SolBits:

Turning the Solar Energy Fairytale into a Reality

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How Might We?

How might we decrease the dependency of fossil fuel generated electricity using solar energy.

The PROBLEM

Problem Statement and Significance

There is a large dependency on fossil-fuel generated electricity in the United States. According to the 2011 report from the U.S. Energy Information Administration, fossil fuels account for 82% of all sources of energy within the US and account for 40% of the creation of electric power [1]. The problem has not been solved because it is an economic factor. It is cheaper to produce electricity from fossil fuels; they account for 46% of total subsidies in the United States [3]. Alternative sources of energy cost more initially, especially long-term investments such as wind farms ($1.3 million per turbine), solar cars, and tapping into geothermal energy ($.035 per kWh, $25000 to install) as opposed to fossil fuel-generated electricity ($0.12 per kWh, system pre-installed) [4,2]. Apart from monetary factors, legislative factors play a large role in fossil fuel policies, as many candidates who are in or are running for political positions are sponsored by stakeholders in the fossil fuel industry, leaving little leverage for political party members to push for alternative means for acquiring energy.) Additionally, there is the common misconception that solar power is not readily available, is expensive, and has limited uses.

Context of the Problem

There are many reasons as to why the consumption of fossil fuel is a problem. We are focused on the environmental impact fossil fuel creation and usage has on the environment. Power plants in the United States that are sustained by fossil fuels emit: 67% of US's sulfur dioxide emissions, 23% nitrogen oxide emissions, and 40% man-made carbon dioxide emissions, all of which can lead to and produce smog, acid rain, haze, and possibly climate change [1]. Nitrogen oxides contribute to the formation of photochemical ozone (smog); carbon dioxide affects the earth's radiative balance [6]; methane has a global warming potential 23 times that of carbon dioxide [1]; nitrogen oxides, carbon dioxide, methane, and sulfur dioxide contributes to the formation of acid rain [6]. Beyond these effects, the mentioned chemicals and more can also cause visibility impairment and eutrophication [3]. Each electricity-generating method derived from fossil fuels has their own negative impact towards the environment. To combat these negative effects on the environment, we propose a cleaner way to generate power by promoting solar energy. Using personal solar photovoltaic cells will decrease the amount of fossil fuels that are used as well as limiting the toxins released into the air and ground [8]. There is a specification to "personal" solar photovoltaic cells, as it promotes taking initiative to being more resourceful and mindful when selecting their electricity source. Stakeholders include the government, power companies (ie. Georgia Power),

environmentalists (ie. Greenpeace), and institutions that aim to be eco-friendly (ie. Georgia Institute of Technology). A reason why the problem has not been solved is an economic factor. It is cheaper to produce electricity from fossil fuels; they account for 46% of total subsidies [4,2]. Our goal is to make solar power more viable, so that less fossil fuels are consumed than would otherwise be used. However, using solar energy is a major investment and will cost individuals monetarily when incorporating the product into their lifestyle causing solar power to be less appealing when compared to conventional methods for energy production. To combat this, the solution will be versatile and low-cost so that energy can be produced in many places and for a variety of uses. Society will benefit from the long-term environmental burden that would be decreased by the use of our new solar technology. Ideally, these cells will be developed so that when combined with other clean forms of energy, they can decrease the usage of fossil fuels.

The SOLUTION

Goal

Our goal is to deal with the economic and social aspects of the problem by creating an inexpensive, user friendly, and versatile solution that generates clean power. We are focusing on these aspects of the problem as a successful solution will create social and economic pressure to bring about large scale change in society away from fossil fuel based energy. Solar companies are criticized for lack of economic viability and dependence on government funding [9], which scares away potential investors and creates negative impressions on the general public. Creating an economically viable solution will create economic pressure against fossil fuel generated energy. By making it user friendly and versatile, it becomes quickly integratable in daily life, which serves to further change public opinion that clean energy is viable, creating social pressure. The goal is that the economic and social pressure would spark societal shift toward alternative energy sources. Should the solution succeed, it will significantly impact the effect human society has on the environment - solar energy, over the course of a standard cell's life cycle will produce 0.08-0.2 lbs. of carbon dioxide equivalent per kilowatt hour, a significant improvement over fossil fuel generated electricity, such as coal, which produces 1.4-3.6 lbs CO2E/kWH) [10]. Even on a personal use level, the carbon footprint of society as a whole can be quickly minimized.

