

SOLAR SOLUTIONS: AN ETHICAL APPROACH

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INTRODUCTION: MODERN SOLAR ENERGY HARVESTING

It's no secret that the world is running out of resources, be it reserves of oil or even coal that the United States often burns for electricity. That being said, modern approaches to energy collection have been making headway in both media and practice. Solar energy is at the forefront of this "green energy" wave. However, there is still much advancement needed in both solar technology and infrastructure before one could expect a massive revamping of America's electricity grid with solar energy input. According to reports in 2011 "...the average home located in the U.S. southeast would require about 1,000 square feet of solar panels to cover all of its electricity needs" [1]. The major cause of this issue is the high inefficiency of modern photovoltaic cells (solar panels used to convert light energy into electricity). In fact panels available on the market currently only offer between 5 and 20% efficiency [1]. Leading to the major issue related to solar energy harvesting, that of land requirements for efficient generation of electricity.

Research is currently being conducted to try and produce more efficient panels that allow both individual customers as well as companies to be able to harvest more energy with less space. As these advancements continue, consumers can expect less square footage of panels to meet their energy needs. This ultimately means electricity production from photovoltaic cells could be conducted in smaller areas with equivalent energy output. This is where DGP Solar, a solar panel company which I am a part of, is making exciting new discoveries in solar panel efficiency.

Ethical Dilemma: PPL Elk Forest Energy Plant

PPL one of Pennsylvania's largest power suppliers has recently gotten in contact with DGP Solar. PPL is showing interest in constructing a massive solar collection plant in the middle of Elk forest, a PA natural park, located in north central Pennsylvania. PPL is proposing remove 50 square miles of this forest in order to build a solar plant to supply Pennsylvanians with a more cost-effective energy solution. This means approximately 16% of the forest would be destroyed to make room for the new power plant which will be using DGP Panels.

The problem with this situation is that while working at DGP Solar, I have come across a solution to the inefficiency issue of our current line of panels offering around 10% efficiency. In the lab, my panel was able to produce 40% efficiency in a controlled setting. However this panel will still be in development for 6 months until it has been tested enough

to be sold to customers. Our company is aware of this high efficiency panel in production and has hit a dilemma with PPL. PPL wants to begin construction of their Elk Forest plant within the next three months. This poses an interesting situation for DGP Solar; does the company use its test and industry proven 10% efficiency panels or delay their production 3 months and use 40% efficiency panels consuming only 4% of the Elk Forest? However, DGP Solar's CEO wishes for us to rush production of the 40% efficient panel and meet the deadline requested by PPL. This scenario would offer PPL a 40% efficient panel that has not finished all of its testing and is prone to failure. As a lead engineer, it is my duty to make the best solution of these three situations.

WHY THE HOLDBACK IN EFFICIENCY?

The problem with solar energy production is not that there is a lack of sunlight hitting panels to produce more electricity. The problem is that the panels are operating at an extremely low efficiency causing this low energy output. To put the amount of solar energy hitting the earth at any given time one can look at how much energy is hitting the earth in a quantitative way. Scientists have figured that, "...enough sunlight falls on the Earth in a minute to meet humanity's energy demand for an entire year" [2]. This amount of energy combined with more efficient panels could lead to solar energy being a leading form of electricity given a large enough harvesting area. One may wonder how large this area would have to be, and luckily enough, we are also able to figure out this area thanks to current efficiency rates and the energy consumption of all humans on earth. This calculation will find that if 4% of the world's desert was used solely for photovoltaic energy generation we could meet all of humanities needs for electricity [2]. To put a quantitative number on that, it would take 500,000 square miles of panels to meet all these needs. To put things into better perspective, that is just about twice the size of Texas.

That is an alarming amount of space to be used for nothing more than solar panels. Luckily, with the new DGP Solar panels, one could expect to use around a quarter of that space to produce the same amount of energy. DGP Solar was able to produce this higher efficiency panel by changing current systems and overlapping internals to produce a more efficient product. The product we have produced is four times more efficient at 40% conversion of light energy to electricity and will cost only twice as much as our current panels.

Pricing is just another factor that is holding back the growth of solar efficiency. This is because of the lack of support due to the fact it takes many years for individuals to start to see their gains from free electricity. Currently, a family

can expect to spend around \$40,000 to \$60,000 to install enough panels to power their home. These figures come directly from the National Renewable Energy Laboratory [3]. With the next generation of DGP Panels, a family could expect to spend half of this to fully power their home, and only need a quarter of the space to do so. DGP Solar has also looked into different forms of solar energy generation and found their new panels beat more cost effective solutions such as flat-panel thermoelectric conversion. This method can currently operate at a max of around 5% [4]. Which despite being more cost effective than current systems will not compete with the 40% efficiency panel. With a better foundation of the improvements and setbacks is established one can begin to understand the issue at hand.

