	1.00	1.00	1.00
SUM	3.00	3.00	3.00

Energy Storage [NormC]				
Selection Criteria	#1	#2	#3	Design Alternative Priorities {Pi}
1. Fish Turbines	0.333	0.333	0.333	0.333
2. Solar Cylinders	0.333	0.333	0.333	0.333
3. Sunflower	0.333	0.333	0.333	0.333
SUM	1.000	1.000	1.000	1.000

Consistency Check		
{Ws} = [C]{Pi}	{Pi}	Cons = {Ws}./{Pi}
Weighted Sum Vector	Criteria Weights	Consistency Vector
1.000	0.333	3.000
1.000	0.333	3.000
1.000	0.333	3.000

Random Index Values (RI)	
LAMBDA	3.000
RI	0.520
CI	0.453
CR	0.870

Figure 9: Energy Storage Consistency Check

Energy Generated by Wind [C]			
Selection Criteria	#1	#2	#3
1. Fish Turbines	1.00	0.33	0.33
2. Solar Cylinders	3.00	1.00	0.20
3. Sunflower	3.00	5.00	1.00
SUM	7.00	6.33	1.53

Energy Generated by Wind [NormC]				
Selection Criteria	#1	#2	#3	Design Alternative Priorities {Pi}
1. Fish Turbines	0.143	0.053	0.217	0.138
2. Solar Cylinders	0.429	0.158	0.130	0.239
3. Sunflower	0.429	0.789	0.652	0.623
SUM	1.000	1.000	1.000	1.000

Consistency Check		
{Ws} = [C]{Pi}	{Pi}	Cons = {Ws}./{Pi}
Weighted Sum Vector	Criteria Weights	Consistency Vector
0.425	0.138	3.089
0.777	0.239	3.250
2.231	0.623	3.579

Random Index Values (RI)	
LAMBDA	3.306
RI	0.520
CI	0.508
CR	0.978

Figure 10: Solar Generated Energy Consistency Check

Energy Generated by Solar [C]			
Selection Criteria	#1	#2	#3
1. Fish Turbines	1.00	0.33	0.20
2. Solar Cylinders	3.00	1.00	0.33
3. Sunflower	5.00	3.00	1.00
SUM	9.00	4.33	1.53

Energy Generated by Solar [NormC]				
Selection Criteria	#1	#2	#3	Design Alternative Priorities {Pi}
1. Fish Turbines	0.111	0.077	0.130	0.106
2. Solar Cylinders	0.333	0.231	0.217	0.260
3. Sunflower	0.556	0.692	0.652	0.633
SUM	1.000	1.000	1.000	1.000

Consistency Check		
{Ws} = [C]{Pi}	{Pi}	Cons = {Ws}./{Pi}
Weighted Sum Vector	Criteria Weights	Consistency Vector
0.320	0.106	3.011
0.790	0.260	3.033
1.946	0.633	3.072

Random Index Values (RI)	
LAMBDA	3.039
RI	0.520
CI	0.460
CR	0.884

Figure 11: Structurally Sound Consistency Check

Structurally Sound [C]			
Selection Criteria	#1	#2	#3
1. Fish Turbines	1.00	0.33	3.00
2. Solar Cylinders	3.00	1.00	3.00
3. Sunflower	0.33	0.33	1.00
SUM	4.33	1.67	7.00

Structurally Sound [NormC]				
Selection Criteria	#1	#2	#3	Design Alternative Priorities {Pi}
1. Fish Turbines	0.231	0.200	0.429	0.286
2. Solar Cylinders	0.692	0.600	0.429	0.574
3. Sunflower	0.077	0.200	0.143	0.140
SUM	1.000	1.000	1.000	1.000

Consistency Check		
{Ws} = [C]{Pi}	{Pi}	Cons = {Ws}./{Pi}
Weighted Sum Vector	Criteria Weights	Consistency Vector
0.897	0.286	3.133
1.853	0.574	3.230
0.427	0.140	3.049

