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ENGL 110C Final Report

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How can we further incorporate solar power into the world we live in?

Abstract

Any kind of civilization requires forms of resources to make it possible to live in relative safety, health, and prosperity. Ever since civilization existed, it required some form of power. The ancients used water and gravity to move machinery and grind crops. As technology advanced, human power has been needed less and less and we have relied on different forms of power and energy to take its place. Specifically, modern societies have the ability to use the wind, the sun, and even the flow of the ocean to generate electricity to power everything from household appliances to hundred story sky scrapers. We are learning more and more about the detrimental nature of our current habits. It is clear that we are destroying our planet by using non-renewable resources and producing harmful by-products like smog. The Earth provides resources that we can use that will never run out and will not cause harm to us or our planet; it is up to us to use these resources wisely and fully. Solar power is becoming more of a viable solution with technology that is only getting better. This paper will explore how we can further incorporate this ever present source of energy.

Intro

There is no doubt that the world would be better off if we all relied on renewable, clean energy. Our current situation is costing us in time, money, and resources. As we move toward replacing the old with the new technology it is important to understand the right way to implement alternative energies. The potential that we have with solar power greatly exceeds the understanding of most people. No longer is alternative energy only something that hippies banter about; it has become the future, and a necessary one at that. This paper will explore how we need to go about implementing solar power and what it can mean for the earth.

Body

The present problem is quite obvious. How can we as a nation and world remove a detrimental system that is so ingrained into our economy and way of thinking and living while at the same time replacing it with a viable alternative that will be able to last in the long term? It needs to be clear that the switch will benefit the world; that the impact will be less detrimental. To answer that question we need to look at the environmental and socioeconomic impact of solar power verses oil and gas.

Everyone has seen the documentaries and PSA’s about how our dependence on oil is destroying our world. It is very important to understand what is actually happening due to our treatment of the environment. As an example, it helps to look at the Tar Sands project occurring in Alberta, Canada. This one project has a laundry list of disturbing facts. The project is being run to extract all the fossil fuels in the area. First of all, running this project is incredibly costly. On average, the digging machines must sift through two tons of sand to extract only one barrel of oil. In other words, the energy used to obtain 42 gallons of oil could be used to power the average American household for four days (Destroying the Environment to Get Our Oil Fix). Just this work site is estimated to produce almost 126 million tons of CO2 annually. Currently the earth is getting 1-2 degrees Celsius hotter every year. At first glance, that does not seem like much, however this is enough to drastically alter the size of our poles as well as the habits of animals all over the world. As if that were not enough of a reason to start implementing solar power, the world’s oceans are also seeing adverse effects. More CO2 in the oceans, lakes, and rivers means worse drinking water which would be much worse for third world and developing countries (Bradford). The oceans are also rising. That seemingly small 1-2 degrees a year means that soon the earth will be hotter than has ever been recorded. Most obviously, this means that the oceans could be rising by tens of meters in the coming years. This is only a brief outline of the adverse effects of the current system of oil dependence.

It is important to understand the workings of solar panels and parabolic troughs to understand how they need to be used. Solar panels work by converting the light energy into electrons in an electrical current. They consist of two panes of glass and two types of silicon. The light enters the top pane and hits what is called the P-N junction between the two types of silicon. The top silicon is called N type due to the fact that it contains the electrons that are knocked loose by the photons in the light. After these electrons are knocked loose, they exit through the conduit to whatever is being powered (referred to as the load). They then continue through another conduit to the N type silicon (N for negative) where the process is repeated. Solar panels are a simple way to turn sunlight into energy (EERE: Solar).

Parabolic troughs are slightly more involved but they have more potential. These structures work by reflecting the sunlight off their bowl-shaped interior onto a tube running along the focus point of the parabola (Renewable and Sustainable Energy). This tube contains treated oil. It is heated by the sunlight and pressure carries it through vats of water. Being much hotter than the boiling point of water, the tube containing the oil causes it to evaporate and create fumes. These fumes turn a large turbine which is connected to an electric generator (Parabolic Troughs). The spinning motion creates electricity. The oil itself never touches anything but the tube so it is simply pumped back into the trough to be reheated (Forristall). This is just one more way to harness the power of the ever present sun to provide electricity to the masses.

A change only makes sense if the new system is better. The environmental impact, if we were to switch completely to solar power and other alternative energies, drops to nearly zero. No more fumes being pumped into our atmosphere. No more dangerous compounds in our drinking water. The sun will always be here so there is no harvesting cost. Our technology has advanced to the point where it makes sense to make the shift to solar power. However, it will never happen unless it is cost efficient. There is currently a plan in the works for a NASA training center to be constructed in Hattiesburg, Mississippi which provides a good example of the practicality of constructing such a facility.

