CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Zachary W. Been

Project Number
J0201

Project Title
Importance of Processing Lawn Clippings to Release Sugars to Produce Ethanol to Reduce the Use of Fossil Fuels

Abstract

Objectives/Goals
The objective of this project was to investigate if processed grass clippings could more efficiently generate biofuel, specifically ethanol.

Methods/Materials
I processed the grass clippings in three different ways to help break down the cellulose to sugar and then put yeast with the clippings to turn the sugar to ethanol. The processes that I used were microwaving, boiling, and blending the grass clippings. The grass clippings were then placed in water bottles with water and yeast. The goal was to create ethanol and carbon dioxide. The carbon dioxide was measured with a balloon that captured it. The balloon circumference was measured to determine the amount of carbon dioxide produced. This should relate directly to the ethanol produced, as carbon dioxide is a by-product of ethanol production.

Results
The control group of grass clippings showed the most consistent carbon dioxide yield. I did find that one hundred percent of the trials yielded some carbon dioxide and over seventy five percent of the trials yielded enough carbon dioxide to make the balloon stand upright on the bottle.

Conclusions/Discussion
Based on my results, I believe that I should continue to research the best method to produce ethanol with grass clippings. I found that grass clipping could produce ethanol efficiently without being processed. In future research, I would fine-tune my experiment procedures; room temperature, water temperature, length of trial, amounts of grass. I believe that this topic should continue to be researched because if we can create fuels using grass clippings, we can lessen our dependence on fossil fuels, and we won't have to use valuable food crops and prime agricultural lands to create biofuels, when we have an endless supply of grass clippings from our existing lawns.

Summary Statement
I found that processing lawn clippings did not increase the efficiency of producing ethanol.

Help Received
My parents helped me complete the computer research and conduct my experiment. Mrs. Robinson, my fifth grade teacher, was my project advisor. Mr. Whitmore, a science teacher at Norris Middle School, was my Designated Support Provider and reviewed my project for safety.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Sathvik Chanderputla; Satwik Panigrahi; Gopalasetty Rishi

Project Number

J0202

Project Title

Piezo Pedo Power Generator

Abstract

Objectives/Goals

Piezometric materials can convert mechanical energy to electrical energy. Every human being walks about 10,000 steps a day and all the force generated by the footsteps is going waste, we would like to harness that energy by using Piezoelectric transducers.

Therefore, we designed a foot mat using Piezoelectric transducers. Our foot mat is ideal to be used in remote places where electricity is not available or in situations like natural disasters to produce enough electricity to light a bulb or charge a phone.

Methods/Materials

Materials

Breadboard, Jumper Wires , Soldering Iron ,Hot Glue gun ,Piezoelectric Tiles (x16),Copper Wires, wood board, Diodes, LED Bulb, Erasers, Switch, Voltmeter, Battery holder, battery.

Methods:

For the foot mat, we used two wood boards. We connected 16 Piezo transducers in parallel circuit by using a breadboard. We went for parallel circuit to get more current and built a bridge rectifier to convert AC to DC. Then we soldered the circuit on one wood board.

Once the 1st board got ready with the necessary circuit, we placed the 2nd board on top of it. Then we asked six individuals of different weights to walk on the mat one after another. Their pressure on the Piezo tiles generated electricity that we captured using a voltmeter. To harness the maximum force generated by walking, we put erasers as cushion between transducers boards. When enough voltage was produced, the LED light we had connected to the circuit did light up.

Results

We picked six people with different weights and asked them to step on the model. Each of them had to walk on the mat so that he/she could create pressure on the piezo titles with their steps. The pressure from the foot steps generated electricity that we measured using a voltmeter. We gathered the data in 2 different trials for each individual.

Below is the snippet of data we collected:

Weights(Lbs)	Trial1 (Volt)	Trial2(Volt)	Average(Volt)
55	26.2	35	30.6
72	63	94	78.5
90	80	108	94

Summary Statement

Our Piezo foot mat generates clean renewable energy that can be used to change batteries or light LED bulb.

Help Received

Our parents helped us with soldering the circuit design.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Chloe Cheng

Project Number
J0203

Project Title
Solar Power: A Quest for the Future

Abstract

Objectives/Goals
For my experiment, my objective is to find out what types of outdoor conditions are best for collecting solar power. These conditions can be anything that affects the amount of solar power collected, ranging from humidity to wind. Based on my knowledge of my topic before doing my experiment, my hypothesis was that if I collect solar power and run it through a resistor, then the test with the least wind, low humidity, high temperature, and sunny factor will collect the most solar power and electricity.

Methods/Materials
To do this project, I used certain materials to form both my interior, which is my solar power collector, and my exterior, which is used to put everything together. The materials needed for my interior include Arduino Uno Board, Solar Panel, Python(programming), Temperature and Humidity sensor DHT11, DELL Computer, Cables, Breadboard. In addition to the things needed to make the interior of the solar power collector, I will also need other materials to form the exterior of my solar power collector, which include: A thin, wooden board(to make the solar panel easier to carry), Super glue(to secure the solar power collector onto the board), Duct Tape(to secure the project and ensure that the Android and breadboard will not be damaged)
After forming my solar power collector using the materials below, I now need to start the experiment. The steps that I will take to do this include placing the solar power collector out in the sun. Directly after this, I will record the variables in my experiment, which is the sun factor, humidity, precipitation, temperature, and wind.

