High Tech Home for Elementary School Students

Energy Production:

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Abstract: To design an indoor house to be marketed and sold to elementary schools in order to assist in educating students in grades 3-6 in the STEM disciplines (Science, Technology, Engineering and Mathematics). The goal is to develop such a product with the intention of fabricating and marketing the units in a 'for-profit' business venture. The system should be:

a. educational in the areas described (STEM disciplines),
b. easy to construct (and disassemble) with a variety of optional configurations possible,
c. safe, durable, interactive and affordable
d. allow for upgrades and additional 'attachments' over time.
e. incorporate high tech and various technologies to excite and inspire the students, as well as motivate them.

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Problem: To create a section of the house that helps kids to understand and engage in energy production.

Concept of Operation: We are designing a panel to that is to be sold to schools, parents or any organization interested in furthering the education of Science, Technology, Engineering and Mathematics in elementary students. Our group is responsible for developing a subsystem that will go into detail on energy production.

Specifications:

1) To identify and build energy production systems:
    - Micro hydro
        i. Water fall
        ii. Dam
        iii. Rivers
        iv. Work with water group to show
    - Geothermal
        i. Heating water from earth's core
    - Solar panels
        i. On houses for communities
        ii. Desert for large scale energy production
    - Wind
        i. Wind turbines on beaches, mountain tops, desert
        ii. Have fan blow small scale one to power LED
    - Mechanical
        i. Cranks
    - Solar heating
2) To experiment with
    - Micro hydro
        - Different propellers
        - Flow rate
        - Size
    - Geothermal
        - Flow rate
        - Water heat
    - Solar panels
        - Cloud patterns

        - Roof angle
        - Sun angle
        - Sun brightness
    - Wind
        - Wind speed
        - Turbine height
        - Propellers
    - Mechanical
        - RPM
        - Gears
    - Solar heating
        - Sun angle
        - Tubing angle
        - Clouds
        - Amount of water
3) To interface with
    - Each will have the ability to power one another and create sustainable energy making the whole setup green

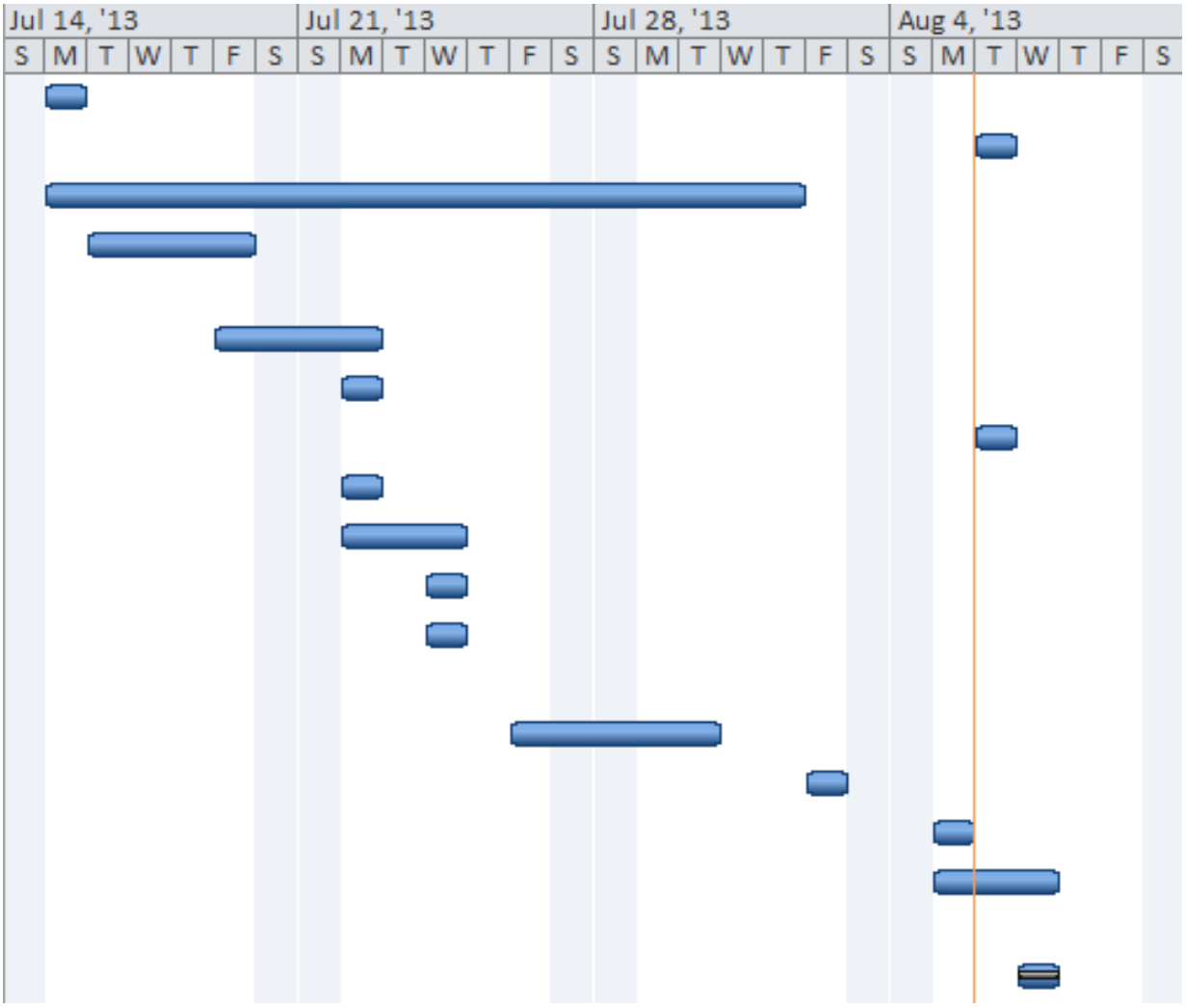
Developing Specs: The specs were developed by doing surveys with elementary kids. Lots of background research was also done on different kinds of energy production and activities that kids enjoy and easily connect with.