Random Index Values (RI)	
LAMBDA	3.137
RI	0.520
CI	0.478
CR	0.918

Figure 12: Final Rating Matrix

Final Rating Matrix			
Selection Criteria	Fish Turbines	Solar Cylinders	Sunflower
Structurally Sound	0.286	0.574	0.140
Energy Generated By Solar	0.106	0.260	0.633
Energy Generated By Wind	0.138	0.239	0.623
Energy Storage	0.333	0.333	0.333
Force Required to Move	0.607	0.303	0.090
Wind Speed	0.310	0.189	0.501

Concept	Alternative Value
1. Fish Turbines	0.250
2. Solar Cylinders	0.329
3. Sunflower	0.421

TRANSPOSED						
1. Fish Turbines	0.286446886	0.106156324	0.137626675	0.333333	0.607002	0.310245
2. Solar Cylinders	0.573626374	0.260497956	0.238966983	0.333333	0.303344	0.189033
3. Sunflower	0.13992674	0.63334572	0.623406342	0.333333	0.089654	0.500722

The final chosen concept designed from the concept selection matrices was the sunflower design concept.

1.8 Spring Project Plan

For our spring project plan we first need to finalize a design. We were originally going to go with a dual linear actuator design so that the solar panel can move through two axis. We found some flaws with this and are leaning on using a slew drive to drive the horizontal motion and a linear actuator to drive the vertical motion of the solar panel. Once the design is fully finalized, the metal parts need to be submitted to the machine shop so the solar panel frame will be fully finished. Over the coming weeks, the chassis of the actual device will also need to be constructed. This chassis is where all the cabling is going to go. One thing we will need to do is waterproof the chassis for the cables do not get short circuited since the device will be outside, exposed to the elements. Once the chassis and the solar panel mount are complete, we just need to integrate the circuitry from the battery as well as the photo electric sensor to work with the solar panel. Having all this integrated is essential for proper operation of the device. Once the solar panel and all the cabling for the solar panel are complete, the structure can be fully closed, and we can mount the turbine. Once the turbine is mounted, the cables just must be wired to allow for the wind turbine to work properly.

Chapter Two: EML 4552C

2.1 Spring Plan

For our spring project plan, our first step is to finalize the design. Originally, we considered a dual linear actuator setup for the solar panel's two-axis movement. However, after identifying some drawbacks, we are now inclined towards utilizing a slew drive for horizontal motion and a linear actuator for vertical motion. Once the design is solidified, the metal components will be sent to the machine shop to complete the solar panel frame. Concurrently, construction of the device's chassis will commence, serving as the housing for all cables.

Waterproofing the chassis is imperative to prevent short circuits, given the device's outdoor exposure. Following the completion of the chassis and solar panel mount, integration of circuitry from the battery and photoelectric sensor is paramount for optimal functionality. Upon finalizing the solar panel and associated cabling, the structure can be sealed, and the turbine mounted. Proper wiring of the cables is essential for the wind turbine to operate effectively once mounted.

Project Plan.

For our spring project plan, our first step is to finish designing everything. Originally, we thought about using two linear actuators to move the solar panel in two directions. But, we found some problems with that idea. Now, we're thinking of using a slew drive for moving horizontally and a linear actuator for moving vertically. Once we have the design set, we'll send the metal parts to the machine shop to finish making the frame for the solar panel. At the same time, we'll start building the chassis for the device, which will hold all the cables. It's really important to make sure the chassis is waterproof so the cables don't get damaged from the weather. After we finish the chassis and mount the solar panel, we'll need to connect the battery and photoelectric sensor to make sure everything works right. Once the solar panel and cables are all set, we can seal up the structure and attach the turbine. Making sure the cables are wired properly is key for the wind turbine to work well after it's installed.

Build Plan.

