CLEANTECH-PROJECT PROPOSAL: STEPPING FOR SUCCESS (SFS)

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EXECUTIVE SUMMARY

Electricity plays a crucial role in our daily operations- post-offices, mailing services, household lighting, televisions, X-ray and ECG machines. However, in the world approximately 1.2 billion people have little-no access to electricity. As one can imagine, this has massive negative impacts their quality of life as well as the country's economic goals. Specifically, on May 2, 2018, a massive high speed dust storm hit the rural villages of Alwar India and disrupted the electric power grid. Consequently, major cities lost power for 3-4 days and rural villages continue to be at a disadvantage. In fact power outages like this happen every day. Currently, the government is attempting to recover the lost transmission and power lines, however, this doesn't tackle the problem as sandstorms will continue to occur and destroy this system. And so, the goal of this proposal is to come up with a unique solution to resolve the daily power needs of communities during "power-cuts" and natural disasters. The solution will be through piezo-electro electricity which is a mechanism that converts mechanical energy into electrical energy and stores this energy in "charging stations", which can then be used during times of need. Piezo-electricity is definitely the future for power generation as it can have wide-ranging applications- roads, gyms, playground, malls and many more. With this project in place, as a company we experience a vast amount of growth in latest technical fields and can become a leader in fueling the world with piezo-electricity in the future.

UNDERSTANDING, APPROACH, METHOD

BACKGROUND

The Power Grid

India's power network is set up in a way such that current is sent across high-voltage transmission lines from the source of where it is being produced to nearby districts. The high-voltage results in fewer losses in power during the process of transmission. This current is then passed onto local substations where voltage is substantially reduced to satisfy the loads of homes

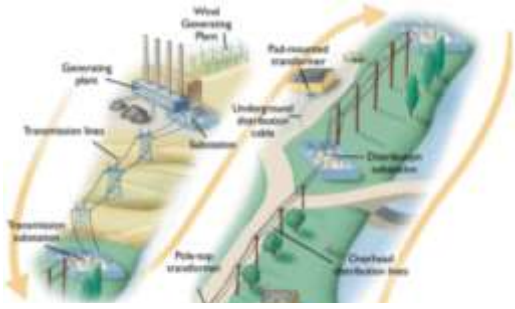


Figure 1: Power Transmission

and work places. This power is then transmitted through overhead distribution lines, into peoples' homes. As evident in Figure 1, this process is rather expensive and tedious due to the number and length of distribution lines and transmission stations particularly for small and rural villages.

PROBLEM

The Problem

May 2-3 2018 Bharatpur Alwar India and many of its rural regions were struck with a massive high-speed dust storm. Consequently, there were numerous fatalities and over $350,000,000 USD in damage after 1500-2000 transformer and the entire electric grid was disrupted. While the government is making an effort to reestablish power in some of the major cities of Alwar, many sub-districts of Alwar still don't have access to power. In fact, the World Bank claims that over 200,000,000 people in India still don't have access to electricity, out of which in many rural villages "power outages happen every single day for 4-6 hours".

Figure 2: Alwar during the dust storm *https://www.ndtv.com/india-news/powerful-dust-storm-sweeps-through-eastern-rajasthans-alwar-bharatpur-dholpur-18-dead-1846369*

Power Outages

Power outages, often referred to as "Power-cuts" occur very frequently in India. Due an annual growth rate of over 1%, India's population is constantly growing in size. Consequently, their annual demand for electricity per head can be seen to exceed the generation capacity. With the population growing, it may be expected that power generation would increase as well. However, a majority of this population growth is in rural areas which contribute to over 66% of the total population.

Interestingly enough, the electrical needs of people in rural villages is constantly getting pushed back due to the high cost involving the construction of electrical transmission lines and infrastructure. Additionally, in order to satisfy some of the growing needs in some of the major financial centers in India such as Mumbai, Delhi, Kolkata, supply of power to rural areas overtime, is becoming less and less of a priority. However, this is massive negative externalities in hurting local businesses, helping to break the never-ending loop of the poverty cycle, and on the quality of life of every inhabitant living in rural villages. This is an important problem, and the government currently is searching for cost-effective and reliable methods of rural electrification.