Schedule:

Task Name	Duration	Start	Finish
Start Project	1 day	Mon 7/15/13	Mon 7/15/13
Determine Customer Needs			
Class Discussions	14 days	Mon 7/15/13	Thu 8/1/13
Create List of Customer Needs	4 days	Tue 7/16/13	Fri 7/19/13
Research	2 days	Fri 7/19/13	Sat 7/20/13
Revise Problem Statement	1 day	Sat 7/20/13	Sat 7/20/13
Generate Concepts			
Break Down Project	1 day	Mon 7/22/13	Mon 7/22/13
Create List of Designs	3 days	Mon 7/22/13	Wed 7/24/13
Select Best Design	1 day	Wed 7/24/13	Wed 7/24/13
Class Discussion	1 day	Wed 7/24/13	Wed 7/24/13
Research	2 days	Sat 8/24/13	Mon 8/26/13
Revise Concept	3 days	Fri 7/26/13	Tue 7/30/13
Present Current Design	1 day	Fri 8/2/13	Fri 8/2/13

Research	1 day	Mon 8/5/13	Mon 8/5/13
Finalize Design and Presentation	3 days	Mon 8/5/13	Wed 8/7/13
Present	1 day	Wed 8/7/13	Wed 8/7/13

Gantt chart:



Research:

Solar

- One kilowatt equals 1,000 watts.
- One kilowatt-hour (kWh) equals the amount of electricity needed to burn a 100 watt light bulb for 10 hours.
- A sunny location (like Los Angeles, California, US) receives an average of 5.5 hours of sunlight per day each year.
- A cloudy location (like Hamburg, Germany) receives 2.5 hours per day of sunlight each year.
- A 1 kilowatt peak solar system generates around 1,600 kilowatt hours per year in a sunny climate and about 750 kilowatt hours per year in a cloudy climate.
- A solar energy system can provide electricity 24 hours a day when the solar electric modules are combined with batteries in one integrated energy system.
- Solar modules produce electricity even on cloudy days, usually around 10-20% of the amount produced on sunny days.
- The typical components of a solar home system include the solar module, an inverter, a battery, a charge controller (sometimes known as a regulator), wiring, and support structure.
- A typical silicon cell solar module will have a life in excess of 20 years
- Monthly average residential consumption of electricity in the US in 2008 was 920 kilowatt hours. (Source: US DOE)
- Monthly average residential electricity bill in the US in 2008 was $103.67. (Source: US DOE)

Quick Facts about Wind Energy

- What is wind energy?
- The terms "wind energy" or "wind power" describe the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity to power homes, businesses, schools, and the like.
- What causes the wind to blow?
- Wind is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetative cover. This wind flow, or motion energy, when "harvested" by modern wind turbines can be used to generate electricity.
- When was wind energy first used?

- Since earliest recorded history, wind power has been used to move ships, grind grain and pump water. There is evidence that wind energy was used to propel boats along the Nile River as early as 5000 B.C. Within several centuries before Christ, simple windmills were used in China to pump water.
- In the United States, millions of windmills were erected as the American West was developed during the late 19th century. Most of them were used to pump water for farms and ranches. By 1900, small electric wind systems were developed to generate direct current, but most of these units fell into disuse as inexpensive grid power was extended to rural areas during the 1930s. By 1910, wind turbine generators were producing electricity in many European countries.
- How is the energy in the wind captured?
- Wind turbines, like aircraft propeller blades, turn in the moving air and power an electric generator which supplies an electric current. Modern wind turbines fall into two basic groups; the horizontal-axis variety, like the traditional farm windmills used for pumping water; and the vertical-axis design, like the eggbeater-style Darrieus model, named after its French inventor. Modern wind technology takes advantage of advances in materials, engineering, electronics, and aerodynamics. Wind turbines are often grouped together into a single wind power plant, also known as a wind farm, and generate bulk electrical power Electricity from these turbines is fed into the local utility grid and distributes to customers just as it is with conventional power plants.
- How big are wind turbines?
- Wind turbines are available in a variety of sizes, and therefore power ratings. The largest machine, such as the one built in Hawaii, has propellers that span the more than the length of a football field and stands 20 building stories high, and produces enough electricity to power 1400 homes. A small home-sized wind machine has rotors between 8 and 25 feet in diameter and stands upwards of 30 feet and can supply the power needs of an all-electric home or small business.

