Prospectus

Cost-Effective Solar Powered Fan
(Technical Topic)

Actors Involved in Scaling Solar Technology in Developing Countries
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Energy poverty is defined as a lack of access to reliable and affordable modern energy sources (Culver, 2017), and it is a huge crisis that affects billions of people around the world (Indrawati, 2015). Those who do not have any access to sources of electricity can be considered energy impoverished, but those who have access to electricity but cannot afford their electric bill are energy impoverished as well (Culver, 2017). On a global scale, 1.1 billion people do not have access to electricity ("Power to the powerless", 2016). In the United States, residents below the poverty line in multiple states have electricity bills that are over 10% of their household income, which means that they are energy impoverished (Daniel, 2019). To reduce the burden of electric bills on low income households, I am seeking to reduce the amount of cooling needed in the summer months since heating and cooling accounts for about 40% of the overall electric bill in the United States ("72 degrees air", 2019). This can help those below the poverty line reduce the financial burden of running energy demanding AC units in hot summer months. My solution to this problem is a cost effective solar powered fan. This fan can be placed inside the home to cool rooms and residents in order to reduce the reliance on air conditioning units.

Once the technology is created, it is imperative that the technology is effectively introduced into the communities that are suffering from energy poverty. Without the proliferation of solar technology and proper training of users on how to use the technology, the technology itself is worthless. In a case study about the spread of solar technology in Ghana from 1980 to 2010, government policy was determined to be the factor that allowed the solar industry to flourish. However, there are other actors that allowed solar technology to proliferate that are human and non-human factors. An economic downturn and international organizations are some of the other actors that allowed solar technology to scale up in Ghana. By understanding various

actors that play a role in spreading solar technology, I am able to gain a better understanding of the success factors and the dynamics between the actors that were vital in alleviating energy poverty.

A socio-technical solution is needed in order to properly address energy poverty. To provide a technical solution to high electric bills due to increased cooling in summer months, I will create a low cost solar powered fan to reduce AC usage. To understand the social problem of integrating and scaling up solar technology in energy impoverished communities I will analyze the plethora of actors that led to the success in Ghana, where energy impoverished communities were able to access sustainable solar energy.

Technical Problem

Many families struggle to pay their electric bills in the summer when the scorching heat shoots their electric bill up to $150 to $200 a month. Noah's Ark Ministries reached out to the university to find a solution to this problem because they serve energy impoverished residents in Washington D.C. (Brother Woodson, personal communication, September 10, 2019), which is an area with one of the worst energy poverty issues (Daniel, 2019). Current solutions to decrease cooling costs in the summer include installing programmable thermostats (Matulka, 2017). Programmable thermostats allow one to set multiple temperatures that are held constant for long periods of time. They have a hold feature that override the programmed temperature setting and that can lead to increased electric bills rather than lower bills ("Proper use guidelines", n.d.).

The Environmental Protection Agency has questioned the energy savings from installing programmable thermostats due to its inability to confirm that using programmable thermostats lead to savings. Sometimes programmable thermostats actually increase electric bills; it all boils down to how the user interacts with the programmable thermostat (Kaplan, 2009). Spending

money on a new programmable thermostat and not receiving the savings that it promises can make the homeowner even more financially unstable. Creating a feasible solution to high electricity costs can help struggling families stay on budget without sacrificing comfort.

The proposed solution is to create a solar powered fan that can lower electric bills. Fans can cool homes and cool the residents in the home. Fans cool the body by enhancing convection, radiation, and perspiration that are processes that naturally cool the body. Convection moves hot air from the body since the cool air generated from the fan will absorb the heat on the body. Hot air radiates towards areas that are cooler, so if the fan cools areas around people, then heat will travel toward those areas rather than toward them. This phenomenon is called radiation. Perspiration on the skin in warm environments can help one cool down since the breeze from the fan can evaporate the perspiration on the skin, leaving the skin cool (Cooling your home, 2001). The device must be safe, easy to use, and low cost to cater to the customer base we are trying to reach. It will not add any costs to the electric bill since it is entirely self-powered. The essential components of the device are the solar panel, power control, battery, voltage regulation, motor controller, microcontroller, motor, and fan blades. Users can place the solar panel on their window sills and harvest energy from the sun to cool down their homes. To make the product affordable for customers, we are hoping to keep the cost of the device below $100.