The facility needs 30 MW to function under normal circumstances; this means that 324,083 square meters of land is needed to put the solar panels (Green). The panels produce DC, or direct current, that would need to be converted to AC (alternating current). One or several inverters will be needed to change the type of current created from DC to AC, which is what today’s structures need (Solar Power Implementation Plan). The total cost would be about $71,262,000 for the one facility not including installation which would put the cost just over $100,000,000 (Boxwell, 7). Although that may seem like a large amount of money, it needs to be put into perspective. First of all, that is only an initial cost. The cost for maintaining a field of solar panels is almost zero (Ewing, 43). They require only to be cleaned and replaced on the off chance that one breaks. Secondly, it is important to look at the alternative: being powered using coal. A 30 MW facility needs over 2,000 tons of coal to be burned every single day. Needless to say, that is enough coal to make a visible impact on the air around the facility. The coal needed to power this facility, based on current prices, would be $93,402 per day. This means that it would take just over three years for the solar panels to become a better investment; that is how long it would take the total coal cost to equal the cost of putting in solar panels. The parabolic troughs are much the same cost wise. There are advantages though. Only 7,500 square meters of land is needed to obtain the necessary 30 MW leaving more room for the rest of the system. The parabolic troughs need another facility in which to capture the rising steam and turn the turbine to produce electricity. All together the cost of this system would but just under $100,000,000 not including installation. Installation would put it over $125,000,000 dollars. This means that this system would become cost effective only just after three and a half years. One more aspect that needs to be addressed is the efficiency of each option. Normal coal can only be burned at around 35% efficiency. That means only 35% of the potential power that could be harnessed, is harnessed. This is due to costly purification procedures and bad technology. Terrible efficiency means more pollutants. One the other hand, solar power (both panels and troughs) can be operated at around 80% efficiency and regardless of high or low efficiency there will always be zero pollutants. It is clear that solar power is the way of the future.

There are negatives, however, to solar power. Biggest of all is the need for large plots of land in which to place the panels and or troughs. Roughly 324,083 square meters will have to be cleared to make room for our solar panels in order to reach 30 MW, which could have an impact on the local wildlife (Goswami, 254). The other option being a need of only 7,500 square meters for the parabolic troughs. The NASA facility is not in a heavily forested area nor are there any endangered trees in Mississippi. All of the paper that is used by the world is produced by tree farms so there is no danger of impacting the paper industry with this facility or any and all facilities across the world. The concern lies mostly in preserving the habitat of any endangered or threatened animals. As of 2010, there were 9 different species of mammals, birds, and reptiles currently in Forrest County Mississippi listed as endangered or threatened, with only two of these species considered endangered (U.S. Fish and Wildlife Service). Before clearing any area for such a design, there would have to be a survey done to find of these species and relocate them, however this does not present a major issue.

The other impact that powering this facility could have lies in the socioeconomic status of Forrest County Mississippi, where Hattiesburg is located. As of March 2011, the unemployment rate in Forrest County was at 9.6% (Unemployment) with 24.3% of Forrest County residents below the poverty line as of 2008 (Forrest County). The construction of the solar power system will provide an initial boost to the economy of Hattiesburg. After the design is completed, a maintenance crew will be hired, providing more jobs to an area that needs them. While both options would provide the area with jobs, the solar troughs would require a larger maintenance crew, and therefore a larger number of jobs. Looking at this from a macroeconomic standpoint, there would be a noticeable difference in the socioeconomics of the area but not a large one. This is because the facility would require little maintenance. However, if the switch from oil to solar power was made, jobs would remain across the world, they would only change purposes. The industry is the same: power provided to the masses.

In finding a system that provides reliable power for the world, but also does not produce any destructive and dangerous emissions, we should recall the creation mandate God gave to man in the first chapter of Genesis. In Genesis 1 verses 28-30, God blesses man and tells him to subdue the earth, and care for the plants and animals he has created. Sometimes man’s destructive behaviors can cause drastic harm to the rest of nature. We have technology that will produce zero destructive byproducts so it could be argued that we have a responsibility to use those technologies for the betterment of people and the earth.

It is easy to see that solar power is not only the better choice, it is the smarter choice. Solar power is not just another option, it is a necessary future. A correct understanding of these technologies is crucial to implementation of them. The current alternative cannot last for much longer without dire consequences to the earth and to humanity in turn. It could be said that implementing solar energy is our responsibility to ourselves and to the earth we inhabit.

