CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Cole N. Barker

Project Number

J0201

Project Title

Is a Solar Car's Performance Affected by the Angle of Its Solar Panel?

Abstract

Objectives/Goals

My objective is to learn if placing a solar panel on a model car at different angles to the sun affects the speed the car traveled. I think the angle that is the most direct toward the sun will have the best performance.

Methods/Materials

Materials:
1.solar car kit
2.sunlight
3.stopwatch
Procedure:
1. Perform test on a sunny day at 12:00 noon when sun is directly overhead
2. Measure and mark one meter on flat sidewalk
3. Run the model car at the first angle and record time.
4. Run the model 3 more times at this angle and direction and record the time
7. Repeat steps 3-5 with the panel at different angles and opposite direction

Results

The flat panel averaged 3.455 seconds to travel one meter. At a 45 degree angle with the panel facing south, the average sped up to 2.2525 seconds. And at a 90 degree angle facing south, the average went to 2.22 seconds. With the panel facing north at 45 and 90 degree angles the panel must not have received any light because the car didn't move. Also, facing this direction and laying the panel flat the time was 4.3225 seconds.

Conclusions/Discussion

My testing found that while the car traveled fastest with the panel facing south at 45 and 90 degrees, it did not move at all with the panel facing north. Therefore, my conclusion is that the panel worked best when laying flat and directly facing the sun at 12:00 noon.
Using this information, I believe solar powered cars can have improved performance and practicality and soon be a larger part of the automobile industry. My project shows that a flat panel had fairly acceptable performance.

Summary Statement

Testing the performance of a solar panel at different angles to the sun

Help Received

My Dad helped me build the solar car kit.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Landon R. Creighton

Project Number

J0202

Project Title

Engineering a New Way of Generating Electricity Using a Fresnel Lens and a High Temperature Collector

Abstract

Objectives/Goals

There is a constant need for producing energy. The U.S.is the second most energy consuming country in the world (313 BTU per capita). There is a huge need for new ways of producing energy. I am using the unending supply of energy the sun produces. My idea could be advanced and upgraded to commercial level if properly designed and tested. It could also prove quite useful in places where they have no massive energy producers and where wind turbines may not work or photovoltaic cells are too expensive. Design Criteria. It has to be safe.It must use only the sun to power the collector. It must be dependable and reusable. It must be fairly easy to make. It must be ecology friendly.

Methods/Materials

I tried six different prototypes before I came to my working prototype. My prototypes used a variety of different materials but they always used a Fresnel lens to power them. My prototypes are considered high temperature collectors because they collect the suns rays and transfer them to water making it turn to steam. As the water turns to steam it expands taking up to 1700 times in volume. As the boiler tank builds pressure it is released onto a generator fan, which produces energy.

Results

Prototype 1 did not work, due to a faulty design. Its major flaw was failing to make the water turn to steam fast enough or at least to a significant degree. Prototype 2 did not build pressure probably because once I sent it into the pressure tank it cooled and turned back into water. Prototype 3 did not build enough pressure to turn a generator fan. It did produce a lot of steam but it did not build pressure. Prototype 4 failed to consistently produce electricity. Prototype 5 failed by breaking the mirror after the heat became intense. I learned from this prototype that I should have a flat space on the next prototype so I will be able to focus on the target and hopefully produce more heat. Prototype 6 was successful in all areas of my criteria. The pressure in the boiler chamber got to twenty pounds and was able to turn the generator fan for a prolonged amount of time.

Conclusions/Discussion

Prototype 6 was successful. It produced energy with efficiency and consistently turned the generator fan blade. It was ecology friendly and safe. It fit all my criteria perfectly except for being easy to build because it did take a large amount of welding. Prototype 6 took a large amount of time to build pressure it was successful.

Summary Statement

This project proves that I can engineer a working high temperature collector powered by a Fresnel lens.

Help Received

My mom helped me find resources and proofread my work. My Dad helped me build the prototypes and did the welding. Brothers and sister gave advice.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Sean T. Crowley

Project Number

J0203

Project Title

Recharging Batteries with a Windmill to Power an Electric Car

Abstract

Objectives/Goals

My project was to determine if wind can be harnessed and then put into electric cars.

Methods/Materials

wood, plywod, threaded steel rod, volt meter, generator/motor, battery holder, copper wire, bicycle wheel, nuts and washers, screws, staples, plastic sheeting, plexi glass, toy car kit with electric motor, diode

Cut wood into two S-like shapes. Screw wooden slats to both S-like shapes. Bolt sail onto threaded steel rod. Connect rod to axle of bicycle wheel. Bolt plexi glass disc onto threaded steel rod. Screw bicycle wheel onto plywood. Mount battery holder to plywood. Sauder battery holder wires, generator/motor, and diode. Create stand for volt meter and motor/generator.

Results

My results confirmed that my hypothesis was correct. The information from my project expands our knowledge in alternative energy because it gives us a new way to think and learn of how to use wind to power vehicles that do not run on fossil fuels.

Conclusions/Discussion

My project was able to collect natural wind energy that got harnessed and put into batteries that were installed into an electric car.

Summary Statement

Collecting natural wind energy that is then harnessed in batteries that are then istalled into an elctric car.

Help Received

Sister took pictures; Dad supervised use of power tools; Mother funded purchases of materials.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Arshia Deep; Serena Lee; Viren Srivastava

Project Number

J0204

Project Title

U Power: Harnessing Body Heat for Safety

Abstract

Objectives/Goals

The goal was to understand thermoelectric/seebeck effect and apply the learnings in our daily lives by the creating a prototype that harnesses body heat to power a belt that lights up.