Mechanical

1. Kinetic Energy
    - When an object is in motion, the type of energy on display is kinetic energy. Some of the many forms of kinetic energy include rotational (energy from spinning around an axis), vibrational (energy from vibration) and translational (energy from the movement from one location to another). The equation to solve for the amount of kinetic energy of an object at a given time is: KE = (1/2) * m * v^2, where m = the mass of the object and v = the velocity of the object.

Potential Energy

- Where kinetic energy is the energy of motion, potential energy is the energy stored in an object depending on its position. In this form, the energy is not doing work, but it does have the potential to be converted to other energy forms. In the case of mechanical energy, potential energy transforms into kinetic energy when the object is set into motion. Two forms of potential energy are gravitational and elastic potential energy. Gravitational potential energy is the energy of an object depending on its height above the ground. Elastic potential energy is the energy stored in an object that is stretched or compressed, like a spring.

Hydroelectric

Dams: This method extracts the potential energy of water collected in dams. Water turbines and generators are driven to extract such energy. The amount of power extracted depends upon the volume of water as well as upon the difference between the height of the water source and the water outflow. Such difference in height is known as head and the potential energy of the water is directly proportional to the head.

Pumped Storage: Under this method, electricity is generated by moving water between reservoirs located at different heights. This method is useful for supplying electricity on occasions of high peak demands. When the demand is high, water is released from a higher to a lower reservoir by running a turbine and in times of low demand, water from lower reservoirs are pumped up into higher reservoirs.

Run-Of-The-River: As opposed to pumped storage, run-of-the-river electricity stations are not designed to store water and they have a much smaller reservoir capacity than pumped storage stations. The rest of the mechanism, using elevation and drop of water sources, is similar to pumped storage.

Tidal Power Generation: Power plants generating tidal power harness the energy generated by daily rise and fall of water due to the tidal phenomenon.

Geothermal energy facts. Geothermal energy is renewable energy source. Read some interesting facts about geothermal energy.

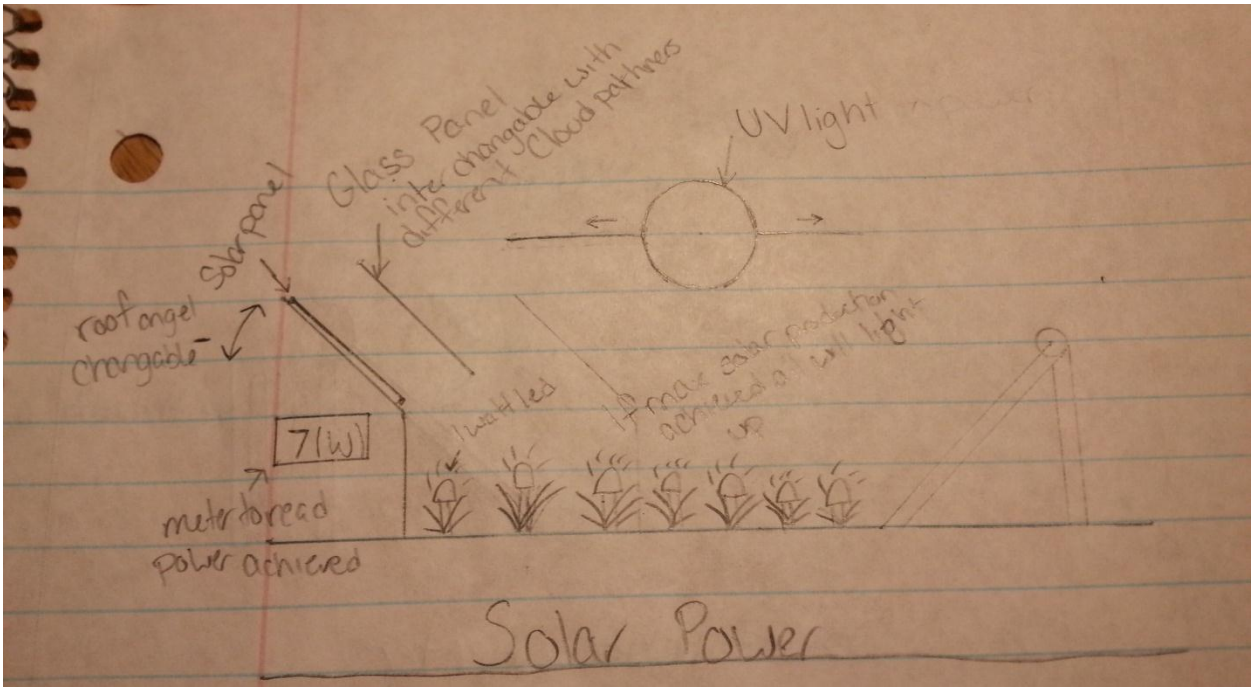
- Geothermal energy is a form of renewable energy derived from heat deep in the earth's crust.
- Geothermal Energy has been around for as long as the Earth has existed. "Geo" means earth, and "thermal" means heat. So, geothermal means earth-heat.
- Geothermal power is generated in over 20 countries around the world including Iceland, the United States, Italy, France, Lithuania, New Zealand, Mexico, Nicaragua, Costa Rica, Russia, the Philippines, Indonesia, the People's Republic of China and Japan.