Results
As a result of my experiment, I now know that the main factor in collecting solar power is to collect it during the sun's peak point, which is at 12:00 PM. Other variables such as wind and humidity do not directly affect the amount of solar power collected.

Conclusions/Discussion
After doing repeated collections of solar power, I can now say that sun factor is the main factor in collecting solar power. This can aid many solar panel users by letting them know what variables, in this case, time of day, is best for collecting solar power. However, the temperature will also slightly influence the amount of solar power collected because the temperature often affects the sun factor. For example, if it is cold, it may be less likely that it will be sunny.

Summary Statement
As a result of my experiment, which includes using a handmade solar power collector to determine which outdoor conditions are best for collecting solar power, I now know that sun factor is the only main factor for collecting solar power.

Help Received
My father aided me in setting up my solar power collector.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Jushen Dhillon

Project Number
J0204

Project Title
The New Fuel: Microalgae

Abstract

Objectives/Goals
Which of the following microalgae produces the best quality and highest quantity biofuel: Nannochloropsis, Scenedesmus, Chlorella or Spirulina?

Methods/Materials
#Obtain equal mass of microalgae culture and grow for 12 weeks to collect sufficient biomass
#Filter microalgae through coffee filter paper and let them dry for 3 days
#Extract cell wall lipids from dried algae via mechanical press
#Convert algae oil into biodiesel through transesterification by preparing methoxide solution by combining 36 ml of methanol and add 1.6 grams of sodium hydroxide
#Heat algae oil to 130 degrees and slowly add 20% by volume of methoxide solution into the algae oil and mix for 5 minutes
#Let solution sit for 24 hours to separate biodiesel from glycerin fats
#Pipette out the top layer of biodiesel and water wash biofuel by adding distilled water to the biofuel and gently flip the test tube slowly for 1 minute
#After 30 minutes remove water from biofuel and repeat process several times till the distilled water is clear and free of visible impurities
#Add equivalent volume of pHLip solution to equivalent volume of biodiesel in a test tube or vial
#Flip vial 10 times gently, then let the two solutions separate and sit for 10 minutes
#Determine the quality of biofuel by evaluating color change of pHlip solution, the interphase between biodiesel and pHlip solution for glycerin precipitates, and turbidity of the biofuel to evaluate for contaminants.

Results
Of the four microalgae species tested, Chlorella produced the highest quantity and best quality biofuel.

Conclusions/Discussion
My hypothesis that Chlorella produces the highest quantity and best quality biofuel, due to its lipid content in the cell wall, was correct. When mass-producing biofuel from algae, Chlorella would be the most economically and environmentally efficient source of biofuel of the four micro-algae I tested. Microalge in general produces more biofuel per acre of land compared to the plant crops. By producing the highest yield and quality of fuel, Chlorella would minimize dependence on fossil fuels, produce 78% less carbon dioxide emissions than fossil fuels and minimize environmental damage through reduced risk for oil spills, water and soil contamination from fracking, and would be carbon neutral.

Summary Statement
Four species of microalgae were tested to determine which would produce the highest quality and quantity of biofuel

Help Received
No help was received while completing this project. I completed the experiment under the supervision of my father.

Name(s)
Shauna N. Gamble

Project Number
J0205

Project Title
Determining Optimal Reflective Border Configuration for Maximizing Solar Energy Production on Shasta Dam

Abstract

Objectives/Goals
The objective of this study is to determine the optimal amount of white reflective border surrounding a photovoltaic solar cell for producing the most amount of electricity on a model Shasta Dam.

Methods/Materials
Using 9 volt rechargeable batteries, alligator clips, Sunnytech photovoltaic solar panels, 4 Shasta Dam sections from foam core boards, protractor, iPhone Compass App,and a digital multimeter, I measured voltage output every 10 minutes for 6 hours on 4 dams with varying widths of white painted borders surrounding solar cell panels.

Results
The voltage output was compared after solar generation periods using the 0cm, 3cm, 6cm, and 9cm white reflective borders surrounding the solar panel sections. The 3cm border proved most effective, producing 26.875% more voltage than the second highest 0cm side-by-side panel dam.

Conclusions/Discussion
Repeated trials demonstrate that the optimal white reflective border configuration surrounding the 8cm square photovoltaic solar cell panels is 3cm to maximize energy production in terms of voltage output. The 3cm border produced approximately 27% more voltage than the Control Dam with side-by-side panels. Based on the real Shasta Dam's dimensions and theorizing its usable space for actual size solar panels, this would provide 1,300 more kW per hour over the 0cm border configuration, therefore concluding that the converted 29 inch space around solar panels on Shasta Dam would maximize energy production.

Summary Statement
I found that a white reflective border around solar panels produces more voltage than side-by-side solar panels with an optimal ratio of border width to square solar panel width of 3 to 8.

Help Received
I designed, built, and performed the experiments by myself. However, I got help with ratio conversions from my dad.

Name(s)
Anakha Ganesh

Project Number
J0206

Project Title
Comparison of Alternative Sources for Efficient Biofuel Production: Effect of Type of Biofuel Source on Energy Density

Abstract

Objectives/Goals
Within two generations, 90% of the world's oil reserves are expected to be depleted. A renewable source of energy is needed for the world to sustain itself. Biofuels, an environmentally friendly alternative, are carbon neutral fuels derived from organic matter. The objective of this experiment was to determine which source oil generated the highest quality biodiesel out of microalgae, macro algae (kelp), and a plant-based biodiesel source (soybeans). It was hypothesized that micro algae oil would yield the highest energy density due to its high lipid content, followed by kelp oil, then soybean oil.