Methods/Materials

We first conducted some background information learn about body heat conversion and the materials needed to conduct experiments. Afterwards, we experimented first with hot and cold water (using a couple of Peltier tiles) to record the voltage produced with temperature differences, then proceeded to attempt building a working prototype. In order to do this, we also had to build a joule thief circuit to amplify the voltage produced. We connected 6 Peltier tiles to a joule thief circuit, inserted it into a belt, and tested it on one of our group members to see if it would light up the LED. After our county science fair, we decided to experiment with different voltage amplifiers, capacitors, and a strip of LED's to see if we could make our prototype more efficient.

Results

We found that using multiple Peltier tiles along with a joule thief circuit significantly amplifies the voltage being produced. After experimenting with hot and cold water, we found that the larger the temperature difference, the more electricity is being produced. When testing our first prototype, we found that the LED lit up when the voltage reached 1.06 V and stayed lit until finally fading out until the voltage reached 0.77 V. This happened after 1-2 minutes of exercising.

Conclusions/Discussion

In conclusion, our engineering goal was met as we understood how body heat conversion works and applied that concept to our daily lives. Learning about the whole process of thermoelectric energy, we came to a conclusion that body heat can be harnessed to power many small low voltage electronic devices and wearables, and that it is very beneficial as the energy source is consistently available anywhere and at all times. We believe that this technology is very promising as we move to a world of devices such as health monitoring, hearing aids, activity trackers, etc. that contribute to the well being of society.

Summary Statement

To create a prototype of a device that provides safety for people who exercise at night using body heat.

Help Received

Ang Shih helped us understand the engineering principles behind seebeck/thermoelectric effect.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Dev C. Dhruv

Project Number

J0205

Project Title

Microbial Fuel Cells: Generating Electricity from Organic Matter

Abstract

Objectives/Goals

A microbial fuel cell is a renewable means of generating electricity using anaerobic bacteria that decompose organic matter. The goal of my project is to find out how the pH of the electrolyte in the cathode chamber of the microbial fuel cell would affect the voltage generated. I hypothesized that an acidic solution would produce the most electrical power. There are more H+ ions then there are electrons, so the bonding reaction occurs quickly, thus more power is generated.

Methods/Materials

Materials:
Medium sized jar (plastic or glass) with removable lid ; Carbon Brushes ; RVC (Anode); Carbon Cloth with Pt catalyst (Cathode); Aquarium Water Pump with tube; Hookup Copper Wire;Multi-meter; Resistors; 1x1x1 PVC Schedule 40 Tee; 1" PVC Schedule 40 connector; 3/4" x1" PVC Reducing Female Adaptor; 3/4"x1" PVC Reducing Male Adaptor; PVC Schedule 40 Threaded cap; Mud from creek bearing microbial bacteria; Agar Powder; Vinegar; Baking Soda ;Saline Water Solution
Procedure: Assemble Salt bridge; Anode & cathode chambers; Electrodes; MFC Unit
Measurement of Voltage & Data Collection (vary pH of electrolyte)

Results

The acidic and alkaline solutions produced erratic results with negative property. However, saltwater, with a neutral pH was an optimum electrolyte as it produced consistently positive voltage with a predictable pattern.

Conclusions/Discussion

My hypothesis was incorrect. More trials could verify the erratic behavior of the alkaline and acidic electrolytes. Also, measuring the pH of the electrolyte before, during, and after the experiment would give a better understanding of the relationship between the pH and the energy generated. With the data I have, it clearly seems that water is the optimum and best electrolyte.

Summary Statement

My project is about generating electricity using anaerobic bacteria inside organic matter, and I altered the pH of the electrolyte in the cathode chamber to see that would affect the voltage generated by the microbial fuel cell.

Help Received

My Parents helped me build the microbial fuel cell

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Nicholas L. Finke

Project Number
J0206

Project Title
Drinking the Ocean: Desalinating Water Using Clean Energy

Abstract

Objectives/Goals
The objective of my project is to build a microbial desalination cell to desalinate seawater using only the energy produced by bacteria digesting organic waste. The microbial desalination cell helps solve two important global problems: it generates clean energy, which reduces greenhouse gas emissions, and it provides drinkable water for the world's expanding population. Due to the abundance of organic waste and seawater, the microbial desalination cell solves both of these problems cheaply, so even people in developing countries can use the technology and benefit from it. It has a simple and reliable design which can be scaled from a small portable unit that could serve an individual family to a large installation in a wastewater treatment plant.

Methods/Materials
I built my microbial desalination cell from scratch, using acrylic plastic cylinders, semipermeable ion exchange membranes, and carbon felt electrodes. I simulated organic waste using benthic mud from a nearby lake. I measured water salinity with a digital refractometer, and I measured voltage and current output with a digital multimeter.

Results
Over a period of 30 days my microbial desalination cell successfully desalinated the simulated seawater from 35 parts per thousand of total dissolved solids (equivalent to seawater) to 24 parts per thousand. The output voltage and current generally decreased over time.

Conclusions/Discussion
My results show it is possible for a microbial desalination cell to use the energy it produces to desalinate seawater. I was not able to completely desalinate my simulated seawater because as the water becomes desalinated, the central chamber of my 3-chamber cell loses conductivity (seawater can be 100 times more conductive than fresh water), so the cell cannot produce enough electricity to desalinate all the seawater. Some ideas to improve desalination performance include: make the anode chamber bigger with a lot more organic waste so more bacteria would generate more electrons, recirculate the solid waste to prevent bacteria from dying from the excess chlorine in the anode chamber, and make the desalination chamber smaller so more electric current can pass through and to enable more sodium and chlorine ions to pass through the membranes.