Annotated Bibliography

Arvizu, A. "Implement Solar Panels for Home." *Share Your Experiences!* N.p., 10 June 2012.

Web. 14 Nov. 2012. <http://www.frommyexperience.com/implement-solar-panels-for-home.php>.

This article is a story of a man who put solar panels on his home. He was able to make it work on his own house so his knowledge can be shared to other homeowners. I can use this to get more of a perspective on the small scale implementation of solar panels. It’s clear that he was able to use the panels for multiple things; I will be able to gain knowledge of how wide the uses can be for solar energy.

Bradford, Travis. *Solar Revolution: The Economic Transformation of the Global Energy*

*Industry*. Cambridge, MA: MIT, 2006. Print.

This book talks extensively about the world as it is now and how it would be if we were to switch to solar energy. It was crucial in my understanding of the broad view of the task of implementing solar power.

Boxwell, Michael. *Solar Electricity Handbook*. Ryton on Dunsmore, Warwickshire, U.K.: Code

Green Pub., 2010. Print.

This book talks about the everyday man’s solar project. I used facts in this book and escalated them to make sense on a larger scale. It gave me a good idea of how solar power is implemented on a small scale which needs to be understood in order to know how it will happen on a larger scale.

"Building a Parabolic Trough Collector." *Energy Education*. N.p., n.d. Web. 14 Nov. 2012.

<http://www.energyeducation.tx.gov/pdf/53cinv.pdf>

Energy Education is a provider of alternative energy focusing on phasing out gas in the right way. They have a presence all over the world with the mission to phase out destructive energy sources and replacing them with renewables. I will be able to use this source to gain a better understanding of how implementing renewable resources needs to be done in order to succeed.

"Destroying the Environment to Get Our Oil Fix." *The Wesleyan Argus*. N.p., n.d. Web. 03 Dec.

2012. <http://wesleyanargus.com/2009/03/11/destroying-the-environment-to-get-our-oil-fix/>.

The author of this article is known for his works about detrimental habits that are taking their toll on the earth. He has done his homework so to speak on the particular case that I referenced. Due to his large audience, his facts need to be true or else he would lose his audience.

"EERE: Solar." *EERE: Solar*. Eere.gov, n.d. Web. 14 Nov. 2012.

<http://www.eere.energy.gov/topics/solar.html>.

Being a government website, the information can be trusted to be represented accurately. The purpose of this website is to present the findings of the U.S. Department of Energy more specifically their findings based on renewable energy. I will use this website to see where our nation stands on using the sun to power itself. Eere contains information on how our nation plans to implement solar and wind power.

Ewing, Rex A., and Doug Pratt. *Got Sun?* Masonville, CO: PixyJack, 2005. Print.

Rex and Pratt have a passion for electrical engineering and solar panels. They understand the gravity of the situation. I chose this topic for the same reason they wrote this book: to spread and encourage thought towards solar energy.

"Forrest County Quick Facts from the US Census Bureau." State and County Quick Facts. U.S Census Bureau, 4 Nov. 2010. Web. 31 May 2011. <http://quickfacts.census.gov/qfd/states/28/28035.html>

I used this source to get more specific information on the local area of Hattiesburg and the affect that the NASA facility would have on the area. Such a case as this would be similar to what needs to happen all across the nation and world. One case can be used to learn about other potential cases of the same nature.

Forristall, R. "Heat Transfer Analysis and Modeling of a Parabolic Trough Solar Receiver

Implemented in Engineering Equation Solver." *Stanford.edu*. N.p., n.d. Web. 14 Nov. 2012. <http://large.stanford.edu/publications/coal/references/troughnet/solarfield/docs/34169.pdf>.

The focus of this case study is to see exactly how the heat is transferred throughout each piece of the parabolic trough. It was composed by the National Renewable Energy Laboratory, a company based in Colorado. Their mission is reaserch and development of technology used in parabolic troughs. I will be able to use this source to learn more about each and every piece of technology that goes into the parabolic trough."Parabolic Troughs."

Goswami, D. Yogi., Frank Kreith, Jan F. Kreider, and Frank Kreith. *Principles of Solar*

*Engineering*. Philadelphia, PA: Taylor & Francis, 2000. Print.

The four authors of this book have decades of experience between them. They know what the nuts and bolts of solar power principles. I used this book to better understand the specifics of solar panels and parabolic troughs.

Green, Martin A. *Third Generation Photovoltaics*. Berlin: Springer, 2006. Print.