Natural Disasters

Dust Storms are categorized as strong, violent winds that uplift fine particles such as silt, clay and dust over long distances and swirl them around in the air at over 40 kilometers per hour. Dust storms occur as a direct consequence of abnormally high temperatures in the region. Furthermore, the intensity of heat in India's seasonal weather patterns, and the dryness of the summer months, created the perfect recipe for a sandstorm. Despite the innumerous fatal deaths and injuries- a direct consequence of the dust storm, power outages often a secondary effect. Due to the strong winds, dust storms can tear down transmission lines, power lines and disrupt the entire grid. Generally speaking, Sunflower electric power corporation states that "A widespread damage to the transmission system can take days, weeks, or even months to repair."

This ambiguity of costs involved preceding sand storm is unimaginably high. Repairs that last months or even years can cost human and resource capital, at the opportunity cost of allocating these resources for an alternative purpose. Additionally, the amount of money needed to reconfigure the entire system is surprisingly high. In fact, a single power pole transformer can cost anywhere from $3,000 to $7,000 excluding service, transportation and power line costs. Consequently, the government is constantly searching for more efficient technologies of energy production that can withstand the high-winds of sand-storms or potentially technologies that can be used as alternatives when power outages occur. The latter, is going to be the major focus of this report.

Negative Consequences of Power-loss

Without power, both the growth of the community as well as the Indian economy was destabilized. With regard to the community of Alwar, due to the lack of visibility, over 400 locally owned hand-loom businesses, housing 70% of employable workers were unable to work at their maximum level of productivity. Effectively this lowered sales and strengthened the never-ending poverty cycle of local inhabitants. By 2021 this industry was expected to generate $141 billion USD as India's revenue, however, at this rate of unproductivity, analysts forecast sales to largely decline.

Furthermore, over 60,000 primary school children and 383,000 households find it inconvenient to perform their daily chores and activities. From first-hand experience having lived in, and witnessed the daily lives of villagers living in rural communities, children feel less inclined to perform school work which leads to a decline in educational standards. As well, women find it convenient to cook and perform household activities due to a lack of air circulation and visibility.

Summary- Current method(s) being used

Immediately preceding the sand storm in May, the State power minister Pushpendra Singh made arrangements to supply over 13,000 poles and material required to build transformers. He was focused on restoring electricity in government services, hospitals and at major building. Despite the efforts to rebuild the Alwar and Bharatpur districts, Meteorologists cautioned the community about another powerful power dust storm the following weekend.

Thus, the current measures being implemented is not sufficient enough. Rebuilding transmission lines and electric poles isn't going to resolve the problem from the root, as it is simply delaying the occurrence of another event as such.

Remaining need for Intervention

Currently, the government of India allocated a budget of over $100 billion in the renewable energy sector to strategize and implement solutions that can electrify communities in cost-effective and eco-friendly ways. Due the continuous need for power during daily power outages and preceding natural disasters, there is a remaining need for intervention from innovative and reliable companies to strategize methods to power communities during power outages. The government is looking for cost-effective solutions that take rural-electrification forward. Hence, it can be seen that the energy sector is in need of an assistance, and effective intervention by proposing alternative solutions to resolve this issue can lead to massive long-term rewards.

POTENTIAL STRATEGIES

There are numerous ways to resolve this problem, however some suit the context of the situation better that others.

Solar Power

Sunlight is abundant during the day and Southern countries tend to have a greater exposure to sunlight making solar power a good source of trapping daylight. However, solar power is unreliable at night, and moreover on cloudy days when approximately 20% of sunlight is blocked from exposure. Additionally, it's difficult to build solar panels on the roofs of houses, as many homes in India have open-concept roofs that people use to dry chill's, hang their clothes for drying, or play games. And so, the only place to install these solar panels are on farming acres. This has a negative impact on the monthly revenue

generated by farmers and the sales of local grocers who rely on these crops for business. In essence, it is clear that solar power simply cannot *fit in* to these communities.

Figure 3: Major districts of Alwar

Hydropower

Looking into hydro power. Although hydro-power is really effective in areas surrounded by water, Alwar has only 5 sub-districts that are surrounded by water sources as evident in the figure shown. The remaining places will require access to this power through large-scale transmission lines which are very costly and can be vulnerable from natural disasters as mentioned previously.