Summary Statement
Using the biological properties of exoelectrogenic bacteria and the chemical processes of electrolysis and reverse osmosis, a microbial desalination cell can desalinate seawater using only the energy produced from organic waste.

Help Received
My Dad helped me build my microbial desalination cell, as some power tools were required, and Dr. Bruce Logan of Penn State University advised me regarding the semipermeable ion exchange membranes.

Name(s)

William C. Gaudreau

Project Number

J0207

Project Title

What's Cookin'?

Abstract

Objectives/Goals

The objective of my project was to find out what type solar oven will best heat water and why.

Methods/Materials

Three different common styles of solar ovens were assembled using materials anyone could find at home; 1 - Rectangular, 2 - Square, and 3 - Funnel. The solar ovens had different sizes, shapes and volumes, but used similar materials and were all lined with reflective aluminum foil or silver lining. The top of the ovens were sealed with clear plastic sheet or plastic oven bag. A bowl of water and a meat thermometer was placed in each oven and the temperature recorded every 10 minutes over an hour.

Results

The results of my experiment show the rectangular box was the most effective in heating water. In two tests the temperature increased by 30-50 degrees Fahrenheit from start to finish, to reach a peak of 115 degrees while the outside temperature was only 65 degrees.

Conclusions/Discussion

I believe the most effective solar oven was the rectangular box because it had the smallest volume and could heat the inside air and water to a higher temperature. My hypothesis before completing the experiment was not correct. I thought the funnel would heat the water to a higher temperature because it would reflect the sun rays toward the water and build heat faster. I was surprised the rectangular box did the best because the other two ovens were larger and had more reflective sides.

Summary Statement

A solar oven's shape and volume will affect how well it can heat water.

Help Received

My dad helped figure out how to build the boxes and cutting cardboard, mother reviewed my written summaries.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Jack Inouye

Project Number

J0208

Project Title

Wave Power: Capturing Usable Energy from the Ocean

Abstract

Objectives/Goals

My project was to design a small scale device that can capture the energy in ocean waves.

Methods/Materials

The design of the device was based on the historical water wheel. It was constructed with curved paddles and a housing which funneled water into the wheel. This increased flow through the system and allowed the water to flow in and out in both directions simultaneously. A voltmeter was used to measure the energy generated. The device was tested in a plexiglass water tank in a see-saw-like motion to generate waves. Three different water levels were tested.

Results

Energy was successfully generated by the device at all three water levels with the water flow in either direction. The highest average voltage was generated with the water level half-way up the device.

Conclusions/Discussion

These results show that this prototype holds promise as another possible way to capture energy from the ocean. Unlike current wave energy devices which depend on tides or those that freely float on the surface, my device has the potential to work in other areas of the ocean, including deep or shallow water away from shorelines, and areas where internal waves may be found.

Summary Statement

A small scale device (modified water wheel) was designed and built which harnessed the bi-directional wave energy in simulated ocean waves.

Help Received

None

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Max S. Kunes

Project Number

J0209

Project Title

Here Comes the Sun

Abstract

Objectives/Goals

Every year, the world gets more polluted by energy production. The purpose of this project is to see what is the difference between the energy production rates of solar-following solar panels and static ones.

Methods/Materials

Microcontroller
Solar Panel
360 Degree Servo
180 Degree Servo
Assorted wiring
C/C#/C++ knowledge

Results

A solar-tracking panel is more efficient than a static panel. I have found, that a static solar panel does not give a consistent voltage throughout the day. For example, from 6-11 AM the voltage was fairly low and slowly rising. On the other hand, the solar-tracking panel had consistent results throughout the day. From 7 AM till about 4 PM the voltage was hovering around 5.5-6.1 volts. Overall, the static solar panel produces much less energy throughout the day than the solar-tracking one did.

Conclusions/Discussion

My hypothesis was correct; a solar-tracking panel is more efficient than a static panel. I have found, that a static solar panel does not give a consistent voltage throughout the day. For example, from 6-11 AM the voltage was fairly low and slowly rising. On the other hand, the solar-tracking panel had consistent results throughout the day. From 7 AM till about 4 PM the voltage was hovering around 5.5-6.1 volts. Overall, the static solar panel produces much less energy throughout the day than the solar-tracking one did.

Summary Statement

I compared the difference between a solar tracking panel and a static solar panel.

Help Received

No one.

Name(s)
Twisha Kurlagunda

Project Number
J0210

Project Title
Analysis of Factors Affecting Solar Cell Performance

Abstract

Objectives/Goals

Solar power is the leading way to address the problem of global warming and pollution from the use of fossil fuels. This project studies the impact energy production of the solar cell due to following factors: (a) Color filters (b) Use of Mirrors (c) Soiling and (d) Time of day (e) Temperature (f) Tilt (g) Orientation.

Methods/Materials

In my experimental setup I used the following materials:(a) 3 mini solar panels (b) Alligator clips (c) Multi-meter (d) Thermocouple (e) Tilt-able easel (f)Hair dryer (g) Color filters (h) Mirrors (i) Dust.
I took measurements connecting the panel to the multimeter and repeated the measurements 6 times during the day for each of the three panels. Every time, I took the measurement, I measured the baseline data using standard conditions (direct sunlight) and compared it against the data using a changed condition (for example with mirrors).