- The entire world resource base of geothermal energy has been calculated in government surveys to be larger than the resource bases of coal, oil, gas and uranium combined.

- For every 100 meters you go below ground, the temperature of the rock increases about 3 degrees Celsius. Or for every 328 feet below ground, the temperature increases 5.4 degrees Fahrenheit.
- New facilities can produce electricity from geothermal energy for between 4.5 and 7.3 cents per kilowatt-hour, making it competitive with new conventional fossil fuel-fired power plants.
- Iceland is situated in an area with a high concentration of volcanoes, making it an ideal location for generating geothermal energy. Over 26% of Iceland's electrical energy is generated from geothermal sources. In addition, geothermal heating is used to heat 87% of homes in Iceland.Icelanders plan to be 100% non-fossil fuel in the near future.
- Geothermal energy is called a renewable energy source because the water is replenished by rainfall, and the heat is continuously produced by the earth.
- Even though geothermal energy is technically a finite resource, the typical lifetime for geothermal activity around magmatic centers - from 5,000 years to 1,000,000 years - is so long that it is considered a renewable resource.
- A common way in which geothermal energy is obtained is through tapping into hydrothermal sites, also called geothermal springs. These sites are geologically active places where water seeps into the Earth's crust and is heated by the Earth's interior, rising to the surface as steam.

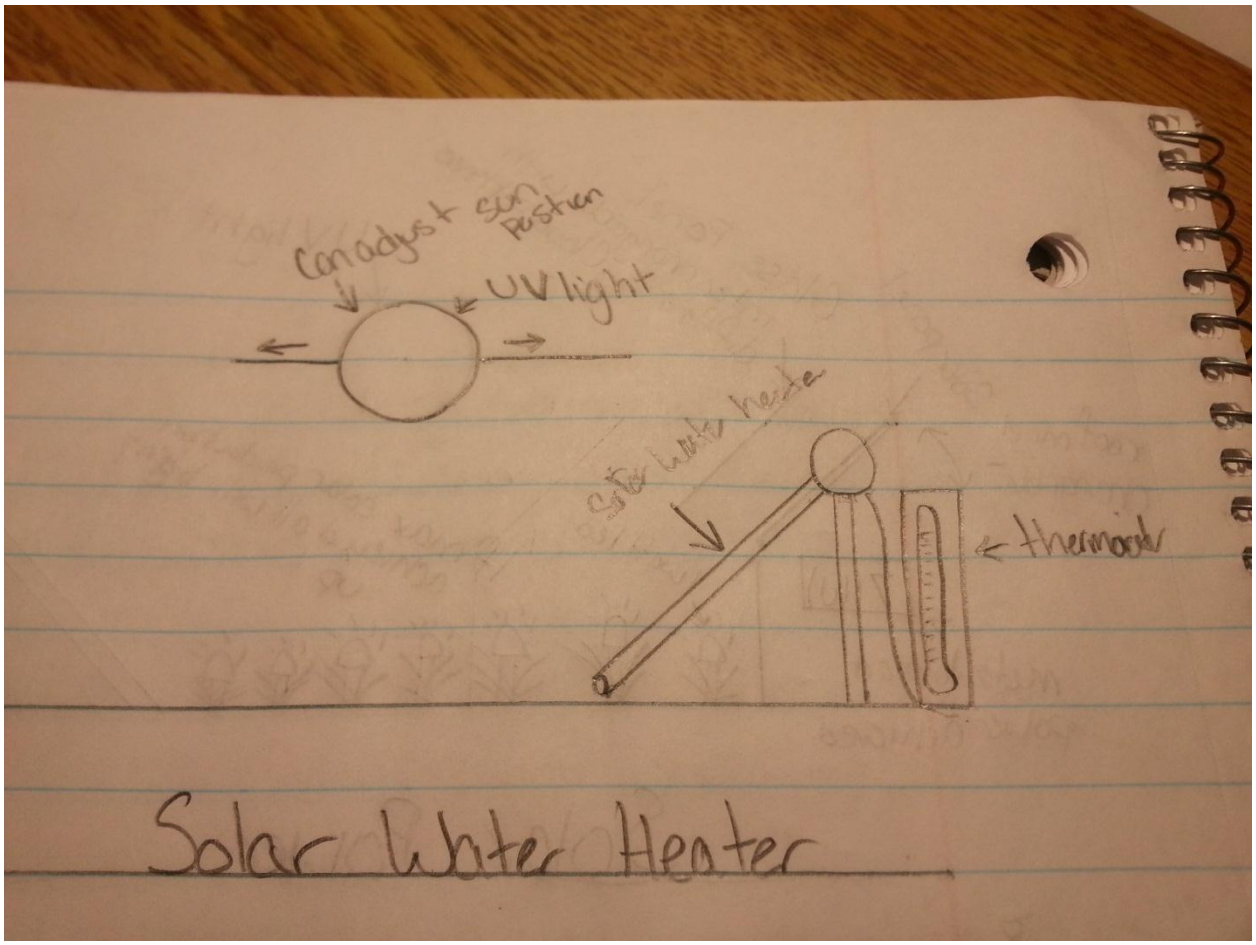
Subsystems:

- **Solar Power**



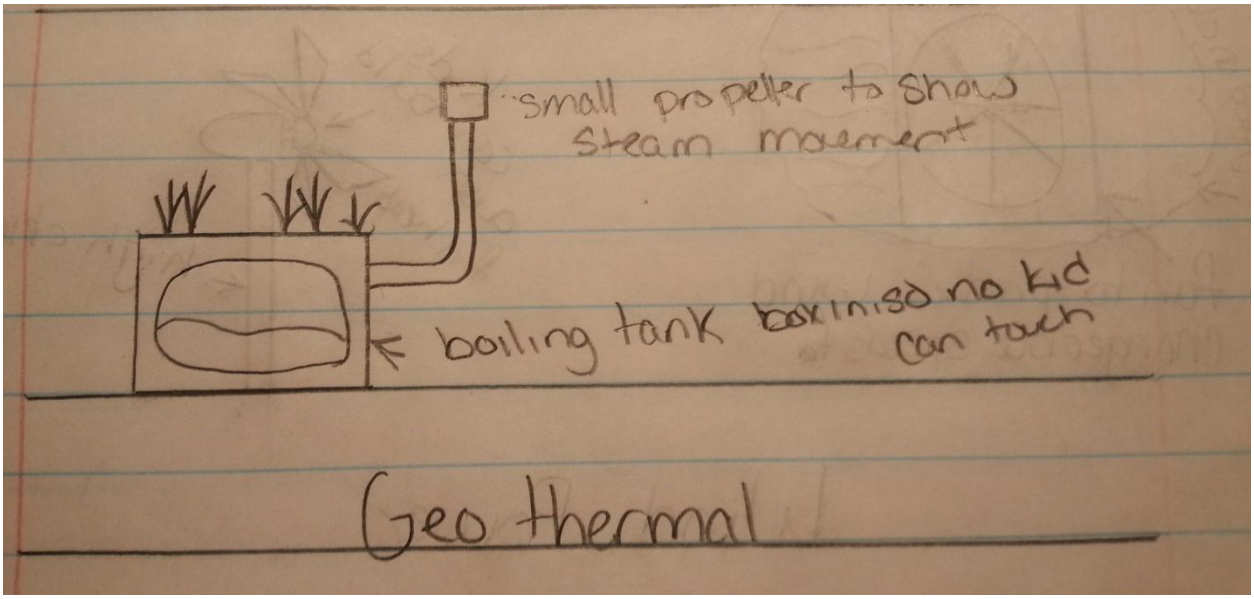
  - Description: the light powers the solar cell
  - A meter then measures the amount of energy being produced
  - If full potential of power is reached then all lights will light up
  - Kids can change variables in the set up like
    - Angle of the roof
    - Distance of the sun
    - Glass panels can be inserted between solar panel and light to simulate cloud patterns