Methods/Materials
The significant materials used in the experiment were soybean oil, kelp oil, micro algae oil, dandelion oil, sodium hydroxide, methanol, and a ring stand to test energy density. Oil was transesterified to convert oil to biodiesel, reacting with methanol and the catalyst sodium hydroxide. To test fuel quality, biodiesel was used to heat water over a constant period of time. Temperature increase was measured using a thermometer.

Results
On average, the microalgae biodiesel raised the temperature by 29.83 ºC. Soybean biodiesel raised the temperature by 24.83 ºC. Kelp biodiesel raised the temperature by 22.5 ºC. Through repeated trials, it was determined that micro algae biodiesel had the highest energy density, followed by soybean biodiesel, then kelp biodiesel. This was due to the characteristics of each biodiesel's source oil.

Conclusions/Discussion
Although lipid content impacted the final energy density, allowing microalgae to exceed soybean, the source oil's chemical structure impacted the energy density more. Since triglyceride oil molecules yielded more biodiesel than diglyceride or monoglyceride oil molecules and microalgae and soybean oil were triglycerides while kelp oil was a diglyceride, microalgae and soybean both exceeded kelp's fuel quality. In further experimentation, the invasive species dandelion was found a promising biodiesel source. Today, waste soybean oil accounts for nearly 50% of America's biodiesel usage. In the future, open ocean farming of microalgae could yield 7x the oil that is converted into high quality biodiesel to reduce the effect on global warming.

Summary Statement
By burning different biodiesel to test energy density, I found that biodiesel such as microalgae with a triglyceride source oil chemical structure has high energy density, making it a promising alternative fuel.

Help Received
I researched and performed the transesterification of oil and testing of energy density. I received supervision during the chemical reaction process and burning of biodiesel; I received help from my science teacher in understanding the chemical structure of oil.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Enzo V. Genovese

Project Number
J0207

Project Title
Hydroelectric Powered House: Is Domestic Water Pressure a Viable Source of Renewable Energy?

Abstract

Objectives/Goals
This project attempts to create electricity from the main water pipe that connects into a house or a building, transforming water pressure into electricity using a hydroelectric generator. If enough electricity is generated, then you can connect the apparatus to solar panel batteries in order to create free and perpetual energy every time you use water in the house.

Methods/Materials
Tested the electrical power produced by measuring the wattage with a using a digital multimeter, and the water pressure using a residential water pressure gauge kit. Used a 12V/10W water turbine generator, 1 foot of 1 inch diameter tubing with a faucet connector, and 7 LEDs of 12V to show visually the electricity produced.

Results
The faucet water flow measured 2 gallons per minute and 40 psi pressure. When the tap water flowed through the generator, 10 Watt hour of electricity were produced, enough to light up continuously seven 12V LEDs. That amounts to 240 Wh for 2,900 gallons per day, or 12 gallons to produce 1 Wh. The same performance was successfully conducted in blowing air from the mouth through the tubing to test the experiment at very low pressure.

Conclusions/Discussion
300 billion gallons per day of freshwater are used in the US. That is 25,000 Megawatt of electricity if all buildings were equipped with this device, or 2 days of electricity used by New York City. It would not justify the cost of hydroelectric generators for all the buildings in the US. Incidentally, I created with my prototype an emergency battery-free flashlight and charger for mobile phone powered by mouth airflow.

Summary Statement
Domestic water pressure is not a viable source of renewable energy.

Help Received
I showed that domestic water pressure is not a viable source of renewable energy, I discovered a battery-free source of electricity for emergencies.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Georgia G. Hutchinson

Project Number

J0208

Project Title

Designing a Data-Driven Dual-Axis Solar Tracker

Abstract

Objectives/Goals

The objective of this study is to design and build a Data-Driven Dual-Axis solar tracker and to test its output relative to that of a fixed panel.

Methods/Materials

Plywood, Raspberry Pi, Stepper Motors and Drivers. Programmed the apparatus to track the sun using longitude and time. Built a model to test the output of a Dual-Axis tracker relative to a fixed panel.

Results

A yearlong model was built to predict the output of a Data-Driven Dual-Axis relative to a fixed panel. It showed that the Dual-Axis solar tracker would generate 1.9 times more electricity over the course of 2018 in San Mateo County, CA. Results gathered on two 2018 days were consistent with the model's predictions.

Conclusions/Discussion

A Data-Driven Dual-Axis solar tracker was designed and built. In a model consistent with observations, it was predicted a Dual-Axis solar tracker would generate 90% more electricity than a fixed panel. Due to the reduced cost of a tracker without sensors, Data-Driven Dual-Axis solar trackers could reduce the payback period of solar by up to 40%.

Summary Statement

I designed a Data-Driven Dual-Axis solar tracker capable of reducing the payback period of solar by 40%..

Help Received

I programmed the sun-tracking code using a solar-position equation. Parts of my apparatus were printed by a CNC router at a local workshop.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Aditya S. Kakarla

Project Number
J0209

Project Title
Fresnel Lens and Temperature vs. Solar Panel Output

Abstract

Objectives/Goals
The objective of this project is to figure out if I can increase the electricity you can receive with a solar panel by increasing/decreasing the temperature and using a Fresnel lens.