Results

My analysis indicated that many factors had a large impact on solar power:
Time of Day: The solar panels energy production varied during the day and peaked during noon. Just two hours later the power decreased by 30%.
Mirror: Use of the mirror substantially increased the power output by 3 times the baseline. One cheap way could be to place a mirror under the solar panel to improve its performance.
Color: Color of light has a strong impact on the output of the solar cell. Green color contributed least to the production of energy while yellow contributed the most in my study.
Soiling: Soiling impacted the energy production but was not substantial.
Orientation: The data shows that south-west was the best direction to orient the panel in the afternoon.
Temperature: As the temperature increases power output decreases by about -0.2% per F.
Tilt: My experiment found that if solar panel is tilted 25 degrees it will have the maximum power output.

Conclusions/Discussion

As hypothesized my study showed that many factors had a significant impact on the solar performance. I believe a thorough understanding of these factors is important for me to find ways to innovate on improving solar cell performance. I would like to extend this research to come up with an idea to increase performance of the solar cell cheaply. Mirrors seem like one good way to do that. I would like to explore this and other ideas in my future experiments.

Summary Statement

This project is a study of various factors affecting the performance of a solar cell.

Help Received

My father helped me tilt the mirror while I took measurements using a multi-meter. He also helped me take temperature measurements using a thermocouple while I took measurement on the multi-meter.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Kevin P. Lopatka

Project Number

J0211

Project Title

Harnessing Kinetic Energy Efficiently

Abstract

Objectives/Goals

The objective of this project was to find the most efficient method of harvesting kinetic energy using magnets and springs. A handmade electromagnetic generator was used as a model. Currently, much of our energy is generated by burning fossil fuels. I am exploring methods of powering small electric devices through kinetic energy to help reduce the burden on fossil fuels.

Methods/Materials

A simple electric generator was created using a coil of wire with magnets suspended within the coil by two springs on either end of the magnets. When carried, the magnets will bounce up and down through the coil creating electricity. The generator is connected to an arduino which records the voltage of the electricity being generated. Six different sets of springs were tested to determine which set of springs would be most efficient in generating electricity.

Results

Each of the six different springs generated different voltages. Spring #1 contributed to generating the most electricity.

Conclusions/Discussion

Because each of the six springs created differing amounts of electricity, it is clear that the amount of electricity is dependent on the type of spring used. The best spring will bounce most rapidly through the coils with the same amount of motion. Springs that do not move much or springs that are too loose are not the most efficient. Through testing it was also seen that the same springs give different results for children and adults which means that height of people and stride length affect spring selection as well.

Summary Statement

My project is to discover how to most efficiently harness kinetic energy.

Help Received

Father helped with arduino setup.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Gunnar H. McCormick

Project Number

J0212

Project Title

Pee Power: Building a Microbial Fuel Cell in an Attempt to Find More Renewable Energy Sources

Abstract

Objectives/Goals

My project investigated possible sources of renewable energy, and the best way to build a microbial fuel cell in order to maximize the electrical output. My goals were to figure out which source produced the most power in a microbial fuel cell, and to get more than 220 millivolts.

Methods/Materials

I built a homemade microbial fuel cell. I tested its output in volts with using ocean water as a source. I than made numerous improvements to my microbial fuel cell with by testing different sizes of the salt bridge, a second pump, and different sizes of electrodes in an attempt to maximize its electrical output. When I reached the most successful combination, I tested it with mud and urine as well.

Results

The most successful design was the fuel cell with the larger salt bridge, a second air pump, and one electrode of each size. I got a maximum output of 401 millivolts with ocean water, a maximum output of 360 millivolts with mud, and a maximum output of 345 millivolts with urine.

Conclusions/Discussion

My data shows that larger salt bridges, more oxygen, and different sized electrodes increased the electrical output of microbial fuel cells. Ocean water produced the most energy; mud and urine were just about even.

Summary Statement

My project is about building a microbial fuel cell to find more renewable energy sources, and to maximize its output.

Help Received

Dad helped to drill holes; Mom helped edit my paper and glue down my board; Ms. Work helped me to fill out this application.

Name(s)
Grant T. McKechnie

Project Number
J0213

Project Title
Can Polymer Electrolyte Membrane Fuel Cells Power the World?

Abstract

Objectives/Goals
The goal of this project was to find out which can run a fan for the most amount of time, hydrogen and oxygen that is stored in a small reservoir, versus hydrogen and oxygen that is stored in a larger reservoir. On top of that, I tested which was more efficient to produce hydrogen and oxygen, batteries or solar cells.

Methods/Materials
PEM fuel cell kit by horizon
Batteries
Solar panel
Lamp
Small Fan
Water

Results
My results for small and large reservoirs were interesting. The large reservoir test was always at one point better than the small reservoir tests. This was because the small reservoir had a maximum that was dwarfed by the size of the large reservoir's max. The small reservoir peaked at 5 min charging time, and then went down hill.

Conclusions/Discussion
At the end of the day, I figured out that YES, the size of the hydrogen and oxygen reservoir affects how long a fuel cell can power a small fan. I also figured out that battery power was quicker in producing hydrogen and oxygen, but solar power ultimately is the way to go. Disposable battery power is bad for the environment. It comes from chemicals that are hard to recycle and that can kill plants and animals. Solar power, on the other hand, is great because it comes from the best and most renewable source, our sun. Solar power is also way better if we humans want to save our planet. I think that hydrogen fuel cell cars will be more efficient than electric cars. Especially when they can use solar power to produce hydrogen and oxygen to power the car. But for now the things you need for a hydrogen fuel cell system in a car are rechargable batteries, solar panels, a big fuel cell, water and some hydrogen (you can get the oxygen from the air and the hydrogen from electrolysis) and there you have it, a zero emissions car that is efficient and good for the earth.