This book was helpful in understanding solar panels. After learning how one solar panel works, I could extrapolate to many panels and apply that knowledge to a large scale project. Martin Green has a background in electrical engineering.

"How Many Solar Cells Would I Need in Order to Provide All of the Electricity That My House

Needs?" *TLC*. N.p., n.d. Web. 14 Nov. 2012. <http://tlc.howstuffworks.com/home/question418.htm>.

This article covers the logistical side of solar panel research that I will need to know in order to understand how easy they will be to implement. It is put out by TLC, which is owned by Discovery. While this article is hosted on a website that does not seem like it would have good scientific information, their work is cited with sources of their own. I will be able to use the information within to practically think about what is necessary to make solar panels a viable source of energy for the future.

Janssen, Rene. "Introduction to Polymer Cells." N.p., n.d. Web. 14 Nov. 2012.

<http://user.chem.tue.nl/janssen/SolarCells/Polymer%20solar%20cells.pdf>.

Rene Janssen is a professor in the department of Chemical Engineering & Chemistry and Applied Physics. She teaches the inner workings of solar cells for a living; needless to say she is qualified to speak on the subject. I will use this source to get a better idea of the inner workings of a solar cell. This will help to gain perspective on conditions that solar cells work the best: a crucial piece of information within the context of solar panel implementation.

Kandt, A., E. Hotchkiss, and A. Walker. "Implementing Solar PV Projects on Historic Buildings

and in Historic Districts." *National Renewable Energy Labratory*. N.p., n.d. Web. 14 Nov. 2012. <http://www.nrel.gov/docs/fy11osti/51297.pdf>.

This source is a case study that was performed by the NREL; it details what is necessary for the implementation of solar technology on historic districts and buildings. As stated above, NREL has the credentials to be able to properly conduct a case study. It is their specialty to do so. I will use this source to see what kind of specialized attention historic districts will need in the case that solar energy becomes a larger source of energy nation and worldwide.

"Mississippi Ecological Services: Federally Protected Species." U.S. Fish and Wildlife Service. U.S. Fish and Wildlife Service, Nov. 2010. Web. 28 May 2011. <http://www.fws.gov/mississippiES/pdf/MS%20county%20list%20for%20T&E%20November%202010.pdf>

I used this source to learn about the micro economical area around Hattiesburg. I gained a better understanding of small scale economics of a specific area which I could then use to understand macro economical topics.

"The Photovoltaic Effect - Introduction." *Sandia National Laboratories: Photovoltaic Home Page*. Web. 01 June 2011. <http://photovoltaics.sandia.gov/docs/PVFEffIntroduction.htm>.

This source was used to gain an better idea of how solar panels work on a small scale. The agreement that this source has with others assures me that it is trustworthy.

“Renewable and Sustainable Energy." *Science Direct*. N.p., n.d. Web. 14 Nov. 2012.

<http://www.sciencedirect.com/science/article/pii/S1364032110000675>.

This article was composed by four engineers researching parabolic troughs and their implementation. They have the experience and knowledge to know about the implementation of parabolic troughs. This source will be useful for me to gain a better understanding of the brief history of parabolic troughs and where the technology is moving. I will also see experimental technologies that could make them even cleaner and cheaper.

*Solar PACES*. N.p., n.d. Web.

<1.http://www.solarpaces.org/CSP\_Technology/docs/solar\_trough.pdf>.

Solar Power And Chemical Energy Systems is a company dedicated to research and development of solar parabolic troughs. All across the world they have made advances toward providing clean renewable energy. They have articles about their designs and how the troughs are implemented. The technology they present and use is cutting edge and has been in place for several years.

"Solar Power Implementation Plan." *Solar Power Implementation Plan*. N.p., n.d. Web. 14 Nov.

2012. <http://www.sunlightelectric.com/implementation.php>.

This article contains information about every major facet of the implementation of solar panels. It is put out by Solar Electric, a company solely involved in manufacturing and implementing solar panels as a real and viable source of energy for today and tomorrow. The specificity of this article will be helpful for me to see every step of what goes into creating a major source of alternative energy from concept to ongoing performance. Every step is covered by this company and this article.

"Unemployment Rate in Forrest County, MS." Economic Research - St. Louis Fed. Federal Reserve Bank of St. Louis, 5 May 2011. Web. 31 May 2011. <http://research.stlouisfed.org/fred2/series/MSFORR0URN>

Again, this source was used to gain perspective on the local area of Hattiesburg. It is important to see how such a venture would affect a small area in order to understand it on any kind of large scale.