Avery Barnett

History of Solar Energy - The Evolution

Solar energy is one of the oldest forms of energy that have been used on Earth. The Sun's energy was used as a means of creating fire, heating houses and, now, used as a means of creating electricity. The sun is a driver of the universe and many of Earth's processes depend on it. The sun is an immensely important resource and without it, the world could not function.

Tracing the sun's importance, there is a myth about Archimedes using mirrors in order to concentrate the sun's energy to ignite Roman ships during the siege by Marcellus between 214 and 212 B.C..[1] This myth spurred curiosity in understanding if what Archimedes did could actually happen. This is where Father A. Kircher comes in. Kircher used up to five mirrors to reflect the sun's light onto a concentrated spot. He observed that as he added another mirror, the heat at the concentrated spot increased. In the end, he concluded that multiple correctly aligned plane mirrors were better than mirrors of other shapes to start a fire. Due to his discovery, this concept is known as Kircher's Mirrors.[2] Following Kircher, there were many investigations into Archimedes' action. The possibility was denounced due to the distance (too far away from the ships) and the type of mirror used. However, through the works of Georges Buffon, it was proven that it was possible with the right amount of irradiance from the sun, mirror size and shape. Buffon used a concave mirror in order to prove that something could be lit at a significant distance after doing many calculations.[3] It is assumed that since Buffon has done it, Archimedes could have done it as well.

---

[1] W. E. Knowles Middleton. "Archimedes, Kircher, Buffon, and the Burning-Mirrors." *Isis* 52, no. 4 (1961): http://www.jstor.org/stable/228646, 533.
[2] Knowles Middleton, "Archimedes, Kircher, Buffon, and the Burning-Mirrors.", 535-36.
[3] Knowles Middleton, "Archimedes, Kircher, Buffon, and the Burning-Mirrors.", 537-543

Ancient Rome was doing more than setting ships on fire. Through improving the Greek's solar architecture, the Romans discovered the greenhouse effect by using glass to keep their houses warm. These structures were called "Heliocamini" meaning sun furnaces.[4] It is possible that the Romans discovered the greenhouse effect through trial and error, which plays a key role in invention and innovation currently. Additionally, this is a prime example of the technology being built before the science. Now, science tells us that the greenhouse effect works as the long wavelengths of sunlight enter the building, but after reflecting off of the Earth, the short wavelengths are unable to escape through the glass, reflecting back inside and heating the air. The greenhouse effect is useful for horticulture when the climate is not warm year round. Ancient Romans used the windows for horticulture in order for fruits to mature faster and grow produce out of season. Acomas, built by indigenous Americans in the twelfth century were sky cities built on plateaus where three rows ran from east to west. Most of the doors and windows were built facing south in order to catch the sun's rays. In this design, the walls were made of adobe. This concept was then utilized by early Europeans where the houses were aligned east to west, and the shutters were closed at night to keep the sun in.[5] The Sun's energy was used for heating purposes as a means for human survival during the winter. The aforementioned are only a few examples of the full versatility of the sun's energy.

With the exploitation of fossil fuels , there was a disinterest in investing in solar energy research and energy alternatives. Those are what hindered the progression of the solar steam engine, the photovoltaic cell and solar water heaters. The solar steam engine was crafted in the

---

[4] Perlin, John. "Solar Energy, History of." In *Encyclopedia of Energy*, by Cutler J. Cleveland. Elsevier Science & Technology, 2004. https://grinnell.idm.oclc.org/login?url=https://search.credoreference.com/content/entry/estenergy/solar_energy_history_of/0?institutionId=4073

[5] Perlin, John. "Solar Energy, History of."

19th century and boasted multiple figures such as Augustin Mouchot and Frank Shuman. Mouchot believed that the Sun's heat could replace coal in Europe's steam engines and ultimately ended up building the first solar engine in the 1870s which provided enough steam to drive machinery.[6] However, due to conflict between Germany and France, his invention was forgotten. It is reported that he detested the use of science for the creation of weapons of destruction. A similar story happened with Frank Shuman, as after constructing the world's largest solar engine in Maadi Egypt using parabolic mirrors, his invention was deconstructed and the parts used for the war materials. Shuman was also known for the making of "Safetee Glass" and he used his expertise in glass, translating it into manipulating solar energy to create heat and furthermore power for the engine. Shuman started by using hot boxes to concentrate the sun's heat where it heated water and formed steam. He then changed his design to use parabolic mirrors due to a recommendation by a famous physicist. These mirrors made the engine more expensive and therefore could not get the intended horsepower.[7]

Nonetheless, during this time there were different engines created which utilized the sun. John Ericsson built the caloric engine which ran on solar energy.[8] Additionally, he predicted the solar constant which was quite accurate to its actual value. Aubrey Eneas followed suit with building the solar motor, but failed because of the weather and the high costs of production. [9]

These inventions all stood the test of time but were overpowered by war, low fossil fuel prices, and being unable to withstand the weather at their locations. Nonetheless, these technologies represented innovation in a time where it was unlikely for one to even be interested

---

[6] Kryza, Frank. *Power of Light*.(Mcgraw-Hill, 2003), 147 - 150.
[7] Kryza, Frank. *Power of Light*.(Mcgraw-Hill, 2003),177 - 183 .
[8] Kryza, Frank. *Power of Light*.(Mcgraw-Hill, 2003), 111 - 114 .
[9] Kryza, Frank. *Power of Light*.(Mcgraw-Hill, 2003), 207 - 226.

in such a feat, given the low public interest and lack of funding. However, these inventors persevered and laid the groundwork for technological progress seen today. These technologies represent how politics plays an integral role in what is able to be successful and what is not. There were no policies in place to protect these industries, and the policies possibly worked against their development and success. This was seen through the funding cuts during war and the lack of government investment in manufacturing. It was not seen as a priority at the time and therefore, it did not get much support.