Summary Statement
My project was about which size hydrogen and oxygen reservoir could make a small fan run for a longer amount of time. On top of that, I tested whether battery power or solar power would be more efficient in producing hydrogen and oxygen.

Help Received
My dad helped me set up the hydrogen fuel cell kit.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Jason B. Morris

Project Number
J0214

Project Title
The Effect of Cooling a Photovoltaic Cell

Abstract

Objectives/Goals
The purpose of this experiment was to determine whether or not the cooling of a photovoltaic cells had a positive impact on the production of solar power. If cooling the photovoltaic cell produced more energy, the follow-up goal was to find the cheapest and most efficient way to generate solar power and warm water (the byproduct of the cooling process) for economically disadvantaged communities.

Methods/Materials
An apparatus needed to be created to cool the photovoltaic cells. Two pieces of sheet metal 12# x 12#, which is considerably cheaper than copper, were placed on top of one another with metal spacers in between the sheets. The internal spacers were placed in a zigzag pattern to direct the flow of the water in order to achieve a more efficient cooling action.

Two water ports were installed and the edges of the cooling unit were sealed off with silicon. The cooling system was placed on the back of the photovoltaic cell and water was pumped through it. Using both a cooled and a non-cooled photovoltaic cell, the power produced at different intervals was measured. The power produced was calculated using Ohm's law, along with a voltmeter and a 20 ohm resistor.

Results
The results showed that the cooled photovoltaic cell produced an average of 20% more power than the non-cooled photovoltaic cell.

This cooling apparatus will reduce the number of photovoltaic cells needed to produce power.

Conclusions/Discussion
This means that economically disadvantaged communities, both within the USA and in other countries, are able to have access to affordable electricity, some of them for the first time.

In addition, the byproduct - warm water, will be available for their household purposes.

Summary Statement
The purpose of this experiment was to determine whether or not the cooling of a photovoltaic cells had a positive impact on the production of solar power.

Help Received
Dad helped cut sharp sheet metal.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Dylan Nguyen; Joshua Van Doren

Project Number
J0215

Project Title

How Do Nature's Elements Affect a Solar Panel's Power Production?

Abstract

Objectives/Goals
The objective of our project is to examine how nature's elements, namely, the panel's angle to the sun, shade, wind, rain, temperature, and dust will affect a solar panel's power production, for the purposes of determining the most ideal natural conditions in which a solar panel will be most efficient.

Methods/Materials
Using a multi-meter, we measured a monocrystalline solar panel's voltage and amperage output to determine it's power production under various elements of nature. We first established the optimal angle of the solar panel to the sun and measured how changing the angle of the panel would affect the output. Using the optimal angle as a constant for the rest of the project, we then tested the panel under shade conditions and various wind speed conditions using a leaf blower and an anemometer for wind speed. In addition, we tested the panel under rain conditions using a sprinkler and local rain chart information to estimate a typical rain event. We also tested the panel under cold temperatures by lowering the panel's surface temperature with ice. Finally, we measured how dust would alter the power output of the panel.

Results
From the data gathered, we found that the greatest change to the power output of a solar panel was determined by the amount of direct sunlight that was able to hit the panel. There was a drop off of power production in our sunny day trials, from an average of 94.5 watts to only 3.5 watts, when the panel was in full shade. The other greatest change was due to the angle. When the panel was angled 40 degrees away from the sun, it caused the average to drop from 87.9 watts to 59.6 watts. Wind and rain had very little or no affect on the power production, while dust only created an average change of 2.5 watts. Contrary to our hypothesis, a lower temperature actually increased the panel's efficiency by an average of 19.9 watts when cooled down by about 68 degrees.

Conclusions/Discussion
To provide the most production from a monocrystalline solar panel, the ideal conditions would be to keep it away from shade, in direct sunlight, and at an optimal angle to the sun if possible. Keeping the panel clean and dust free would be preferred, but this does not change the output that drastically. Wind and rain had little to no affect. If there is a way to keep the temperature of the panel cool, while still maintaining full sunlight, overall power production would be increased.

Summary Statement
We examined how nature's elements affected a solar panel's power production.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Jacob Passalaqua; Matthew Prata

Project Number

J0216

Project Title

Just Charge It: Thermoelectric Generator Gear for the Active Person (Charge Small Electronics Using Your Own Body Heat)

Abstract

Objectives/Goals

The objective of our project is to create a thermoelectric generator vest which can charge small electronic devices such as a cell phone based on the Seebeck Effect.

Methods/Materials

11 Peltier Tiles
11 Heat Sinks
Insulated wire
Transistor
1K Ohms Resister
Toroid
LEDs
Window Screen
Old Shirt for vest
Infrared laser Thermometer
Cell Phone & Charger Cable
Multi Meter

Results

Our goal was to generate 4 volts with our TEG with as little as a 30 degree temperature difference between body heat and ambient temperature. At first our TEG only produced .7 volts so we looked into making it more efficient and came across a simple devise called the Joule Thief, which is a voltage booster. We built our own Joule Thief and added it to our TEG. We were able to then generator enough electricity to light up a 2 volt LED.

