Pielar Panel

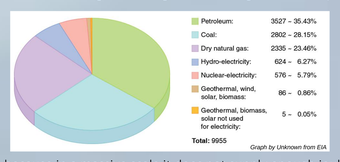
By: Ibrahim Eren Bisen

Background Research

Solar panels have been a reliable way to produce electrical energy since they were first invented in 1839 by Alexandre Edmond Becquerel. Becquerel discovered the photovoltaic effect: a way to generate electricity from sunlight. However, Albert Einstein was the first person to give a physical explanation of the photovoltaic effect. The first silicon solar cell was made at Bell Laboratories by Chapin, Fuller, and Pearson in 1954. It had a 6% efficiency, which was soon increased to 10%. In 1961 the first fundamental theory was made by Shockley and Queisdser based on detailed balance. In 1991 first high-efficiency silicon cell <20% was made by M. Green. Although Becquerel discovered the solar panels and the photovoltaic effect, his solar panel efficiency was less than 5 percent. Since then, people and companies have been trying to improve the efficiency of the solar panel. Not including the military and NASA's solar panels, the most efficient solar panel at the consumer level is about 22.2% efficient and is produced by a company called SunPower. When we started doing this project, we had one question, "What keeps solar panels from being more efficient, and how could we increase the efficiency of these solar panels without a tremendous cost?" After much research, we have created what we call a Pielar Panel, which allows us to create electrical energy from precipitation and sunlight. We researched the existence of panels similar to ours, but we could not find any projects or products that were like ours while working on this project, we designed over 7 Pielar panels.

Importance of Problem

Everyday humans consume more than a million terajoules of electricity. It is equivalent to 3,000 times the daily output of Palo Verde Nuclear Power Plant in Arizona, USA which is worlds one of the biggest nuclear power plants. Our hunger for energy has reached unprecedented levels. As we improved our technology our production increased tremendously. We started digging the ground looking for things to burn to create energy without realizing the damage that burning does to our planet. Time traveled fast and soon enough we started seeing the effects of our pollution and tried to find a way to clean it up and that's how we came up with renewable energy. Today some of us trying to advocate renewable energy but they cannot convince people to convert to renewable energy because in a massive scale it does not supply enough joules to the businesses. Nowadays businesses still resist to convert to renewable energy and they continuing to pollute our world. This is leading to increasing the rate of effects of the climate change which will see in the future. This technology provides so much electricity that it has the possibility of breaking this resistance.



Graph by Unknown from EIA

Purpose

The purpose of this project is to find answer to What keeps solar panels from being efficient and how can we increase the efficiency upon an existing solar panel, without a tremendous cost? While we are doing that also to improve upon a conventional solar panel by adding piezoelectric panels to it, which would, therefore, increase the efficiency and amount of electrical output it can produce by 20 to 110 percent depending on the location.


Image by dpa on http://www.sunwindenergy.com/photovoltaics/scientists-developing-solar-cells-rainy-days

Hypothesis

We will be able to create a Special Solar panel that will increase the electrical energy output from 20% to 110% depending on the precipitation amount of the location that the solar panel is in.


Image by Solynta on https://solyntaenergy.com/2017/08/22/do-solar-panels-still-work-when-raining/

How Piezoelectric Panels Work

When you turn sugar into crystal its piezoelectric properties become useful and more dominant. Piezoelectric Materials turn mechanical stress, like pressure, soundwaves, and other vibrations into electricity and vice versa. This phenomenon was first discovered by the physicist brothers Jacques and Pierre Curie in 1880. They realized that if they compressed thin slices of certain crystals negative and positive charges will appear on opposite faces with different this difference in charges, or voltage meant that compressed crystal could drive current through a circuit like a battery. When the brother run electricity through the crystals it changed shapes and created noises. Turning mechanical energy into electrical, and electrical energy to mechanical were remarkable. First applications of the piezoelectricity were in sonar device in world war 2. How are materials made into piezoelectric, the answer has 3 parts its atomic structure, its distribution of electricity within it, and if it could be converted into crystalline. The piezoelectric effect can be found in many men made and naturally occurring crystals. The most common naturally occurring piezoelectric effect materials are quartz, topaz, tourmaline, Rochelle salts, and cane sugar. The most common human-made piezoelectric crystals are quartz-like langasite, and gallium orthophosphate and the most common piezoelectric crystal is quartz. The Jacques and Pierre Curie brothers also discovered that if electricity is applied to crystals which have the chemical properties similar to a piezoelectric crystal, the crystal will deform. Usually, charges in the piezoelectric crystal are precisely balanced. If something squeezes the panel or the crystal, it forces the charges out of balance. Positive and negative charges appear on opposite crystal faces which then creates electrical energy. When mechanical force is applied to the crystal, it generates AC voltage