We will use CAD software and printed circuit board (PCB) design software to design our product. Once the components are manufactured, we will use Virtual Benches to test and debug our circuits. Once all the subsystems have been tested, we will integrate them together and run it. If we are able to run the fan only using the power of the sun, then it will be a technical success.

STS Problem

Scaling up solar technology in a developing country has many challenges and factors that can lead to success or failure. However, scaling up solar technology in a developing country is vital because it can boost economic growth, reduce poverty, and provide health benefits. The issue of global warming makes it even more imperative that solar technology be scaled up because it can steer developing countries away from carbon emitting nonrenewable energy sources. A case study about disseminating solar technology in Ghana from 1980 to 2010 is an important study to analyze because it can provide other developing countries key insight into how to successfully scale up solar technology. The case study explored the process of scaling up photovoltaics in Ghana and determined that there were 4 stages of development that were defined by government policy about solar technology. The first stage was indicated by the flow of NGOs into Ghana that provided solar technology to mainly schools and hospitals. In this stage government policy was incoherent and did not focus on how to sustain solar technology in Ghana for the long run. Phase two was defined by the government policy called the Ghana Vision 2020 that sought to connect the country using a national electric grid. The influx of private and public capital into scaling up solar marked phase three and liberalization in this period allowed more private companies into the solar sector. Policies that promoted public-private cooperation in stage 4 allowed solar technology to be disseminated (Amankwah-Amoaha, 2015).

Scholars believe that the main source of success for the proliferation of solar technology in Ghana was government policy that allowed the solar industry to flourish (Amankwah-Amoaha, 2015). However, there were several other factors that allowed solar technology to spread throughout the country, including international bodies, NGOs, environmental factors, the recession in the early 1980s, and the reduction in the price of solar panels. If we only think that

government policy was the only success factor behind the spread of solar technology, we fail to understand how the other actors played a role in the proliferation of solar technology in Ghana.

Utilizing actor network theory, I claim that it was government policy in addition to the other actors listed above that allowed solar technology to proliferate in Ghana. Actor network theory is a framework that seeks to understand the technology-society relationship by analyzing power dynamics among human and non-human actors with a network builder that assembles a network to accomplish a goal. Utilizing actor network theory will allow me to better understand the factors that are responsible for the rise of the solar usage in Ghana (Cressman, 2009). I will specifically analyze seemingly negative actors such as environmental crises or economic recessions that were actually key motivators in scaling up solar technology in Ghana. Additionally, I will make an argument that support from international bodies and NGOs allowed the Ghanaian government to be a network builder to promote solar technology. Finally, I will argue that the technological actor, solar technology, had to decrease in price for all of the actors to be influential.

Conclusion

The result of the technical project will be a low cost solar powered fan that will be used to reduce electric bills in the summer. Fans can cool a home and the residents in the home through convection, radiation, and evaporating perspiration. The deliverable of the STS project is a thorough analysis of how not only government policy but also other actors lead to successful integration and adaptation of solar technology in developing countries specifically Ghana. The actors and the dynamics of these actors that scaled solar technology in Ghana are important to analyze since successful patterns can be determined by the interactions among the actors. These two projects together address the problem of energy poverty. Energy poverty cannot be solved

through technology alone because if the technology cannot reach the audience that needs it the most, then energy poverty will not be alleviated. The creation of affordable, reliable, safe energy generators and the analysis of actors that can provide sustainable delivery of these products to those who need it result in successful reduction of energy poverty.

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