Conclusions/Discussion

Our experiment proved to be correct. By using Peltier tiles, we were able to create a thermoelectric generator based on the Seebeck effect. We were able to charge our cell phone, light up our display board and run a clock all at the same time with our TEG but only when we created a large artificial temperature difference by using a hot plate and room temperature. However, by adding 1 homemade Joule Thief to our TEG, we were able to generate 3 times the voltage thus generating 2 volts with just using simulated body heat. With this major break through, we believe that by adding a Joule Thief to each Peltier circuit on the TEG we should be able to generate enough volts to charge our smart phone.

Summary Statement

Based on the Seebeck Effect, we built a thermoelectric vest that produces electricity powered by body heat to generate enough volts to charge a small electronic device.

Help Received

My Mother, Christine Prata, helped sew the window screen to the shirt. She also helped us solder wires together and for safety she observed us during our experiments.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Arvind Ramachandran

Project Number
J0217

Project Title
Waste Not, Watt Not: Effect of Coffee Grounds on the Efficiency of Microbial Fuel Cells

Abstract

Objectives/Goals
Microbial Fuel Cells (MFCs) generate electricity using energy produced by bacteria when they break down organic waste. My project aims to determine if coffee grounds can be used to improve the efficiency of an MFC. I predicted that coffee grounds would improve the efficiency of MFCs because they contain high amounts of nitrogen, which promote bacterial growth.

Methods/Materials
I assembled 5 two-chamber MFCs using plastic containers. I used galvanized zinc mesh, carbon paper, and copper wires to construct electrodes. I made salt bridges by pouring a solution of water, agar-agar and salt into plastic tubes. I connected the electrodes in the two chambers with a solid wire for electrons to flow from cathode to anode. I connected the chambers with a salt bridge for hydrogen cations to move from anode to cathode. Each cathode chamber contained 705ml of water. The anaerobic anode chambers contained different concentrations of a mixture of soil and coffee grounds; I used 0% (control), 40%, 60%, 80% and 100% coffee grounds. I used a multimeter to measure the voltage and current generated by each MFC over 3 days, and repeated the experiment 3 times.

Results
The Control (0% coffee) produced the least amount of electricity. MFCs with higher concentrations of coffee grounds produced higher voltage and current; MFC #5 (100% coffee) was the highest and produced 150mV on average. While MFC #5 (100% coffee) produced the most voltage, it was only marginally better than MFC #4 (80% coffee grounds). When measured over 3 days, the Control produced steadily increasing voltage, whereas other MFCs did not show consistent improvements over time.

Conclusions/Discussion
In conclusion, my hypothesis that coffee grounds would improve the efficiency of MFCs was supported. MFCs containing coffee grounds were more efficient, and higher concentrations of coffee grounds increased the amount of electricity produced. The MFC containing only coffee grounds produced the most electricity in all three trials.

Summary Statement
My project examines the effect of coffee grounds on the efficiency of soil-based microbial fuel cells

Help Received
My dad assisted me in building the Microbial Fuel cell; my mom helped with the board; and my science teacher, Mrs. Nguyen, provided guidance throughout this project.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Anton N. Semerdjiev

Project Number

J0218

Project Title

The Photovoltaic Effect

Abstract

Objectives/Goals

My task in this project was to investigate how the frequency (color) of light affects the output of a solar panel. Based on my background research, my hypothesis was that the colors of light with higher frequencies would result in higher electrical power at the output of the solar panel.

Methods/Materials

The order from highest to least frequency corresponded to the following colors: sunlight, violet, blue, green, yellow, orange, and red. During the experiment, I used a monocrystalline solar panel and color filters to filter sunlight and change the independent variable color or frequency of light. I mounted the solar panel on a base made of Lego bricks to keep the angle towards the sun rays the same. The dependent variables, the output current and voltage, I measured with a multimeter. Then, I found the output electrical power by multiplying these two variables.

Results

The experiment results were different from what I had expected. Sunlight did result in the highest output power. However, colors like yellow and orange produced more electricity than darker colors.

Conclusions/Discussion

After analyzing the data, I came to the conclusion that the frequency of light shining on a solar panel does affect its output. My hypothesis was mainly based on a formula that showed the relationship between frequency and light energy. I assumed that the higher energy the photons had the more electrons would be released. I overlooked the fact that a single photon can only knock off a single electron, therefore how energized the light is doesn't necessary mean more electrons will be freed. I should have also taken into consideration that solar cells are made of various materials with different band gaps. A band gap is the energy needed to knock off an electron from its position and allow it to become part of the electrical current. The colors that have photon energies at the band gap will be the most efficient ones. Sunlight, having the broadest spectrum, has the highest number of photons within the band gap of the solar cell, therefore generates the highest power. For my monocrystalline solar panel the colors that worked best, after unfiltered sunlight, were yellow, orange, and red. The rest of the colors I tested had higher frequencies but generated lower output power.

Summary Statement

My project was based on finding out which frequency or color of light worked the best or in other words resulted in highest output power of a solar panel.

Help Received

My mom for helping with my online research and teaching me how to use the multimeter. My dad for assisting me during my experiment to complete the trials fast so the intensity of light wouldn't change much. Last but not least, my science teacher Mr. Cady for his valuable guidance.

Name(s)
Siya Sharma

Project Number
J0219

Project Title

Dye-Sensitized Solar Cells vs. Silicon Based Solar Cells: Which One Is More Efficient?

Abstract

Objectives/Goals
The objective of my project is to compare the efficiency of Dye-Sensitized Solar Cells to that of standard Silicon Based Solar Cells.