Moreover, the technologies highlight how innovation and technology comes before the science itself. Thermodynamics - a physics discipline which governs relations between heat and other forms of energy - was not known before engines were a physical concept.[10] It was the development of the engine which spurred the initiative to find out how things worked in that realm. Similarly, although the photovoltaic effect was observed, scientists did not believe that it was an actual phenomenon until the photoelectric effect and the discovery of the electron. This emphasizes how an invention causes the discovery of science, but due to the social atmosphere and expectations, the invention is deemed null until there is a way to explain it.

The solar inventions were the beginnings of a greener and cleaner future, and represent many different aspects of technology. It would be interesting to observe if other aspects such as human biases were ingrained in the technology although it was meant for the greater good of all. Additionally, it could be argued that the technologies are biased against people in lower income statuses due to the high cost of technology, and the equipment and land space needed for its

[10] Hall, Nancy. "What Is Thermodynamics?" NASA. Accessed May 16, 2019. https://www.grc.nasa.gov/WWW/K-12/airplane/thermo.html.

operation. The cost and capital needed were probably minute details that were considered in the building and inventing of the different pieces.

These solar engines were just the antecedents of the solid state photovoltaic cell discovered by Charles Fritts. Charles Fritts made the first primitive solar cell using selenium covered with a transparent gold film.[11] There was no explanation for this and it was disregarded because of the reasons aforementioned. However, this was not the first instance of the phenomenon. The photovoltaic effect or Becquerel effect was first noticed by Edmund Becquerel around the 1850s.[12] The difference was that he observed it in liquid and there was not much use for it at the time. Solar cells had humble beginnings as they were only mildly efficient. They had to undergo many innovations in order for them to be at the state they are now. Firstly, scientists and inventors had to understand that the phenomenon was not an 'anomaly'. Secondly, research had to be done in order to get more efficiency from the material. Using silicon for photovoltaic cells was found by accident and led to a subsequent great innovation, and now large sums of money are being put into research and development whereas in previous times, these innovations as aforementioned were found by accident. This has caused selenium to no longer be used, due to the expense and inefficiencies. Currently, silicon is being used in modern-day photovoltaic cells, which leads to another area of interest; to map out how they went from selenium to silicon and the different trials and errors undergone in order to understand if the invention process was linear, or if different institutions and people used different materials to come to a similar conclusion. It is plausible that inventors worked in secret in order to prevent others from stealing their ideas and obtaining a first-mover advantage. Currently, through the use of patents, inventors

---

[11] Kryza, Frank. *Power of Light*. (Mcgraw-Hill, 2003), 255.

[12] Kryza, Frank. *Power of Light*. (Mcgraw-Hill, 2003), 255.

can claim their design and profit, as other inventors will have to purchase licenses to use similar concepts. Patents are relatively new in comparison to the process of inventing; however, even today the different failed designs and efforts are not publicized which gives the image of a 'perfect' world and science. Nonetheless, the photovoltaic cell represents a revolution in the solar energy industry.

The rise of the solar cell has caused decreased wastage as satellites can now be powered while in space through PV cells and has led to cleaner energy use and their ability to be adapted for any surface. Photovoltaic cells are adapted to be used on roofs, land and, upcoming, walls. The cells are so versatile that they are able to be ingrained and power household objects. Despite its versatility, PV cells still have implications, which includes analyzing their life cycle analysis to understand the full environmental cost below face value. Moreover, PV is still quite pricey for the average person, creating barriers to use. The PV cell is just one more invention on the road to a renewable energy future.

The inventors who have been highlighted, for the most part, were spurred to invent based on what was going around them, or wound up finding something by accident. These are prime examples of the nature of technology - unpredictable at times and represent many possibly unintended repercussions to people in society. The technologies have played a role in the renewable energy atmosphere seen today (some more than others). Possible expansions from this project could include expanding the inventions to that of the solar water heater, and other appliances that utilize solar energy such as calculators, inspecting their patent history and see if there are further inventions in the works. Additionally, inspecting different life cycle analyses for the cost to benefit ratio and how it compares to conventional methods. It is worth noting that

although the technology utilizes renewable resources, it takes natural and non-renewable resources for the invention to be made.

From hot boxes to solar engines to the solar cell, the sun represents the force of nature and the multipurpose use represents its importance in our lives. In my opinion, the greatest invention using solar power is the photovoltaic cell. The photovoltaic cell represents a world of opportunities and new inventions. However, we cannot forget that making the cell utilizes precious resources which we are trying to save. The solar cell can assist with the energy crisis, but it would be interesting to analyse if there are other negative impacts which could be evoked. Regardless, the photovoltaic cell is an invention that we cannot regret, with its use trending upwards in most recent years.

Citations:

Elsevier Science & Technology, 2004.

https://grinnell.idm.oclc.org/login?url=https://search.credoreference.com/content/entry/estenergy/solar_energy_history_of/0?institutionId=4073

Hall, Nancy. "What Is Thermodynamics?" NASA. Accessed May 16, 2019. https://www.grc.nasa.gov/WWW/K-12/airplane/thermo.html.

Kryza, Frank. *Power of Light*. Mcgraw-Hill, 2003.

Perlin, John. "Solar Energy, History of." In *Encyclopedia of Energy*, by Cutler J. Cleveland.

W. E. Knowles Middleton. "Archimedes, Kircher, Buffon, and the Burning-Mirrors." *Isis* 52, no. 4 (1961): 533-43. http://www.jstor.org/stable/228646.