ATTACKING THE ETHICS

PPL has left DGP Solar with quite an ethical issue about destroying forest land to produce a new power plant. Not only does this pose an ethical issue but the CEO of DGP Solar has put an ethical issue on myself to rush the new generation of panels to market. These different scenarios can be looked at in many different aspects according to many different codes in engineering. To best represent these ethical issues I decided to break them down into two groups. The first issue group we will look at is to allow the destruction of 16% of Elk forest. Or to delay the project 3 months which may lose our company the job, but at the same time will destroy only 4% of Elk forest. The second group focuses on the ethics of rushing the project 3 months and not concluding the testing on the new generation of cells.

Ethical Attack #1: Deforestation

For the first ethical issue, I have to look at the code of ethics for not only professional engineers, but civil engineers, as well. The Civil Engineering Code of Ethics is applied because of the deforestation at hand. It is clear that the environmental way to look at things would be to support the development of new green technologies but in a manner that will not disrupt nature any more than it needs to. Due to the nature of this situation, there is the issue of deforestation; however, the customer has already specified this land to be used for the new power plant.

Looking at the ethics code for professional engineers one of the canons that directly fit my issue at hand, that of deforestation, was, "Hold paramount the safety, health, and welfare of the public" [5]. This canon fits the situation at hand for DGP Solar because of the deforestation in the Elk forest. This will eliminate beautiful land currently used for hiking and other recreational activities by the public. But will also interfere with the animals and other factors associated with a forest such as conversion of CO₂ back to O₂. To put a forest into perspective we cannot only view it as trees without life. A forest is composed of an entire bio system containing all different types of plants and animals calling the ecosystem

their home [6]. This taken into consideration, the deforestation not only obstructs trees, but also life. The people living around this area would not be in support of the deforestation and would be in support of whatever solution disturbed the least amount of forest. Deforestation in itself is a modern ethical issue and is cause for alarm due to the increasing rates around the world. In fact, according to the intergovernmental Panel on Climate Change, "Deforestation, mainly in tropical areas, accounts for up to 20% of the total anthropogenic emissions of carbon, a greenhouse gas" [7]. Despite that this fact is applied to mainly tropical areas, deforestation can be viewed as an issue all over the globe in many different climates. Case in point, it can be seen in the situation here. Even though it is hard to tell how much greenhouse gas emission may increase due to this deforestation it is bound to happen.

Another canon this time from the Civil Engineering Code of Ethics is, "using their knowledge and skill for the enhancement of human welfare and the environment" [8]. This ethical issue comes into play when dealing with deforestation, because of that fact that with the construction of this plant the environment will be harmed. However at the same time the quality of life for people living in the state of Pennsylvania will improve because they will be receiving low cost electricity because of this power plant.

There is a solution for this ethical dilemma though. The project could be delayed and save 12% of the forest and only use 4% in space for the power plant. The cost of this solution, however, is the chance of losing the account with PPL due to pushing back their previously set construction date. I personally believe that there would be public support of this answer though. In 2013, the Short Term Energy Outlook Report presented by the U.S. Energy Information Administration reported that, "Solar generation by the electric power sector increase 81% in 2013" [9]. This being said, the electric power sector is funded by its customers, and with a majority of people supporting green initiatives, I would suspect they would support not only the construction of this plant, but also the hold off for more efficient panels accompanied with the limited amount of deforestation.

Ethical Attack #2: Rushed Products

The second ethical issue I faced in this situation was one put upon me by the CEO of DGP Solar, the rush of development for the next generation of panels. Therefore development would need to be cut by three months to reach the imposed deadline by PPL. The ethics behind this rush in development are that DGP Solar would be selling a product that has not been given proper time to fully test and could be faulty once used in application.

This ethical issue interferes directly with the canon from the ethics code for professional engineers discussed in the previous section on deforestation. "Hold paramount the safety, health, and welfare of the public" [5]. If inefficient research and testing is done of these panels it is hard to

guarantee that there will be no safety faults related to them. At the same time, it is hard to tell if they will be 100% market ready without proper testing and could be subject to failure. Which, in itself, is another cannon of the professional engineering code of ethics, "Engineers shall avoid deceptive acts" [5]. To sell the next generation of panels on a large scale without proper testing would be deceptive to PPL. PPL is expecting panels that will last and preform as reported from DGP Solar.