Methods/Materials
Three Dye-Sensitized Solar Cells of equal size and thickness were constructed from scratch. These 3 Dye-Sensitized Solar Cells along with 3 commercially available Silicon Based Solar Cells (of same dimensions) were then placed in direct sunlight at the same time. Using a digital multimeter, the output from these solar cells was measured in terms of Open Circuit Voltage (V) and Short Circuit Current (mA). Finally, based on the measurements of Voltage and Short Circuit Current, the efficiency of Dye-Sensitized Solar Cells was compared to that of standard Silicon Based Solar Cells.

Results
In all three trials, the Silicon Based Solar Cells had much higher Open Circuit Voltage and Short Circuit Current readings as compared to the Dye-Sensitized Solar Cells. The Silicon Based Solar Cells had an average Voltage output of 3.55 V, 3.53 V, and 3.48 V, and Short Circuit Current output of 57.6 mA, 57.7 mA, and 55.8 mA during the three trials. In comparison, the Dye-Sensitized Solar Cells had an average Voltage output of only 0.24 V, 0.23 V, and 0.20 V and average Short Circuit Current output of 4.8 mA, 4.7 mA, and 4.4 mA.

Conclusions/Discussion
Efficiency of a solar cell is defined as the ratio of output energy from a cell to input energy from the sun. The amount of electrical power a Dye Sensitized Solar Cell (DSSC) can produce depends on how effectively the photons are absorbed by the dye. Dyes in general have poor absorption across the solar spectrum which means that fewer photons in the sunlight are being used for current generation. In addition, lack of stability and losses due to its chemical components result in an overall lower efficiency for DSSC. Silicon Based Solar Cells in comparison have better absorption across the entire spectrum of sunlight resulting in higher efficiencies. My hypothesis was that given my project settings, I would expect the Silicon Based Cells to be more efficient. Based on the results of output Voltage and Open Circuit Current measurements in all 3 trials, my hypothesis stood correct. In conclusion, Silicon Based Solar Cells are more efficient than Dye-Sensitized Solar Cells.

Summary Statement
To compare the efficiency of Dye-Sensitized Solar Cells with that of Silicon Based Solar Cells.

Help Received
Father provided help: With supervision during construction of Dye Sensitized Solar Cells; while sourcing some of the materials used in the project; during preliminary research of the project.

Name(s)

Isabel W. Sperandio

Project Number

J0220

Project Title

Does the Color of Light and the Temperature of Solar Panels Improve the Efficiency?

Abstract

Objectives/Goals

The purpose of this experiment is to find out if solar panels are more efficient at a certain temperature, when a certain color of light is shined on it, or when fluorescent colors are shined on it. When something is fluorescent it absorbs UV light and emits it as a light with a longer wavelength.This would be very useful because the best solar panels can only absorb 20% of the sun#s energy. Moreover, they are very expensive to build, so improving them would help make them worth more, and we would be able to produce more clean energy.

Methods/Materials

I did two experiments. The first experiment would test which temperature solar panels have the highest amount of electricity at. I changed the temperature by putting dry ice, wet ice, and blowing hot air (with a hair dryer) at the solar panel with a hair dryer. Then I measured voltage and amperage with a multimeter. My second experiment would test if different colors of light, and fluorescent colors affected it. I put a colored sheet at the bottom of the box, reflected light off of it and on to the panel, measured voltage and amperes and then went on to the next color.

Results

In my temperature experiment, the solar panel produced electricity in the cold than when it was warm. Amazingly, my solar panel produce 373% more energy in extreme cold temperatures (-56 degrees at 1.332 micro watts) than in warm temperature (60 degrees at 0.3563 micro watts). The different colors also changed the watts of the solar panel. The yellow was at 0.722 micro watts while the blue was 0.389 micro watts. Fluorescent yellow worked very well for the solar panel, surprisingly a few nanowatts better than the white. Fluorescent yellow was at 0.811 micro watts and white was at 0.771 micro watts.

Conclusions/Discussion

From my experiment, I can conclude that solar panels are more efficient in the cold, and in fluorescent light. A way to improve them would be to have a water cooling system, where the solar panel pumps the cool water over itself and into the house. A see- through fluorescent coating might also help boost the electricity production of a solar panel up.

Summary Statement

My project is testing if the color of light and the temperature of solar panels improve the efficiency.

Help Received

My dad helped expand on idea, gave suggestions, helped wire my board, and supplied my materials.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Sean P. Weiss

Project Number

J0221

Project Title

From Waste to Watts

Abstract

Objectives/Goals

In this experiment, I tested which animals# waste produces the most easily harnessed methane energy.

Methods/Materials

I used animal waste from cow, horse, dog and pig to undergo fermentation and harvest methane gas, which can then be converted to energy. I will need to be able to harness the energy quickly and efficiently to make sure I get maximum methane output. From there I need to find a way to measure and analyze the methane collected and carry out calculations to convert the information.

Results

I found that cow waste has the potential to produce more energy than any other animal because it produces a long-term count of methane gas. It was able to produce easily captured methane for over a month and still continues to produce weeks later. It can reach its full methane potential from 75 degree Fahrenheit incubation. Overall, cow waste has a great potential for making a cleaner planet and a cleaner source of power.

Conclusions/Discussion

My research has proved my research-based hypothesis correct. I hypothesized that if cow waste undergoes fermentation fastest, then it will make the most stable and usable methane gas because fermentation helps to produce methane. Finally the dog waste didn#t produce any methane but I do have a solution to that problem. It needed to be incubated at a higher temperature in order to produce any methane. All in all my experiment was a large success because I have found a cleaner source of energy for us to make a cleaner society.