So our plan to build this device is to first get all the materials. All the parts that need to be machines have been sent to the machine shop to be completed. One that is done, mounting the solar panel will be relatively easy with the team's help. Building the cassis is the main challenging part since it must be waterproof to keep all the cabling secured, not short circuit. We will build the chassis out of pressure treated lumber and make it with a slope to allow any water that falls on the device to slide off. Once the full chassis is complete, the necessary holes for the cables will need to be made. The final touch on the device is to calk all the edges to maximize the amount of waterproofing the device has.

Appendices

Appendix A: Code of Conduct

A.1. Mission Statement

"Team 303" is on a mission to change the face of renewable power generation in the field of sustainable energy. Our goal is to build a revolutionary hybrid energy generator that effortlessly harnesses the boundless potential of wind and solar energy. With a minimum power output of 100W, this innovative gadget is designed to not only meet but also exceed the demands of today's environmentally conscious society, establishing a new benchmark for clean energy accessibility. We understand that creativity has no boundaries at Team 303. While we diligently abide by the above limitations, we warmly welcome the chance for future improvements and modifications. We are committed to pushing the limits of clean energy technology, and we encourage discussion and collaboration to make sure that our product is continuously improved to help create a more environmentally friendly and sustainable future. Come along as we rethink the production of renewable energy and usher in a new era of clean electricity. Team 303 is committed to promoting a sustainable future for everybody while advancing innovation and change. Our constant dedication to user safety, product dependability, and unmatched portability distinguishes us from the competition. The device is expertly made and incorporates cutting-edge fail-safe mechanisms to guard against potential damage brought on by large loads. Due to its practical design, just one person needs to transport it up.

A.2. Outside Obligations

In Team 303, we emphasize the outside obligations of our members to ensure the successful completion of our projects. Each member understands the importance of meeting deadlines and fulfilling their individual responsibilities, as this not only reflects their commitment to the group but also impacts on the overall quality of our work. Beyond the regular group meetings, our members are expected to manage their time effectively, engage in continuous research and skill development, and maintain open lines of communication with both the team and our clients. These outside obligations foster a culture of accountability and professionalism within our design group, enabling us to consistently deliver exceptional results and meet the expectations of our clients and stakeholders. It is expected that when a team member has extenuating circumstances, the other team members make up for that and vice versa. . Those believed to not be fulfilling outside obligations will be docked in points through a group vote.

A.3. Communication

At Team 303, we believe that effective communication is the key to our project success. We understand that smooth teamwork relies on clear and open conversations. Our team regularly comes together, whether in person or through virtual meetings, to share ideas, discuss progress, and tackle any challenges that come our way. We also make use of digital collaboration tools like Microsoft Teams to easily share files, designs, and feedback in real-time, ensuring that we all stay on the same page. Plus, we keep an open group chat where any team member can ask questions or discuss project-related matters. This transparent and inclusive approach not only boosts our creativity but also simplifies our decision-making process. We value active listening, constructive feedback, and respecting everyone's viewpoints, making sure we are well-prepared to handle complex projects and deliver innovative solutions that exceed our clients' expectations.

A.4. Team Roles:

Team Lead: Billy Touza

Technical Lead: Andrew Putnam

CAD Designer: Tristan Witkowski and Alberto San Segundo

Treasurer: Brandon Ortiz

Documentation Specialist: Carlos Vilarino

A.5. Dress Code:

For team meetings no dress code will be enforcement, sponsor or advisor meeting will be business casual, presentations and abet meeting business formal.

A.6. Attendance Policy:

Late arrivals to meetings more than fifteen minutes past scheduled time will be noted, a discussion and vote will occur if needed to doc a letter grade from a frequently late team member. Late arrival to formal presentation will be immediately docked a letter grade. If someone is going to be late or absent a meeting, the person must communicate that with the rest of the team with at least 24 hours notice.

A.7. How to Notify Group:

Microsoft teams can be used along with text to relay valuable information to the group.