Piezoelectricity

Piezo-electricity is a modern and cost-effective technology that is gaining a lot of attention recently. Piezo-electricity uses a simple engineering concept known as "the law of energy conservation", stating that "energy is never created, nor lost, it is simply transferred from one form to another". This type of energy simply converts mechanical energy to electrical energy which can be later used to satisfy daily needs.

Piezoelectric footwear

Currently, strategies have been developed to install piezo-electric shoe insoles which have compact and sleek design. Technically speaking, Piezo-electric sensors are installed in the insoles of foot ware with a rechargeable attached around the ankle which can later be plugged in to small loads. The downside? Many villagers in the rural districts don't wear any footwear and others find that footwear makes it inconvenient for them to perform their daily chores. Furthermore, due to the fewer amount of piezo-electric sensors that places on footwear, walking between 2.5-5 miles only generates power enough to charge an I-phone. Considering the immediate needs of the community of Alwar, the technology isn't sufficient enough to power the village during power outages and natural disasters.

Piezoelectric panels

Piezoelectric panels is a technology can be installed on walkways to generate electricity when people step on it. In essence, Piezo-electric panels consist of a set of steel plates placed on the ground consisting of sophisticated electrical interfaces and piezo-electric sensors that convert the mechanical energy (generated from the force gravity exerted from the center of mass of objects)

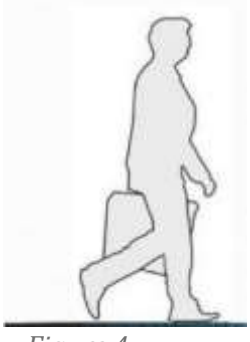


Figure 4: Piezoelectric panels

into electricity. This electricity is then transported and stored in nearby power-banks through underground cables. Villagers and small local businesses are assigned inverters based on a weekly estimate of their power consumption which can then be recharged at these power-stations. When power at this rechargeable station exceeds a certain threshold, this power is then sold back to the grid and redistributed towards nearby villages.

CONCLUSIONS

Piezo-electric panels are the optimal solution due to numerous reasons.

1. **Lack of dependency:** Since this system isn't directly connected to a national power grid or large transmission lines it definitely avoids the cost of overhead-transmission lines and transformers which have a high cost as mentioned earlier on in the report.
2. **Susceptible to natural disasters and weather fluctuations:** Transmission lines are needed to send power from the panels to the storage units are connected through underground power lines avoids the potential for damage due to surrounding or during natural disasters.
3. **Renewable:** This technology aims to conserve and make use of the vast amounts of energy generally lost from heavy foot trafficking. As a result, this technology is completely eco-friendly, and leaves no carbon footprint- important to the Indian government
4. **Access to power during power outages:** Since villagers have to simply charge their inverters to power their homes, this makes it a stand-alone system. Now, the village is capable of running independently with minimum government intervention. And so, now they can have access to power even during times of power outage.

RECOMMENDED ACTIONS/METHODS

The process of energy generation

Piezo-electric crystals in the form of quartz/ cane/are lumped in a crystal lattice structure with neutral balance are arranged together. For the purposes of our project, we will use PZT (lead zirconate titanate) to generate more voltage from a smaller mechanical pressure. With the application of mechanical power, it causes the atoms in this structure to shift, which lead to asymmetry. Consequently, there is net positive charge on one terminal and a net negative charge on the other. As a result, current can easily flow from one terminal to the other causing electricity to be generated.

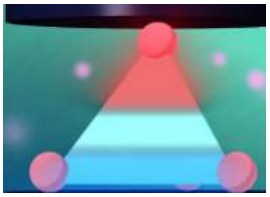


Figure 5: Crystal structure (change)

Product

The general functionality of all these piezo-electric sensors will be held within the piezo-electric sensors/ "elements" as shown in the diagram to the right. These elements will conduct the electricity which will be held captive by the upper and lower conducting foil. This foil then transmits this power to the interface and further through underground transmission lines it will reach the battery charging stations where the power is stored. The upper metal that is made out of a strong metal and placed on-top of this structure, durable to severe weather conditions and able to withstand weights of more than 2000 pounds.