Summary Statement

I found a way to harvest green, usable energy produced from the methane gases from animal waste and identify the animal waste with the highest energy potential.

Help Received

I worked alone on this project and only had help from my mom getting the animal waste from the local farm.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
Luke R. Wilhelm

Project Number
J0222

Project Title
Danger High Voltage: Especially When Cold

Abstract

Objectives/Goals
The objective of this experiment is to see how the voltage output of a solar cell is affected by different temperatures.

Methods/Materials
Materials: solar cell, multimeter, lamp, hairdryer, ice packs, wooden board, box, wire clips.
Methods: shining light over solar cells, use ice packs and hairdryer to influence temperature, record voltage, record different temperatures.

Results
When the solar cell is colder, the voltage output is higher. Using a circuit consisting of the solar cell under the light and the 2,000 ohm resistor, the hottest average temperature of 66.4 degrees Celsius produced the lowest voltage output of 4.1 volts. The lowest average temperature of 12.7 degrees Celsius, produced the highest average voltage output of 4.6 volts.

Conclusions/Discussion
The results from this experiment support the hypothesis, which was that the solar cell's voltage output would decrease as the temperature rises. This is because of the quasiparticles, called phonons, which move around the solar cell faster in higher temperatures. This movement blocks the flow of electrons, which then in turn decreases the voltage output.

Summary Statement
This project is about testing to see how different temperatures affect the voltage output of a solar cell.

Help Received
My parents helped me construct the testing apparatus I used to conduct my experiment.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Heaven A. Williams

Project Number

J0223

Project Title

Solar Water Collector: Effect of Collector Diameter, Tilt, and Cover Material on Efficiency

Abstract

Objectives/Goals

The purpose of this project was to explore the impact of copper tube diameter, tilt, and cover material on the efficiency of a homemade solar water collector.

Methods/Materials

Two identical solar collector boxes were built with aluminum sheet absorbers at the base. Effectiveness of three different copper tubes (inside diameters, 1.27cm; 1.9050cm; 2.5400cm) was compared. These three different diameter copper tubes had the same length and parallel riser design. Two solar collectors with two different diameter copper tubes were tested at a time, with collectors always facing south to maximize the amount of solar energy collected. Six additional tests compared the effectiveness of two identical solar collectors (inside diameters, 1.27cm) mounted at different angles. In six final tests, the water collectors were covered with different transparent materials (acrylic sheet and glass) to test for efficiency.

Results

Results of the first six tests showed that the most effective copper tube had the smallest diameter (1.27cm). The acrylic sheet performed better than ordinary glass, always having the highest temperature increase. In six final tests, the solar collector mounted at an angle equal to the latitude of the test site's geographical location performed best.

Conclusions/Discussion

These results suggests that perhaps the 1.27cm copper tube used for this experiment, with increased number of riser tubes, decreased spacing between the risers, and an increased water collector surface area would perhaps maximize the efficiency of a collector. Further investigation to explore the impact of increased number of riser tubes, increased solar water collector surface area, and decreased spacing between riser tubes, using the 1.27cm copper tube should be explored.

Summary Statement

The impact of copper tube diameter, tilt, and cover material on the efficiency of a homemade solar water collector.

Help Received

Mr. Luke Rinard, an engineer, provided some guidance. Mr. Henry Guerrero soldered the copper tubes.

CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Derek Li Yao

Project Number

J0224

Project Title

Charging a Smartphone Using Its Own Heat Source

Abstract

Objectives/Goals

My objective of my project was to try see if you could charge a smartphone using its own heat that it emits. My hypothesis was: If I can capture enough heat from a smartphone and convert it efficiently into electricity, then I can power a smartphone using its own heat without any batteries or kinetic energy. My project focuses on renewable energy and utilizing heat as a source of electricity without.

Methods/Materials

My experimental design would use a iPhone, a TEG module, a heat sink, an adjustable voltage step- up circuit, and a travel adapter charger. Before we begin, it is essential to know that a TEG module produces electricity when one side is heated and the other side is cooled. The larger the temperature differential on the TEG module, the more electricity is produced. A heat sink cools something hot. A voltage step- up circuit steps up the input voltage to a higher output voltage. How my experimental design works is you attach a TEG module to the back of a smartphone. The heat of the smartphone produced and the heat sink on the other side of the TEG module makes electricity. But since the electricity is not sufficient to charge a smartphone, you would hook up the TEG module to the adjustable voltage step- up circuit to increase the voltage. With high enough voltage and current to charge a smartphone, you would then attach a port to the step- up circuit. You then plug in the travel adapter into the port and the smartphone to charge the smartphone. So essentially, you are charging a smartphone using its own heat.

Results

I was not able to successfully accomplish the goal of my project because of insufficient voltage needed to be able to step up the voltage. To further explain, you need a certain input voltage for a step- up circuit to work but I was not able to achieve that voltage limit because the temperature differential was not high enough. But once I get enough voltage for the step- up circuit to work, my project will work.

Conclusions/Discussion

I was not able to achieve my objective but I am confident that this project will work. This project expands our knowledge of renewable energy because the research from my project might be beneficial to other people working on the subject of alternate energy. I hope that this project inspires others to look into alternate energy because the field of alternate energy is a unexplored, promising potential for other ways of obtaining energy.

Summary Statement

My project essentially focuses on renewable energy by taking the heat of a smartphone and converting it to electricity to charge the phone.

Help Received