Methods/Materials
A Fresnel lens and a infrared thermometer probe were used, so I could see the temperature of the solar panel and the effect of the Fresnel lens on the solar panel. I would check the voltage of the solar panel with and without the Fresnel lens, and I would use my thermometer to check the temperature. I would change the temperature by using plastic bags with hot or cold water in it. This would help to simulate a warm or cold environment.

Results
The results of this project showed that cooler temperature would increase the voltage by around 0.217 volts per degree Fahrenheit, and the Fresnel lens would increase the voltage by around 1.7%. These results mean that having a colder surface temperature for the solar panel, and using a Fresnel lens both increased the amount of electricity that would be produced by the solar panel. My lowest temperature, 53 degrees Fahrenheit, had around 23% more voltage than my recording with the highest temperature, 116.6 degrees Fahrenheit.

Conclusions/Discussion
Providing a colder environment and using a Fresnel lens will increase energy output of a solar panel. This project could help us learn more in better utilization of solar panels, and therefore finding new applications such as cars or even airplanes

Summary Statement
use of Fresnel lens and cooler temperature helped improve output of solar cell

Help Received
I received help from my parents in procuring Materials for my project and I learned concept of solar cell energy production from my Dad and online

Name(s)
Alexis T. MacAvoy

Project Number
J0210

Project Title
A Rising Power: Improving the Power Output of Microbial Fuel Cells, a Solution to Our Quest for Renewable Energy Sources

Abstract

Objectives/Goals
As global warming increases and an energy crisis looms, microbial fuel cells (MFC) offer the promise of clean, renewable power. After studying MFC design and function, how do different substrates, electrolytes in the cathode, temperatures, and nutrients in the anode impact power output of a MFC? Using mud from San Mateo creek and Bay wetlands, bay glucose MFC will produce maximum power because anaerobic bacteria will thrive with an enriched energy source.

Methods/Materials
Mud was collected and sifted from San Mateo Creek and Bay wetlands. 8 MFCs were built using a single cell design with a plastic container and mud sandwiched between a cathode and anode graphite discs. 5g of glucose was mixed with both mud sources. Once closed, a hacker board connected the external wires to the MFC. For the environmental temperature variable, a bay and creek MFC was maintained at a temperature of 28 deg C (controls, 18 deg C). 8 MFCs were allowed to reach power output equilibrium after 1 week. Conductivity of mud samples was measured and 5g of salt added to the cathode side of the MFCs. Power output was measured using 7 different resistors by measuring voltage of the MFC and calculating power (V2/R) in microwatts (uW). All MFCs were measured with 7 different resistors every other day until the power output declined. Analyses and graphs were performed in MS Excel.

Results
By far, the MFC that produced the most power output was the 'bay glucose' MFC: max power 5.75 uW, day 5. Bay mud had the highest conductivity and the added salt increased the conductivity 100-fold. The lowest internal resistance was bay MFC at 47 ohms, day 5. All creek MFCs produced little to no power regardless of changes.

Conclusions/Discussion
The 10-fold power boost for the bay glucose MFC was due to added nutrients enhancing bacterial performance. Power decline observed across MFCs in the last 2 trials may be a result of MFCs depleting the nutrient supply. Creek MFCs produced little power likely due to the cleanliness of the ecosystem. Testing multiple resistors demonstrated that the internal resistance of all the MFCs was abnormally high. This means that the MFCs lost a significant amount of power that could have been transferred to an external load. Future experimentation with MFCs could include using mud from bacterial-rich sources, altering glucose/salt quantities, and building 2-chamber MFCs to improve lifespan.

Summary Statement
I tested how different substrates, electrolytes in the cathode, temperatures, and nutrients in the anode impacted power output of a microbial fuel cell.

Help Received
My parents bought the supples and drove me to get the mud.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Talha Mala

Project Number
J0211

Project Title
Gone with the Wind: The Effect of a Wind Turbine's RPM on the Amount of Energy Produced

Abstract

Objectives/Goals
The objective of my project is to explore the amount of electricity generated by a wind turbine as an alternative form of energy and to examine the effect of the number of revolutions per minute (RPM) on the voltage output. I hypothesized that as the number of RPMs increases the amount of electricity generated (as measured in volts) would also increase.

Methods/Materials
I used a 27-volt motor, a glue gun, a soldering iron, a utility knife, a propeller, a bulb, wires, a PVC pipe, a hammer, a drill, a voltmeter, and spray paint. I used an electric fan to produce wind. I assembled the wind turbine, and I used a lightweight string affixed to the shaft of the wind turbine and a stopwatch to measure the number of revolutions per minute at every speed of the fan. I then used the voltmeter to measure the voltage output at every variation of fan speed.

Results
As the speed of the fan increased and more "wind" was generated, the number of RPMs of the wind turbine also increased. The greater the RPMs of the wind turbine, the greater the voltage output was as measured by the voltmeter. Please see table for quantitative results.

Conclusions/Discussion
I repeated my experiment 5 times per fan speed. This resulted in a total of 15 trials for my study. My results supported my hypothesis and suggested that there is a strong correlation between the amount of voltage produced and the number of revolutions per minute of a wind turbine. As reducing our carbon footprint becomes a more pressing issue and we are shifting away from the use of fossil fuels, the scope of my study is important to understanding the dynamics of a wind turbine and improving the efficiency of it. Wind energy is a clean and sustainable energy -- meaning that it is renewable and non-polluting.