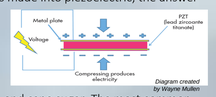


Diagram created by Wayne Mullen

How Pielar Panels Work

Every family company or a customer has a budget. This budget might be tight or loose. This is the main difference between the two solar panels, Piezoelectricity Crystal Integrated TLSC Panel is created on a loose budget and Pielar Panel is created on a tighter budget. The main difference in terms of engineering these two solar panels is that PCITLSC looks like a normal window and its transparent and it is aesthetically more pleasing, and Pielar Panel looks like a normal solar panel, but it is just thicker due to having the piezoelectric panel at the bottom of the solar panel. The process of producing electrical energy with Pielar panel is more simple basically when pressure is applied to the solar panel by any kind of precipitation it will cause the move the solar panel vertically every time solar panel moves vertically the silicon type of material that is underneath the solar panel will hit the series of the piezoelectric panels which will cause it to produce electrical energy. Electrical energy that is produced by the Piezoelectric panel sis carried out by the cables throughout the Piezoelectric panel.


Image by Unknown from www.Amazon.com

How Solar Panels Work

The earth intercepts a lot of solar power approximately 173 thousand terawatts. That's ten thousand times more power than the planet's population uses. The first solar panel was invented by Alexandre Edmond Becquerel in 1839. Solar Panels are made up of smaller units called solar cells. The most common Solar cells are made from Silicon, a semiconductor that is the second most abundant element on Earth. In a solar cell crystalline silicon is sandwiched between conductive layers usually consisting of copper. Each silicon atom is connected to its neighbors by four strong bonds, a silicon solar cell uses two different layers of silicon. An N type silicon has extra electrons, and P type od silicon has a extra spaces for electrons, called holes. It means electrons can wonder around both layers leading to creation of electrical current. Solar panels are made from two main elements, silicon, and silver (Sometimes Copper). Solar panels consist of many solar cells which are sliced up silicones. Here is the process of converting sunlight into electrical energy; first the solar panel observes the sunlight and converts it into electron energy which can then be converted into electrical energy. Photovoltaic effect generates electron energy. Photons of the sunlight strike the solar cell, and two layers of the solar cell cause electron jump between the two layers which creates electron energy. In order to collect the flowing produced electron energy, it needs the best conductor that's on the market which is in this case silver. After the collection of the electron energy, it is converted into electrical energy which can then be used for many things.

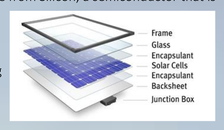


Diagram created by Good Energy https://goodenergy.co.uk/how-do-solar-panels-work/

Piezoelectricity Crystal Integrated TLSC Works

To understand the transparent Pielar panel, we first need to comprehend two main concepts, which are piezoelectricity crystals and TLSC's which are transparent luminescent solar concentrators. Piezoelectric crystals create energy when mechanical force is applied. Amount of created energy changes depending on the type of crystal that the effect is applied to. Quartz is the crystal that generates the most electrical energy output out of the 15 most common transparent piezoelectric crystals. The main elements to create quartz is oxygen and silicon, which are the two most abundant materials on earth. The second element to understand the transparent Pielar Panel is to understand TLSC, which is a transparent luminescent solar concentrator. TLSC is a special kind of solar panel. This solar panel is transparent, and it is more efficient than the best consumer-level solar panel by about 10 percent. Unlike typical solar panels, this solar panel creates energy through different wavelengths. A conventional solar panel converts the visible parts of ultraviolet light, which is from 400 nm to 700 nm.

Still, TLSC uses an organic material, which is Rochelle Salts, to convert the non-visible part of the ultraviolet lights. The collected ultraviolet waves are then stored in the Rochelle salts, which directs them towards the thin solar cells that are wrapped around the Rochelle salts. So, the energy produced by the TLSC Panel does not have to do anything with solar radiation. This fact also means that the Piezoelectricity crystal integrated solar panel does not need to be in hot areas; it just needs a source of light and a mechanical force. Piezoelectricity crystal integrated TLSC is slicing quartz crystal to thin pieces that are about .1 cm thick and then wrapping it with the best conductor, which is silver. Therefore, we can put these two materials together, and we also. By not putting an enormous amount of mechanical power, we are also preventing the risk of the quartz getting damaged. According to university Michigan, if the TLSC panels are integrated into skyscrapers, the amount of energy produced from the panels will surpass the amount of electrical energy input that is needed by the building. If we integrate the Piezoelectricity, we will not only generate electricity that is required by the main building, but we will be able to provide the source of energy to the nearby buildings. Piezoelectricity integrated TLSC panel is 250% percent more efficient than the Pielar panel, and our Pielar panel is about 150% more efficient than a typical solar panel. In the end, piezoelectricity crystal integrated TLSC is ultimately 400% more efficient than a regular solar panel.