- Solar Water Heating



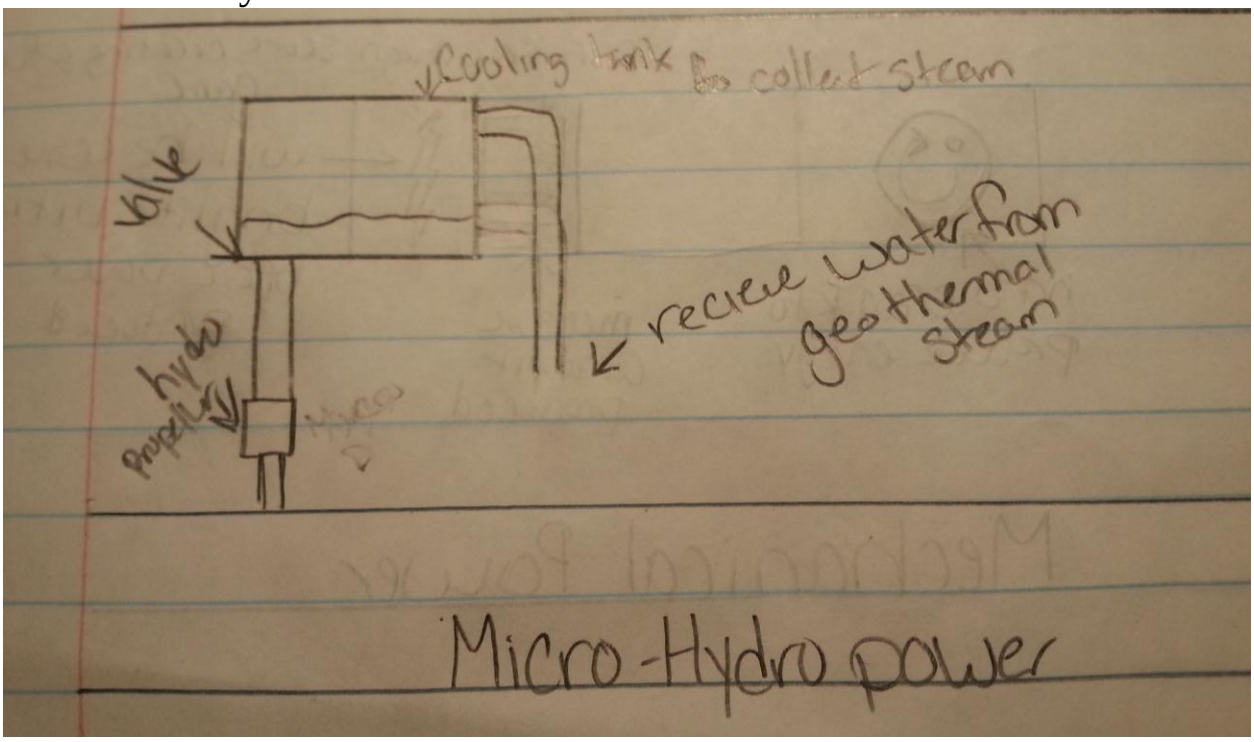
- Description: the light will create the energy that will cause the heater to warm the water
- As the water warms the thermometer will read the temperature increase
- Variables:
  - The lights distance
  - Angle of heater
  - Amount of water

- Geothermal



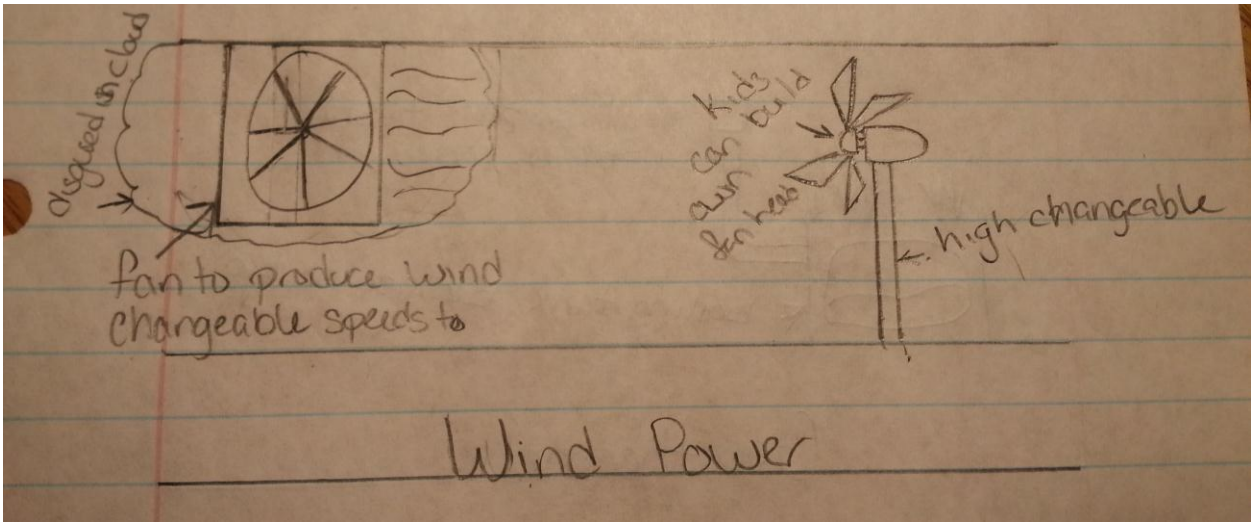
  - Description: water would be collected into a heating tank where it would be heated simulating the earths ground as the heater.
  - The water would then move a small pre installed turbine that would show on a meter the electric produced
  - Variables:
    - Flow rate