Summary Statement
My project examines wind energy as an alternative form of energy and how the amount of voltage generated is dependent on the number of revolutions per minute of a wind turbine.

Help Received
I designed my experiment and model by myself. However, my dad helped me cut the wood and drill a hole in the PVC pipe.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Colin J. Manfredo

Project Number
J0212

Project Title
Can an Inline Hydroelectric Turbine Save Homeowners Money on Their Electric Bill?

Abstract

Objectives/Goals
If an inline hydroelectric powered turbine is used for residential homes, will it create enough power to lower a homeowner's energy bill? The objective was to take the incoming water pressure (psi) from residential homes and convert it into usable energy for homeowners, testing the savings on residential energy bills. This project would be a more affordable, alternative energy source to solar power.

Methods/Materials
Engineered the design for the hydroelectric turbine for use in residential homes. Engineered a small scale model to be used as the testing subject. Tested water pressure (psi), tested voltage using a DROK digital volt meter, and tested amperage using an auto-ranging multimeter. Analyzed average water usage for residential homes and compared to national averages. Met with Water Engineer to discuss mathematics and design. Used the hydro potential formula to find needed wattage. Completed mathematics to convert alternative energy into savings on residential homeowner's electric bill.

Results
The inline hydroelectric turbine that I engineered could produce an annual savings of $281.68 due to the higher tiered pricing in California. The average residential homeowner in the United States would save $140.84 annually. The optimal levels of efficiency for my small scale model hydroelectric turbine produced 12.8 volts with an entering water pressure of 58 psi into the turbine and an exit water pressure of 30 psi, creating .157 amps. I also found the more water used by residential homes measured in gallons per minute, would result in more savings per home.

Conclusions/Discussion
Even though I've proven you can use a hydroelectric turbine to create energy in residential homes using a municipal water source, the annual savings needs to be increased to compete with solar power. There is reduced water pressure after the water travels through the turbine, but the placement of the turbine on the main valve will be critical to gaining the water pressure back to acceptable levels. Engineering the turbine in place of water pressure reducers could be critical in the design. I've also learned that taking this idea into the agricultural field where there is greater volume of water for longer periods of time and exit water pressure (psi) is not as relevant, can save farmers a considerable savings on their electric bill.

Summary Statement
I engineered an inline hydroelectric turbine that uses residential water pressure to generate electricity that will save homeowners money on their electric bill, eventually being an alternative source to solar energy.

Help Received
I designed, built, and tested the inline hydroelectric turbine myself. I got help in understanding the mathematics and design issues with the exit water pressure from Jim Wegley from Keller & Wegley Engineering.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Gavin S. Manley

Project Number
J0213

Project Title
Paper Batteries: A Clean Alternative

Abstract

Objectives/Goals
When I set out to work on my science experiment, I was very interested in the idea that I could make a paper battery that was ultra thin, and that such a tiny piece of paper could produce voltage. As I continued my research, I knew this was an amazing idea because it was also good for the environment. These paper batteries are better for the environment than the modern batteries (example: AA battery). The modern batteries all use a chemical build-up to produce electricity. The paper batteries use no chemicals at all. This means that the paper batteries are recyclable and do not create e-waste. The A batteries all use a chemical build-up that (when taken apart incorrectly) lets out a greenhouse gas that is very bad for the environment.

Methods/Materials
The result was found by testing the amount of voltage that the battery produced and seeing which had more, my paper battery or the AA battery. My procedure was to first, build a paper battery. Second, test my hypothesis. My final step was to record data. After much research and many test runs, I was able to create a working papery battery.

Results
I was able to create a working papery battery. Unfortunately, it was not as powerful as the AA battery.

Conclusions/Discussion
My results were supported in my hypothesis. I hypothesized that the AA battery would have more voltage than the paper battery, unless carbon nanotube ink became available "over the counter." It is easy to see that future research and testing, using carbon nanotube ink will further benefit this category. Carbon nanotube ink would increase the voltage of the paper battery because graphite releases voltage slower than carbon nanotube, even though they are both great conductors. Carbon nanotube ink is made of conductive, multiwalled carbon (nano=1/1000000000 m, nanotube=4/1000000000 m) nanotubes. For my future research, I would like to test this same theory using the carbon nanotube ink.

Summary Statement
The purpose my science research is to make a non-chemical paper battery, as an environmentally safe alternative to the AA battery, which is both affordable and easy to print from home.

Help Received

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Aaron I. McKeeman

Project Number
J0214

Project Title
SwellSpark Turns Ocean Swells into Electric Energy

Abstract

Objectives/Goals
The goal of this project was to create a buoy that can convert ocean swells into clean, efficient electric energy without polluting or harming the environment.

Methods/Materials
First I envisioned a fog buoy that uses the ocean swells to make sound, and I wondered if there was a way to make electrical energy from swell through a similar process. After sketching ideas, I constructed a buoy with a generator inside that attached to a spool with line wrapped around it that would reach down to an anchor on the seafloor. When the buoy goes up and down because of the swell, the tension of the string changes, causing the string to pull on the spool, making the generator spin, and creating electric energy. The data collected from the SwellSpark buoy was gathered by first measuring the amplitude of the swell using noaa.com's buoys data to determine what the amplitude of the swell was. Then after measuring the voltage output of my buoy with a volt monitor, both amplitude and volt output were correlated to see how much volt output the SwellSpark could produce using only ocean swells.