Solution Description

Our solution to this problem is a solar charger with three main concepts: modular, inexpensive, and versatile. The cells are made to be small and easy to carry, as well as following the concept of big systems being easier to build using small components rather than taking a large base unit and fitting it to smaller means and uses. Each modular unit will be inexpensive as a small initial investment. The design is made to be multipurpose and convertible to increase the variable uses of a single unit compared to one singular large installation; one single unit can be used to charge a variety of small electronics, and can be pieced with other units to potentially be used on high-powered systems. This solution is inexpensive, modular, and has big and small applications, providing the appeal of applicability in multiple areas and uses.

Objectives and status update

1. *OBJECTIVE I: Develop a working prototype that will be able to give charge to*

electronics and then distribute it amongst team members in order to test the functionality of the prototype and ensure that there are no major problems with the design and performance.

TASKS

1.1. Electronic Research

Research all electronic component related to our project.

Status: Completed

Assessment: Become knowledgeable enough to begin work on prototype

1.2. Goal/Research Analysis

Reflect on the goal of the project and the research in order to ensure that we have a firm plan and no holes in our research.

Status: Completed

Assessment: Have a project within scope that solves a grand challenge

1.3. Establish Constraints; Establish Requirements

Assess the restrictions and feasibility of the functions and requirements of the project

Status: Completed

Assessment: Have a plan of all features to be implemented after considering restrictions and feasibility

1.4. Prototype Idea; Research Necessary Technology

Create a mockup of the prototype and conduct any further necessary needed to create it

Status: Completed

Assessment: Create a list of features and technology needed for prototype

1.5. Develop Full Schematics for Prototype

Create schematics for our prototype

Status: Completed

Assessment: Create a blueprint for the prototype to be machined.

1.6. Obtain Supplies, Machine Parts for Prototype; Assemble Prototype

Order parts for first prototype and create prototype

Status: Completed

Assessment: Get parts and create prototype

1.7. Performance Test Prototype

Test prototype for basic functionality

Status: Completed

Assessment: Prototype is able to fit with other pieces and hold and give charge.

1.8. Conduct Usage Tests; Conduct Statistical Analysis

Figure out size of sample group and of what demographics. Create and conduct a survey to be distributed to a sample group regarding their opinion on modular solar power and scalability

Status: Ongoing

Assessment: Consumer needs with modular solar energy are found

What remains: Creating copies, conduct usage test, and statistical analysis

Plan of Action: Create usage tests, and find user group

1.9. Refine Prototype; Create Copies of Prototype; Alpha Test

Modify changes to the prototype, create copies, and give to member for alpha test

Status: To do.

Plan of Action: Finish prototype before the summer or early summer and give to team members for alpha testing.

2. *OBJECTIVE II: Refine the prototype from the information obtained during the Alpha test in order to improve and fix any major flaws that would hinder performance and functionality and then determine the appropriate group to mass distribute the prototypes in order to further test the functionality and the user acceptance of the prototype.*

TASKS

2.1. Obtain Supplies & Machine Parts for Prototype

Order supplies and create more prototypes

Status: To do.

Plan of Action: Order supplies and create more prototypes for further testing

2.2. Assemble Prototype; Performance Test Prototype

Figure out a way to assess success and the appropriate sample group

Status: To do

Plan of Action: Determine sample group to distribute prototypes to, create a assessment metric to determine success.