- Micro-hydro



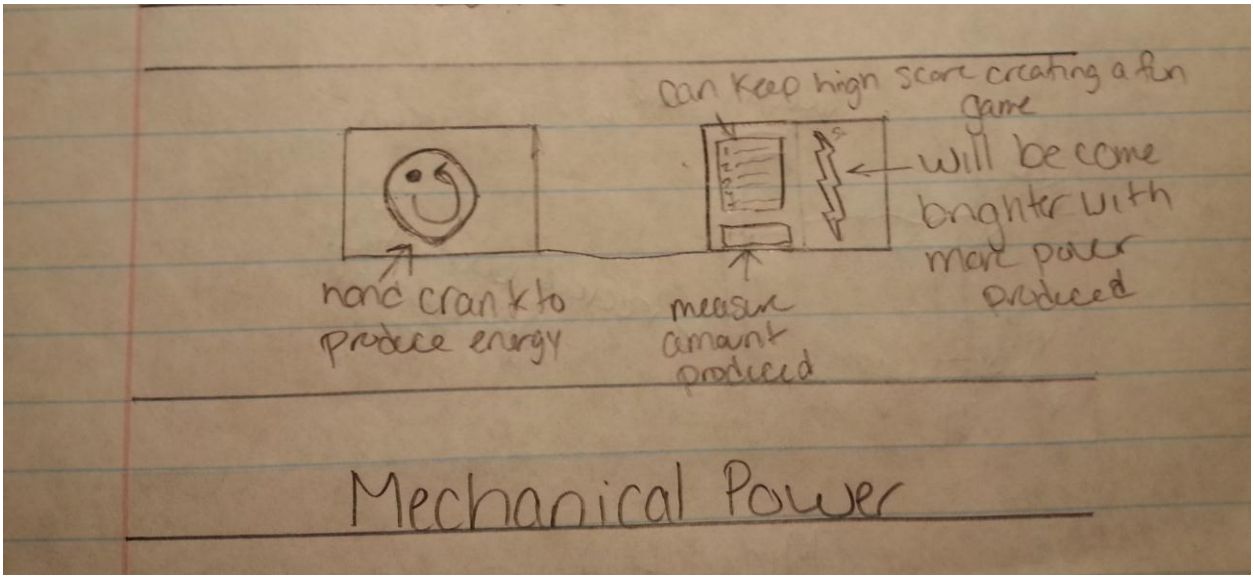
  - Description: Water will be located in a tank
  - Using gravity the water will flow through a valve located on the bottom of the tank
  - The water will then flow a pipe that has a micro hydro turbine in it
  - Variables:
    - Flow rate

- Wind Power



  - Description: A fan will produce wind
  - Kids will build their own propellers for turbine and produce electric
  - A meter will measure the electric produced and then will be connected to lights that will light grow in brightness as more energy is produced
  - Variables:
    - Height of turbine
    - Fan speed
    - Custom propellers

- Mechanical



  - Description: A hand crank will produced electric
  - The electric will go to the box where a meter will show how much current is being produced
  - The more power being produced the higher a bar on the lighting bolt will rise as it lights up
  - The top 10 ten highest current produced will be record on a leaders board
  - Variables:
    - How fast can the turn the crank
    - Competition on leader board

How each will interact:

- Mechanical power will be able to power the light for solar power and water heating or run the fan for the wind turbine
- The power created by the solar panel can power the fan and vise versa
- The solar water heater could heat the water for geothermal
- The water flow from geothermal could feed micro hydro and vise versa

Design Matrices:

A=EDUCATIONAL
B=ENGAGING
C=DURABLE
D=MODULAR
E=ASSEMBLY
F=SAFETY

PAIR WISE COMPARISON

	A	B	C	D	E	F
A	1	1	5	4	2	0.5
B	1	1	4	5	2	0.5
C	0.2	0.25	1	2	2	0.25
D	0.25	0.2	0.5	1	1	0.2
E	0.5	0.5	0.5	1	1	0.16
F	2	2	4	5	6	1