Results
The SwellSpark creates up to twenty volts using ocean swells as a power source. A pattern I noticed when testing the SwellSpark buoy is that the larger the amplitude of the wave the more volts are produced by it.

Conclusions/Discussion
The goal of this project has been successfully accomplished, although the SwellSpark could use even more development because there are numerous possibilities for it. This buoy can produce an average of eighteen volts from ocean swells which fulfills my goal.

This is just the beginning of the SwellSpark. Some exciting future possibilities for it are:
- Provide power for fishermen and their boats.
- Provide power for people on islands with no electricity.
- Provide power for the Bajau people that live in huts on the ocean with no electricity.
- Build buoy farms to power large cities.
- It's possible that the SwellSpark could be a part of a hybrid boat in the future.

Summary Statement
I developed the SwellSpark, which is a buoy that is capable of harnessing ocean swells and converting them into clean efficient electric energy.

Help Received
My mother and father both supported me in this project by getting the supplies for this project and driving me to places I needed to go for this project such as the ocean. Also my teachers supported me in this project.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Pranav S. Moudgalya

Project Number
J0215

Project Title
The Photovoltaic Effect: Maximizing the Efficacy of Solar Panels through Variation in Exposure and Wavelength

Abstract

Objectives/Goals
The main objective of my research was to find ways that the efficacy of polycrystalline solar panels could be maximized by testing the effects of exposure, light frequency, and temperature on model solar panels.

Methods/Materials
Three experiments titled "Exposure" "Wavelength" and "Temperature" respectively were conducted on a series of polycrystalline solar panels. "Exposure" tested the effect of varying angle tilts, "Wavelength" tested the effects of various color frequencies on the panels, and "Temperature" tested the effect of varying temperature. During all three experiments, an "UltraBrite Desk Lamp" was used to simulate the movement of the sun in a controlled environment. Finally, voltage (v) was calculated using an open source software called Logger Lite and was taken using hardware from Vernier. 300 calculations were conducted for each trial using Logger Lite and scores were tested for significance with 87.4% power at $P<0.01$. Average voltage was compared across variables using one-way ANOVA tests. A post-hoc Tukey HSD Test was used to test the significance, statistical power, standard deviation, and standard distribution of the data.

Results
My research illustrates that in Experiment 1, 15 degrees was the optimal angle for the solar panels to be titled towards the sun. In Experiment 2, the control group did test the best (an average of 1.8 volts) however, a 600 nm (Yellow) filter was the highest performing when it came to color filters (average of 1.7 volts). Finally, Experiment 3 showed that the panels under a cold treatment performed the best and were significantly better than the control group and the hot group. The cold solar panels produced the greatest result which was about 9% better than the control and was 33% than the hot panels.

Conclusions/Discussion
The central conclusion is that solar panels can be improved in many ways that don't require expensive reinstallation. The first experiment used a setup mimicking 0 degrees longitude which indicates that solar panels should be tilted 15 degrees, according to the longitudinal location of the panel. Changing the temperature and frequency of light are also globally applicable and in the end, my research hopes to serve as a baseline to improve solar technology.

Summary Statement
My research indicates that variations in exposure, light frequency, and temperature should be used to increase the voltage and overall performance of solar panels.

Help Received
My parents were with me throughout the duration of my research and provided financial and moral support.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Natalie G. Neypes

Project Number
J0216

Project Title
Micro Machines: Determining the Optimal Temperature Range for a Microbial Fuel Cell

Abstract

Objectives/Goals
To determine how to create a well-functioning microbial fuel cell, I decided to test what temperature range a microbial fuel cell best functions.

Methods/Materials
Tested what temperature range a two-chambered microbial fuel cell best functions by creating 3 two-chambered microbial fuel cells. Placed mud in the fuel cell to generate the energy. Connected a multimeter to the fuel cell and tested milliamps and millivolts every day for 10 days to determine the optimal temperature range. After, I converted the data into watts.

Results
The 3 two-chambered microbial fuel cells were placed at three different temperature ranges to determine what temperature a microbial fuel cell best functions. I found that when placing a fuel cell at the baseline temperature (room temperature), at a temperature cooler than the baseline temperature, and at a temperature warmer than the baseline temperature, the fuel cell generated the most energy at a temperature warmer than the baseline temperature.

Conclusions/Discussion
Creating two-chambered microbial fuel cells and testing the optimal temperature range proved that a microbial fuel cell best functions at a temperature warmer than the baseline temperature. It also proves that a microbial fuel cell can be an effective renewable energy resource.

Summary Statement
After building 3 two-chambered microbial fuel cells, placing them at 3 different temperature ranges to test the energy generated for 10 days, I found that a microbial fuel cell best functions at a temperature warmer than room temperature.

Help Received
I designed, built, and performed the experiments myself. However, my dad assisted in drilling holes on plastic containers in order to build the fuel cells.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Patrick M. Ngo

Project Number
J0217

Project Title
An Alternative Choice for Alternative Energy

Abstract

Objectives/Goals
The objective of this experiment is to create a more reliable renewable energy source that can outperform current methods for clean energy collection.

Methods/Materials
Created a scale model consisting of a hydroelectric unit and a Vertical Axis Wind Turbine (VAWT) Unit. A stopwatch, voltmeter, and a controlled environment were used while conducting time trials on the scale model. A controlled amount of water and a controlled wind speed were used when testing each individual unit.