Proper research length is important to any revamping new technology. Without the proper testing, millions of dollars could be spent on unproven technology. An example that shows ground breaking technology at use can be seen at Caltech. Caltech is working on converting solar energy into a stable and transportable fuel that can be used at any time of the day regardless of sun light [10]. This represents the need for proper testing because if this system was put into place before it is proven to be effective, millions of dollars could go to waste on unproven technology. Leading to the ethical issue of presenting a product that is not yet tested to fully work and cannot be guaranteed to fully work.

The civil engineering code of ethics addresses this issue also with the cannon, "Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession and shall act with zero-tolerance for bribery, fraud, and corruption" [8]. The situation the CEO of DGP Solar has put me in would cause myself to break the honor associated with engineering by releasing a product to a company that I did not believe was fully tested and ready for sale. Nothing good will come from releasing a product that is not been thoroughly tested in different conditions and scenarios. A similar situation to this one happened to American company General Motors. GM rushed the production of U.S. built diesel car engines to help make a more fuel-conscious line of vehicle. GM failed in this gamble causing them to lose millions of dollars [11]. Backing the claim that due to unproven researched and rushed deadline mistakes are likely to be made and can have catastrophic results.

CONCLUSION: ETHICAL SOLUTION

There is no doubt that DGP Solar is left in a difficult situation due to all of these ethical issues. There however is one solution that outshines the rest, and that is pushing back PPLs deadline three more months. The reason this solution can be seen as the best is because the only set back that PPL will face is having to hold off the three months. Once those months have passes PPL will only have to process 4% of the forest as opposed to 16%. At the same time PPL will be receiving a fully tested and proven product from DGP Solar which will most likely out preform the panels they would have received three months earlier.

If PPL was sensible and explained the situation thoroughly, I believe they would to also agree with this choice. Not only would it be a better solution for their

company, but would also reflect well on their customers because of the "green" choices that were made by disturbing a significantly less amount of forest space. Overall the situation with PPL and DGP Solar is a complex one it can also be handled in a sensible manner once broken down into individual ethical issues and selecting the most sound solution.

REFERENCES

- [1]R. Gabbard. (2011). "Solar energy." *Green energy: An A-to-Z guide*. (Online Encyclopedia) <http://dx.doi.org/10.4135/9781412971850.n115>
- [2]G. Harper. (2010). "Solar energy." *Encyclopedia of science and technology communication*. (Online Encyclopedia) <http://dx.doi.org/10.4135/9781412959216.n279>
- [3]A. Watson, L. Giudice, L. Lisell, L. Doris, S. Busche. (2012) "Introduction." *NREL Report, Solar Ready: An Overview of Implementation Practices*. (Online Report). <http://permanent.access.gpo.gov/gpo18904/51296.pdf>
- [4]J. Karni. (2011). "Solar Energy: The Thermoelectric Alternative." *Nature Materials*. (Online Article). <http://www.nature.com/nmat/journal/v10/n7/full/nmat3057.html>
- [5](2007). "NSPE Code of Ethics for Engineers." *National Society of Professional Engineers*. (Ethics Code). <http://www.nspe.org/Ethics/CodeofEthics/index.html>
- [6](2008). "Deforestation." *International Encyclopedia of the Social Sciences*. (Online Encyclopedia). http://go.galegroup.com/ps/retrieve.do?inPS=true&prodId=GVRL&userGroupName=upitt_main&docId=GALE%7CCX3045300539&contentSegment=&navContext=none
- [7]B. Schmook. (2011). "Deforestation." *Green Politics: An A-to-Z Guide*. (Online Encyclopedia). <http://knowledge.sagepub.com/view/greenpolitics/SAGE.xml>
- [8](2009). "Code of Ethics." *American Society of Civil Engineers*. (Ethics Code). <http://www.asce.org/Leadership-and-Management/Ethics/Code-of-Ethics/>
- [9](2013). "Renewables and Carbon Dioxide Emissions." *U.S. Energy Information Administration: Short-Term Energy Outlook*. (Online Report). http://www.eia.gov/forecasts/steo/report/renew_co2.cfm
- [10]L. Donaldson. (2011). "Solar energy fueled up: Energy." *Materials Today*. (Online Article). <http://www.sciencedirect.com/science/article/pii/S1369702111700505#>
- [11]W. Brown. (1984). "GM Diesel Pullout Called a Surprise." *The Washington Post*. (Online Newspaper Article). <http://search.proquest.com/docview/138101356>

ADDITIONAL SOURCES

B. Merchant. (2013). "These New Renewable Energy Stats Will Blow Your Coal-Powered Mind." *Motherboard*. (Online Article). <http://motherboard.vice.com/blog/these-renewable-energy-stats-will-blow-your-coal-powered-brain>

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