POINTS	PERCENTAGE
13.5	23
13.5	23
5.7	10
3.15	4
3.66	6
20	34
59.56	

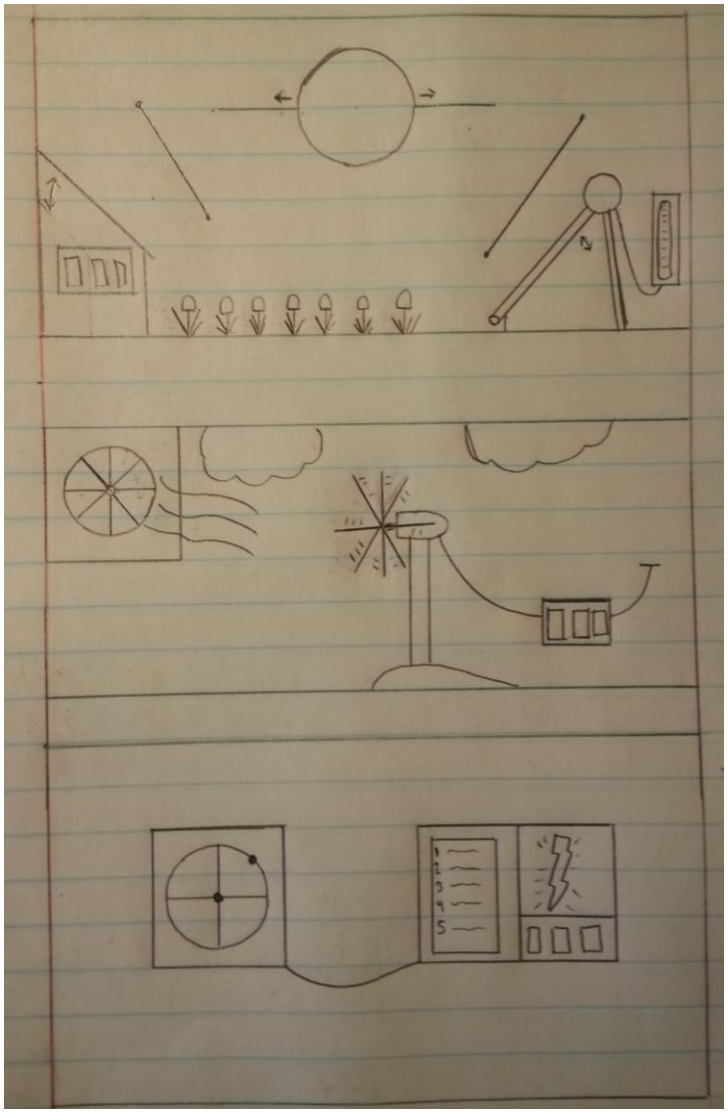
CONCEPT SCREENING

	1	2	3	4	5	6
A	+	+	+	+	+	+
B	0	+	+	0	-	-
C	+	+	+	+	+	+
D	+	+	+	+	-	-
E	+	+	+	+	-	-
F	+	+	0	+	-	+
PLUSES	5	6	5	5	2	3
SAMES	1	0	1	1	0	0
MINUS	0	0	0	0	4	3
NET	5	6	5	5	-2	0
RANK	2	1	2	2	6	5
CONTINUE	YES	YES	YES	YES	NO	NO

CONCEPT SCORING

	SOLAR		WIND		MECHANICAL	
A	3	0.23	3	0.23	3	0.23
B	2	0.23	4	0.23	5	0.23
C	4	0.1	4	0.1	3	0.1
D	5	0.04	5	0.04	3	0.04
E	5	0.06	5	0.06	4	0.06
F	5	0.34	4	0.34	3	0.34
TOTAL SCORE	3.45		3.87		3.52	
RANK	3		1		2	
CONTINUE	DEVELOP		DEVELOP		DEVELOP	

Final Design:



Description:

- **Solar Power-** For solar power there is a half a house with a solar panel attached on the top to show ways in which solar power can be attained. The roof angle is then also adjustable to experiment with different types of roofs u may find depending on location. A meter is then found mount on the side of the house wall to show the amount of power being created. Also, the lights disguised as flowers will begin to light up resembling the eco-friendliness of solar power. If maximum power is produced then all the light will

light up giving the kids an objective to try to reach. Along with that there is an area for the kids insert a glass panel with different forms of cloud patterns to experiment with the effect of weather conditions on solar power.

- **Solar Water Heating-** the solar water heater runs off the light just like the solar panel. The light will allow the heater to do its job and heat the water where the temp change can be seen on a thermometer. Just like the solar panel the angle can be adjust along with the glass panels for weather conditions can be inserted.
- **Wind Power-** there is a fan that will act like in place of the wind with different speeds to resemble weather change. The kids will then be able to create their own custom propellers to attach to turbine. This will allow them to experiment with many different possibilities in there own design. The height of the motor will also be adjustable for maximum experimentation. The power created by the turbine will then be read on a meter and then be used to light up the sky in the background. The more power the brighter the sky will become.
- **Mechanical-** a hand crank that when turned will create a current. The current will then be measured on a meter to tell the kids how much they are producing. A lighting bolt will then being to light up from bottom to top as the rate of the current increases. The high point of the currents rate will be measured and then kept on a leaders board to create of competition and keep kinds interested.
- In the end all of the subsystems are able to run off each other if elected to. The system will be plugged into the wall to create the electric responsible for running the systems. But if they really want to experiment they are able to run the light of the hand crank which will power the solar panel and water heater. The energy produced by the solar panel will then be able to power the fan making the system totally independent

Cost:

1. Thermometer (x5) 20
2. Solar Cell (x1) 79.95
3. UV light (x1) 40
4. LEDs (x1) 15
5. Fan (x1) 15.95
6. Wind turbine (x1) 54.99
7. Wire (however much we need) .20 per foot
8. Solar Water Heater (x1) 50
9. Small tubing (x2) .65
10. Propeller (X1) 11.95
11. Cooling tank (x1) 10
12. Micro hydro turbine (x1) 129

Total need is about 509

Conclusion- The energy teams design has a lot of positive features because in our final idea we have met all the objectives we have set out to accomplish. Our biggest objective was to educate kids on energy production and to provide hands on experiences for real life techniques. And we did this with the 3 ideas we have on our panel. We have solar power, wind power, and mechanical energy on this panel. We completed all the other objectives we set out to accomplish also. This project will definitely allow the kids to have fun while still in a safe learning environment for them.

Some lessons we learned from this is that in designing something it will have multiple iterations and people in future classes will improve on our design and eventually create and sell this product. We also learned how to work well as a team and get the work done in the most efficient and best way.

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