Results
After multiple trials on the scale model, it was determined that the overall model could outperform each individual unit. While each unit was able to perform in a 5% range efficiency to the hypothesis, the overall unit was able to perform more reliably and therefore had a higher efficiency. The efficiency of the overall model depended on how well each unit performed with the other. Each unit cooperated with the other, which resulted in a greater efficiency than expected.

Conclusions/Discussion
From multiple trials, it was evident that combining renewable energy sources can result in higher efficiencies of the overall model, because of the compliance of each unit. The overall scale model was able to perform at a higher efficiency than expected because the a small portion of the energy produced by the VAWT unit was used in pumping for the hydroelectric unit. Additionally, combined renewable energy sources can outperform individual sources in the power obtained and efficiency, and therefore can be used to provide energy more reliably.

Summary Statement
I developed an eco-friendly renewable energy source that outperforms current renewable energy sources in efficiency, and tested the design with a scale model.

Help Received
I built the scale model by myself. I was assisted in testing the model by my father, in order to obtain accurate data for each time increment.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Max Norden

Project Number
J0218

Project Title
Power from Water: A Study of Friction and Precipitation

Abstract

Objectives/Goals
The objective of this experiment is to show how one can extract power from water. The experiment hypothesizes that, if you drip water through suspended silica dust onto a metal plate, then it will charge the copper plate 1 nanovolt per drip.

Methods/Materials
MATERIALS
glass jar with stopper or lid, tap water, silica dust, steel sheet, copper sheet, aluminum sheet, acrylic sheet, PC oscilloscope, drip-valve

METHODS
Drip water into jar containing silica dust onto plates of 4 different materials. Record voltages on oscilloscope as drops land on sample materials.

Results
10 water droplets fell through the silica dust on to each of the 4 sample plates. The experiment was repeated 5 times for each plate. The results showed that there was a greater mean voltage induced for the metal samples over the acrylic sample and that the greatest voltage was seen with the copper sample.

Conclusions/Discussion
The hypothesis: if you drip water through silica onto a metal plate, then it will charge the copper plate 1 nanovolt per drip appears not to be supported by this experiment. The accuracy to which this experiment was able to record data was in millivolts, not nanovolts.
The static charge of each drop was unable to be registered, so this experiment relies on averaging data sets. The averaged data does show differences between the plate materials. The experiment appears to show that if you drip water though silica dust onto a copper plate, it will register a greater charge than if you were to drip it onto acrylic, stainless steel, or aluminum.

Summary Statement
This experiment is trying to show how one can extract power from water, by water droplets (rain) interacting with silica (dust) as they fall on to a copper plate inducing voltage.

Help Received
I designed and performed the experiment myself. My parents helped me with the drilling of the glass and learning the software used with the oscilloscope and presentation graphs. Mr. Lewis, my science teacher, reviewed my work and gave constructive feedback.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Jordan Prawira

Project Number

J0219

Project Title

Stack-A-Wind: Developing Small Vertical Axis Wind Turbines (VAWT) for Various Wind Speeds

Abstract

Objectives/Goals

The goal is to develop a vertical-axis wind turbine that will work for regions below 30m or the turbulent area in suburbs/residential areas.

Methods/Materials

The design criteria and constraints were based on Mr. Nader Shareghi, Director of Public Work Department at Mountain House Community Services District, and US Department of Energy "Small Wind Guidebook for Small HAWT." Development of VAWT was completed in 4 stages that includes different aspect ratios of height and width, different numbers of blades, different blade profile designs and stackable positions. The best VAWT from each stage became the control for the next stage. Prototypes for each stage were built from thin aluminum foil sheets with wood dowels/skewers, then attached to a hub and DC motor. Box fan with 3 different wind speeds, measured with an anemometer, was set up 12in. away from VAWT. The outcome of all stages was power generated, measured using a multimeter and how the VAWT responded in various wind speeds (stalling or not).

Results

The data showed as the VAWT evolved from stage 1-4, the power generated improved significantly and there was less stalling. The average power increases as the wind speed increases. The blade surface area increases as the aspect ratio increases. However, higher aspect ratio doesn't increase the average power generated. The average power produced on all wind speeds increases with the number of blades, at a slower rate. Additional surface area in blade profile may add more weight that affects the power generated because it requires higher wind force to push the blade.

Conclusions/Discussion

Stackable VAWT improved the power generated by creating differences of high forces on concave side & low forces on convex side of the blade. In VAWT, aerodynamic shapes (curved) for blade designs didn't help in generating more power. The aspect ratio of height and width and number of blades affect more than the surface area and/or blade design profile in generating more power. Weight of the blade is also important because it affects the power generated negatively. The Stack-a-Wind design saves space and produces more power in the same footprint. This may be a viable alternative for suburbs or residential areas because it works in curved winds below 30m. A proposed solution for stackable VAWT installed either in a backyard of a residence or in a common area. Safety parameters must be established.

Summary Statement

Developing small vertical-axis wind turbines that can harness a clean, renewable wind energy in region below 30m or turbulent area (various wind speeds).

Help Received

Thanks to Mr. Nader Shareghi, Director of Public Work Department at Mountain House Community Services District; Mrs. Housman and Mr. Lee, science teachers, for their support and feedback; My family for providing materials, photos and assisting me in excel and board.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Alexa G. Rodriguez

Project Number
J0220

Project Title
How Can I Charge or Power My Cell Phone without an Outlet?