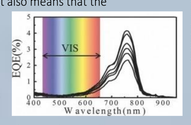


Diagram Created by unknown on https://www.icenineteen.com

Application and Extensions

Real life applications of our piezoelectric panel are limitless. Our piezoelectric panel functions as a conventional solar panel would but also creates electrical energy from precipitation.

Here are a few of the applications for Pielar panels

1. Providing energy to households and industrial buildings
2. Utility-Scale PV power plants
3. Electric vehicle charging stations
4. Solar water heating
5. Solar heating of buildings
6. Solar drying of agricultural and animal products
7. Solar-powered aircrafts
8. Consumer level building-integrated piezoelectric panels
9. APU's (Auxiliary power units) for various types of vehicles
10. Solar electric power generation
11. Solar thermal power production
12. Solar green houses


Image taken by University of Michigan on https://breathe.wordpress.com/ 2014 /06/23/doubling-windows-roublers-solar-cells/

As a future extension, other researchers can design a piezoelectric solar panel using Transparent Luminescent Solar Concentrators (TLSC) which would be more aesthetically pleasing and could cover larger surfaces.

Variables

- Dependent Variable
  - Efficiency of the piezoelectric discs
  - Efficiency of the solar panel
  - Efficiency of Solar cells
  - Efficiency of TLSC Panels
  - Efficiency of Rochelle Salts
  - Density of Rochelle Salts
- Independent Variable
  - Amount of sunlight
  - Amount of precipitation
  - Density of rain
  - Speed of rain
  - Speed of Wind
  - Density of Hail
  - Speed of hail

Graphs and Pictures


The Independent Austin https://www.brownwoodtx.com/ news/2013/08/28/look-take-tour-of-texas-jenga-tower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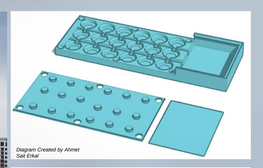
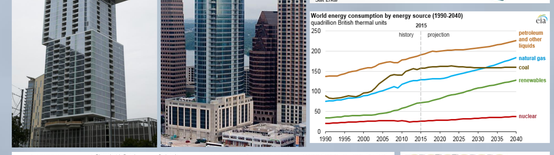
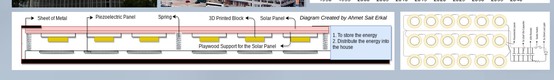


Diagram Created by Ahmet Sait Erkal





Results

We did fully achieve our hypothesis and surpassed it. According to our hypothesis, we were going to increase the efficiency of a solar panel in the southern states from 20 to 60 and from 60 to 110 in the northern states. We reject the hypothesis because our results show that our Pielar panel will increase the efficiency of a solar panel in the southern states from 50% to160% and from 160% to 270% in the northern states. In our hypothesis we never talked about the Advanced TLSC Panels. Advanced TLSC Panels are in southern states 65% to 200% more efficient and in the northern states they are 230% to 370% more efficient. This shows that our solar panels have the capacity to power skyscrapers just by switching normal windows to our Advanced


Created by Guner Arslan

	Normal Solar Panel				Pielar Panel						Percentage of Efficiency Improvement Between The Normal Solar Panel and Our Pielar Panel	
	Hot Area (Austin)		Cold Area (Philedelphia)		Hot Area (Austin)				Cold Area (Philedelphia)		Cities	
	Total energy produced in that state		Total energy produced in that state		Total energy produced in that state from preception		Total energy produced in that state from our solar panel		Total energy produced in that state from preception	Total energy produced in that state from our solar panel	Hot Area (Austin)	Cold Area (Philedelphia)
Winter	946.68	watts	911.40	watts	442.87	watts	1,389.55	watts	1,518.75 watts	2,430.15 watts	**46.8%**	**166.6%**
Spring	1,228.92	watts	1,323.00	watts	1,071.63	watts	2,300.55	watts	2,187.00 watts	3,510.00 watts	**87.2%**	**165.3%**
Summer	1,380.33	watts	1,522.92	watts	1,633.50	watts	3,013.83	watts	4,084.83 watts	5,607.75 watts	**118.3%**	**268.2%**
Autumn	1,264.20	watts	1,181.88	watts	1,771.47	watts	3,035.67	watts	2,850.12 watts	4,032.00 watts	**140.1%**	**241.2%**