2.3. Decide on Sample Group; Distribute Prototypes

Find sample group and distribute prototypes

Status: To do

Plan of Action: Gather sample group and distribute prototype

2.4. Collect Feedback; Conduct Statistical Analysis

Gather information on the success of the prototype

Status: To do

Plan of Action: Gather the information from the assessment metric and analyze to determine the success of our prototype.

How has your project changed over time?

The biggest changes with this project have been in changing the physical design of the device. At first, it was thought that it might be possible to use solar cells, cut them and set them in

a custom case. It was soon learned that cutting the cells is extremely difficult to do precisely. The plan then changed to finding a new way of achieving the proper module specifications. The solution was to outsource and order solar modules that were specific to our specifications. After that, the team looked into different methods of connecting these modules together. For a while, it was thought that puzzle piece locking mechanism would be the simplest method for doing so. Once some rapid prototyping was done, though, it was determined that, in practice, this method may not be best. So, now, we have decided to go with using magnets, that, though are slightly more expensive, are more of an elegant solution.

FUTURE

Future implications and Next Steps

The niche of the product is its ability to be used in many applications and in many different fields. The next steps for the product involve mass testing of the cell and the development of different attachment hubs, such as voltmeters, ammeters, usb connectors, that would allow the modularity of the cell to be exploited. To accomplish this we would need to get funding. We are currently looking at entering the Inventure Prize at Georgia Tech. We would also need to research grants and look into funding provided by TAG and the ATDC. Hopefully these programs would not only provide funding but guidance as well. Further, we need to expand our business model. We have the product, now we need to define the business. We need to find a mentor that can help us shape our image and aid us with marketing, and business strategies. through this we hope to get established in the market and be that much closer to a real product. Currently, we are in the process of building a very nice website where interested companies, investors, and consumers can go to learn more about the product and its many uses- something we hope to expand on in the future.

SOURCES

[1] “Air Emissions." *EPA*. Environmental Protection Agency, 17 Oct. 2012. Web. 12 Mar. 2013. http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html.

[2] "Climate Denial Crock of the Week." Climate Denial Crock of the Week. N.p., 11 Feb. 2013. Web. 15 Mar. 2013.

[3] Wald, Matthew L. "Fossil Fuels' Hidden Cost Is in Billions, Study Says." *The New York Times*. The New York Times, 20 Oct. 2009. Web. 13 Mar. 2013.

[4] "Operations and Machines." *Energy Conservation*. Georgia Institute of Technology, 2011. Web. 13 Mar. 2013.

[5] Art, H.W., 1993, Eutrophication, *in* Art, H.W., ed., A dictionary of ecology and environmental science (1st ed.): New York, New York, Henry Holt and Company, p. 190-200.

[6] "Glossary." *EPA*. Environmental Protection Agency, 17 Oct. 2012. Web. 12 Mar. 2013. http://www.epa.gov/cleanenergy/energy-and-you/glossary.html#no2

[7] Koplow, Doug, and John Dernbach. "Federal Fossil Fuel Subsidies and Greenhouse Gas Emissions: A Case Study Of Increasing Transparency For Fiscal Policy." *Annual Review Of Energy & The Environment* 26.1 (2001): 361. *Academic Search Complete*. Web. 11 Mar. 2013.

[8] "Environmental Impacts from the Solar Energy Technologies." *ScienceDirect.com*. N.p., n.d. Web. 15 Mar. 2013.

[9] B. Edson. (2012, Dec 6) *"Mounting Economic Pressure Weighs Heavily on Solar Companies"*. The Motley Fool. [Online] Available: http://beta.fool.com/billedson11/2012/12/26/solar-mounting-economic-pressure-weighs-heavily-so/19613/. [Accessed: Apr. 24, 2014]

[10] "Enviromental Impacts of Solar Power." *UCSUSA.* Union of Concerned Scientists. 5 Mar. 2013. Web. 24 Apr. 2014. Available: http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/environmental-impacts-solar-power.html