Abstract

Objectives/Goals
I'm camping and there is no electricity or an outlet. I need to charge my phone but I don't have an outlet so the objective of my project is,"How Can I Charge or Power my Cellphone Without an Outlet?"

Methods/Materials
I drilled ten solar panels into a board and connected the wires all around. And once I got to the end I connected that long wire to the USB charger. And drilled in a on and off switch to board and also connected it to the USB charger with a Soldering Iron. And attach triangles to the side so it can stand up.

Results
It was successful. It charged my phone outside and it charged 14% in half an hour.

Conclusions/Discussion
I learned that I can save energy through solar panels and create electricity. A way that I can make this better was by adding more solar panel, to produce more electricity.

Summary Statement
My project is about making solar energy and using that energy to charge my phone.

Help Received
My dad helped me drill the holes and used the Soldering Iron.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Diptanshu Sikdar

Project Number
J0221

Project Title
Energy Harvesting Utilizing a Wind-Driven Triboelectric Generator

Abstract

Objectives/Goals
The growing interest in remote sensing leads to my research for making sensors self-powered. Sensors are crucial for monitoring of structural integrities of bridges, railroads, oil and gas pipelines, or alarming of fire danger. Operating intermittently, the advanced sensors only require ~10-100uW of power. While solar power needs direct sunlight, the ubiquitous flow of wind could power the sensors day and night.
The goal of this project is to build a model energy harvesting device to generate electricity from the kinetic energy of airflow utilizing the Triboelectric effect. The energy stored can then be used to power the sensors.

Methods/Materials
The small-scale energy harvester was designed to utilize Triboelectric Charging from the friction between Teflon and copper. The inner surface of a hollow cylindrical stator was coated with strips of copper tapes. One end of a thin Teflon film was attached to the outer surface of a rotor. The kinetic energy of wind was converted to electricity in two steps. The propeller blade converted the kinetic energy of wind into mechanical energy of rotation. Next, as the rotor spun inside the stationary cylinder, the suspended end of Teflon films rubbed against the copper tapes, and the frictional contact and separation between them generated Triboelectric charges. The charges were easily collected from the conducting copper on the stator, and a bridge rectifier converted AC to DC. After troubleshooting multiple prototypes, the low-cost energy harvester was tested with a varied number of Teflon films and different air speeds.

Results
The prototype produced promising results both indoor and outdoor. At a moderated airflow of ~5m/s from a box fan, it generated a ~6V DC output and charged a 100uF capacitor to 4V within 150 seconds delivering more than 10uW of power. The harvested energy was then used to power a sensor (BME 280) to generate weather data which was read using an Arduino Uno Microcontroller. In the outdoor setting under inconsistent, unmeasured wind speed, the device generated ~13.1V of DC output.

Conclusions/Discussion
The low-cost, small-scale, Triboelectric generator harvested kinetic energy from moderate airflow (5m/s) producing 10uW of power and operated a weather sensor without any batteries. This technology could enable the broad deployment of self-powered, remote sensors.

Summary Statement
I designed, built, and tested a novel, low-cost, small-scale, wind-driven, Triboelectric generator harvesting kinetic energy of airflow using friction between Teflon and copper to power battery-free, remote sensors for their wider adoption.

Help Received
I would like to thank my mentor at Schmahl Science Workshops, Dr. Youssef Ismail, for his feedback. Also, I would like to thank my parents for purchasing the materials and allowing me to use household materials during prototype development.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Riley Stickney

Project Number
J0222

Project Title
How Does Temperature Affect the Voltage Output of Solar Panels?

Abstract

Objectives/Goals
The objective of this project is to determine how temperature affects the voltage output of solar panels.

Methods/Materials
A 10 watt solar panel placed in a Styrofoam ice chest with a full spectrum LED bulb placed above it. Wires were fed through the Styrofoam ice chest to connect the solar panel to a multimeter. LED light was turned on and the amperage of the solar panel was recorded at room temperature.

Dry ice was introduced, voltage output on the multimeter was recorded at 15 minute intervals after the LED light was turned on; temperature inside the cooler was measured with an infrared thermometer when the light was turned off at each interval. This was done in a span of 3 hours.

Next, a blow dryer was used to heat the inside of the cooler at incremental degrees of heat (as measured by the infrared thermometer). The LED bulb was lit at those incremental heat temperatures to measure the amperage output. These measurements were completed in 10 minutes.

Results
The solar panel produced more volts when cold than when hot. As the temperature increased, the voltage decreased in a near linear fashion. So, the voltage was inversely proportional to the temperature.

Conclusions/Discussion
My hypothesis was incorrect. Voltage decreased as temperature increased. Cold, but sunny environments will produce more volts than solar panels in sunny, hot environments.

Solar panels would be great to use in sunny, mountainous regions like the Colorado Mountains. In the future, it would be interesting to test if the altitude and thinner atmosphere of the mountains would increase the efficiency of the solar panels. The reason for this may be that the solar panels would be exposed to more direct sun rays and hence more photons that are not filtered out by the atmosphere. Placement of solar farms may need to be reconsidered because solar panels are one of the most promising technologies of green energy.

Summary Statement
I demonstrated that solar panels have higher voltage output at cooler temperatures.

Help Received
I designed the experiment by myself. I used internet seaches to compile and understand the data.