	Normal Solar Panel				Advanced TLSC Panel						Percentage of Efficiency Improvement Between The Normal Solar Panel and Our Advanced TLSC Panel	
	Hot Area (Austin)		Cold Area (Philedelphia)		Hot Area (Austin)				Cold Area (Philedelphia)		Cities	
	Total energy produced in that state		Total energy produced in that state		Total energy produced in that state from preception		Total energy produced in that state from our solar panel		Total energy produced in that state from preception	Total energy produced in that state from our solar panel	Hot Area (Austin)	Cold Area (Philedelphia)
Winter	946.68	watts	911.40	watts	620.01	watts	1,566.69	watts	2,126.25 watts	3,037.65 watts	**65.5%**	**233.3%**
Spring	1,228.92	watts	1,323.00	watts	1,500.28	watts	2,729.20	watts	3,061.80 watts	4,384.80 watts	**122.1%**	**231.4%**
Summer	1,380.33	watts	1,522.92	watts	1,143.45	watts	2,523.78	watts	5,718.76 watts	7,241.68 watts	**82.8%**	**375.5%**
Autumn	1,264.20	watts	1,181.88	watts	2,480.06	watts	3,744.26	watts	3,990.17 watts	5,172.05 watts	**196.2%**	**337.6%**

Materials

We have used various types of materials in this project to demonstrate how our solar panel works such as:

- 18x Piezoelectric panel
- 6x Spring
- 3D Printer
- Hot Glue
- Super Glue
- Electrical wires
- 3v 5mm white LED
- Multimeter
- Soldering iron
- Electrical tape
- 25x 4mm Heat Shrink Tubing
- 4x 10uF 35v Capacitor
- Resistor (10R)
- Button (12mm*12mm) with Cap


Photo Taken by Jose Carbajal

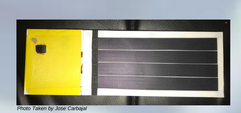


Photo Taken by Jose Carbajal

Piezoelectrcity Crystal Integrated			
Material	Calculation	Total	Currency
TLSC Panel	150	150	$
Rochelle Salts	(depending on the concentration)	100	$
Production of the Transparent	(Sensetive chemical process)	100	$
production of the TLSC Panel	Chemical process (Still in dev.)	50	$
5 ft of Special Conductive Cables	20	20	$
Grand Total	420		$
Sky Scraper full of Piezoelectricity Crystal Integrated Panels			
Each floor is with 40 windows			$
50 floors			$
Grand Total money for a whole skyscraper		840,000	$
Overall Total for a Pielar Panel		193.1	$
A house with Pielar Panel service			
Pilar Panels (10 Panels)	1931		$

Pielar Panel			
Material	Calculation	Total	Currency
5000 piezoelectric Panels	500	500	$
416 Piezoelectric Panels per Solar	500/10	41.6	$
Piezoelectric Cells per Solar Panel	50	50	$
50 feet of Electrical Cables	3	3	$
~10 ft of Electrical Cables	3/5 = 0.6	0.6	$
A Solar Panel	100-200	150	$
Wholesale Solar Panels	50-100	100	$
PCB's	10 to 15	12.5	$
supporting and the placement material	20	20	$
epoxy	10 $	10	$
Overall Total for a Pielar Panel		193.1	$
A house with Pielar Panel service			
Pilar Panels (10 Panels)	1931		$

Procedure

- Identify what keeps a normal solar panel from being efficient
- Brainstorm ideas about how to increase the efficiency of an existing solar panel
- Research on how to increase the efficiency of an existing solar panel
- Decide what materials to use to increase the efficiency
- Decide to use piezoelectric panel
- Start brainstorming designs for our Pielar Panel
- Work on the theoretical data tables
- Collect data for the non-theoretical data tables
- Start working on theoretical circuit
- Start building our Pielar Panel
  - 3D Print the Frame
  - Make Adjustments on The Frame
  - Connect the Solar Panel
  - Insert the Piezoelectric Panels
  - Wire The Piezoelectric Panels
  - Insert the springs
  - Wire the piezoelectric panels to the motherboard
- Post-research about solar panels and piezoelectric technology
- Collect data from Pielar Panel
- Make finishing touches to the model and the poster board

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For the continuation of the bibliography refer to the Handbook.

Background Image Taken By Unknown on https://theenergyadvocate.co.uk/2017/11/07/rise-energy-bills-homes-solar-panels/