A.8. How to Respond to People in Professional Meeting:

Respectful and formal language will be expected from all team members when communicating and during meetings. Open dialogue and respect for others ideas will also be expected. Keeping an open mind and a friendly manner when responding to critiques will also be essential to maintaining professionalism.

A.9. Statement of Understanding:

I, Andrew Putnam, Consign by all above

I, Alberto San Segundo, agree to the requirements as set in this Code of Conduct.

I, William Touza, Agree to all the states terms.

I, Brandon Ortiz, understand the requirements of this project and agree to this Code of Conduct.

I, Tristan Witkowski, understand and agree to the requirements as set in this Code of Conduct.

I Carlos Vilarino understand and agree to the requirements as set in this Code of Conduct.

A.10. What do we do Before Going to an Advisor/Professor.

In instances of issues involving team members the team will schedule dedicated meetings to collectively address and discuss any challenges or issues that may be occurring. As well as discuss future ideas that we are thinking about implementing.

A.11. At What Point do we Contact an Advisor/Professor.

When a significant portion of the team believes that persistent challenges cannot be effectively addressed internally or when there is a tie in votes, the team will seek guidance from an Advisor/Professor to facilitate resolution.

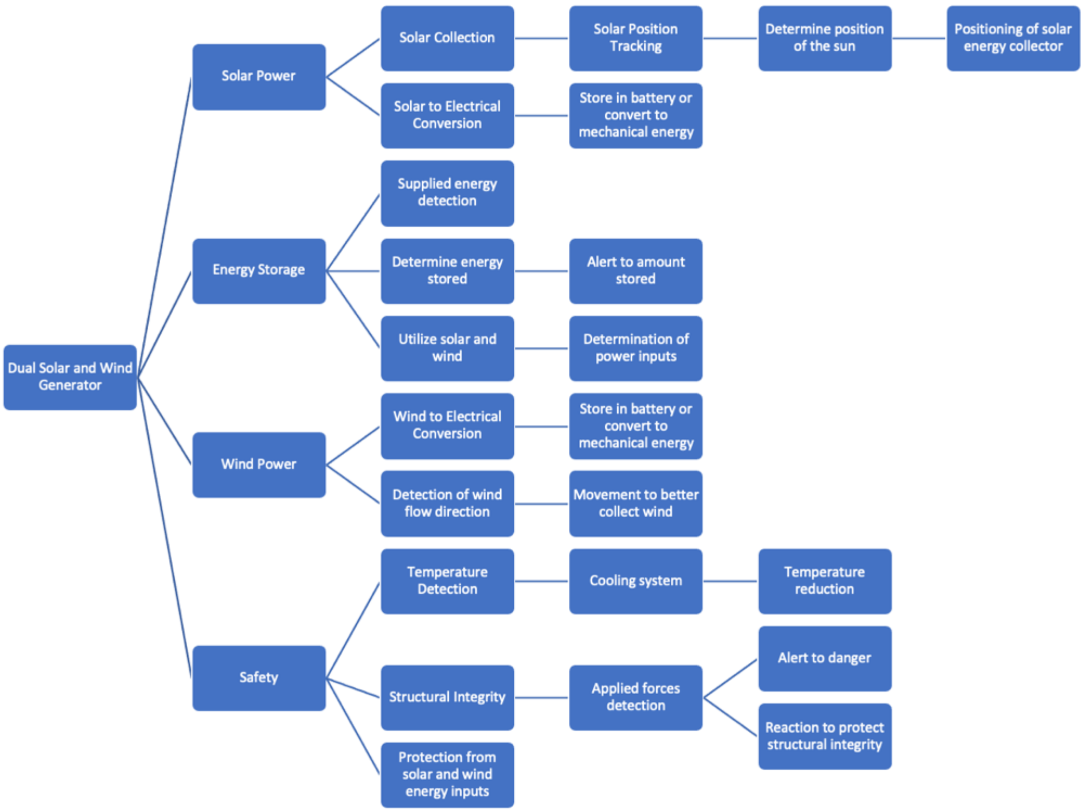
A.12. What do you want the Advisor/Professor to do When you Come.

Our team wants the Advisor/Professor to mediate or make suggestions during a team conversation as well as be a tie breaker when there are tie's during group voting.

A.13. How to Amend.

The code of conduct can be amended with a meeting between all team members, where changes will be discussed, and all team members agree with the proposed amendment.

Appendix B: Functional Decomposition



Appendix C: Target Catalog

Function	Target	Metric
Moveable Design	A single person being able to move the device 50 meters with relative ease	Meters (m)
Determine and Relay Energy Stored	Design Relays current energy storage within 5% of physical amount stored	Watts (w)
Utilize Collected Solar and Wind	Maximum power loss of 20%	Watts (w)
Structurally Sound Materials	Factor of Safety of at least 2	Stress's (σ σ and τ τ)
Weatherproof	Materials must be corrosion resistant for a minimum of 5 years	Years (y)
Solar Collection	Angle of solar collector is within 5 degrees of most efficient angle	Degrees (θ θ)

Wind Flow Collection	Angle of wind collector within 5 degrees normal to wind flow	Degrees (θ)
Movement to better Collect Wind	Begins within 1 minute of flow direction change	Minuets (min)
Wind and Solar to Electrical Conversion	Maximum power loss of 10%, produces 100 Wh	Watts (w)
Store Energy in Battery or Convert to Mechanical Energy	Store a minimum of 1.5 KWh of electricity	Killa-Watt Hours (KWh)
Temperature Detection	Within 5% of actual structure temperature	Celcius (C)
Maintains Stability	Factor of Safety of 2 or greater for forces applied to the structure	Stress's (σ and τ)
Alert to Danger	When in emergency mode an alarm sound is made that is audible from 100 feet away	Feet (ft)
Reaction to Protect Structural Integrity	Reacts within 10 s of recognized issue	Seconds (s)

Carries System Weight	Factor of Safety of 1.5 for applied weight stressors	
Protection from Solar and Wind inputs	Able to withstand a constant solar irradiance of 1360 W/m^2 for 12 hours per day for 5 years, able to withstand wind speeds of 45 mph	Sollar Irradiance (W/m^2) Wind Speed (Mph)

Appendix A: APA Headings (delete)

Heading 1 is Centered, Boldface, Uppercase and Lowercase Heading

Heading 2 is Flush Left, Boldface, Uppercase and Lowercase Heading

Heading 3 is indented, boldface lowercase paragraph heading ending with a period.

Heading 4 is indented, boldface, italicized, lowercase paragraph heading ending with a period.

Heading 5 is indented, italicized, lowercase paragraph heading ending with a period.

See publication manual of the American Psychological Association page 62

Appendix B Figures and Tables (delete)

The text above the cation always introduces the reference material such as a figure or table. You should never show reference material then present the discussion. You can split the discussion around the reference material, but you should always introduce the reference material in your text first then show the information. If you look at the Figure 13 below the caption has a period after the figure number and is left justified whereas the figure itself is centered.

Figure 13. Flush left, normal font settings, sentence case, and ends with a period.

In addition, table captions are placed above the table and have a return after the table number. The second line of the caption provided the description. Note, there is a difference between a return and enter. A return is accomplished with the shortcut key shift + enter. Last, unlike the caption for a figure, a table caption does not end with a period, nor is there a period after the table number.

Table 1

The Word Table and the Table Number are Normal Font and Flush Left. The Caption is Flush Left, Italicized, Uppercase and Lowercase

Level of heading	Format
1	**Centered, Boldface, Uppercase and Lowercase Heading**
2	**Flush Left, Boldface, Uppercase and Lowercase**
3	***Indented, boldface lowercase paragraph heading ending with a period***
4	***Indented, boldface, italicized, lowercase paragraph heading ending with a period.***
5	*Indented, italicized, lowercase paragraph heading ending with a period.*

References

There are no sources in the current document.