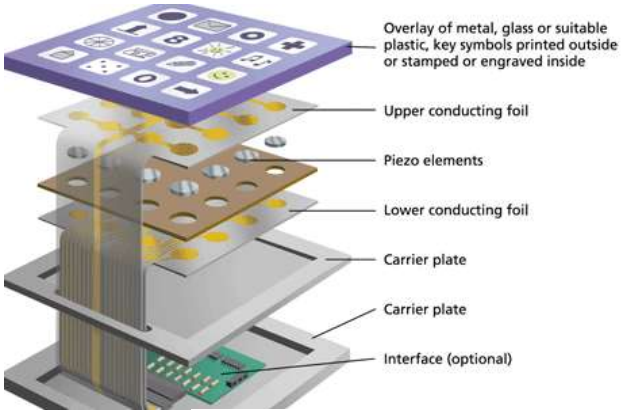


Figure 6: Piezo-electric panels

Distribution and Integration

Within a 2 kilometer radius of these plates, there will be electricity charging stations where the power is stored in lithium-ion batteries (we are currently looking into more sustainable alternatives). Each Home is provided with an inverter based on a detailed assessment of the loads and the amount of electricity consumed. During/ before blackout timings, consumers can charge their inverters which will last then 2-4 depending on the magnitude of the inverter given. Consumers can come to these charging stations and charge their inverters free of cost. They can then plug these inverters back into their homes for electricity. Excessive power can be sent back to the grid through its connection with transmission lines.

FIRM EXPERIENCE AND QUALIFICATIONS

PAST PROJECTS

Energy Vault 234c model – Switzerland	Completed in Oct 2009
Bioenergy Animal Manure- Rwanda	Completed in Feb 2015

DETAILS OF PROJECT(S)

Energy Vault 234c model

The government of Switzerland and many countries all around the world continue to search for ways in which energy can be stored in a more effective manner. Current methods of energy storage with the use of large lithium ion batteries are ineffective and not preferred due to their high initial cost, abundance of space taken up, environmental and disposal hazards. As a result, we attempted to store energy in a


Figure 7: Energy Vault

unique way with our Energy Vault system. Essentially, with the help of a simple physics concept that energy can be transformed from gravitational potential to other forms, we stored energy in concrete blocks during off-peak hours by placing them on a high elevation and generated electricity when needed by moving them downwards. An image of this project can be seen on the right. The benefit of this project relied on the fact that this required low cost and low tech and used the context of the surroundings and what every country has in order to resolve an issue. This project not only received great applaud from community members but is also running and managed well in Switzerland today. For more information please contact:

*Project Supervisor***:** Bill Hanks enervaul@cleanenr.ca

Bioenergy Animal Manure

As we are all aware, communities all around the world are struggling to have access to electricity. In Rwanda where biomass, particularly cow manure was plentiful, our team implemented the Bioenergy animal manure project. Here, we took organic human and animal waste and fermented it. This process converted the "waste" material into relatively useful energy that was later used by local villagers for cooking, heating, power generation and many more.

*Project Supervisor***:** Greg Heywall greg.bioener@cleanenr.ca

Figure 8: Bioenergy

CONSULTANT PROJECT TEAM

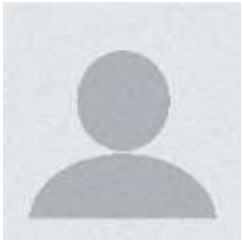


Figure 9: Profile Picture

EDUCATION/SKILLS

C,CPP, HTML, Javascript (and jQuery), CAE design tools, sensors and instrumentation, SolidWorks, CAD, on-site testing
Bachelor of electrical and computer engineering
Masters in data science and global business

EXPERIENCE

Worked as a back end programming developer for CrystalInc (4 years)
Programming senior analyst for Energy Vault
Head of management and design for the Bioenergy Animal manure project

PROPOSED PROJECT

From the table below, our team has conducted a detailed analysis of the required amount of electricity that needs to be produced in order to match the daily needs of the villagers for a week.

Types of users	# of consumers	Load/Appliance	Capacity (W)	Length of use (hrs/day)	Consumption (kW)/ week
Local Businesses	120,000	Low Energy Light Bulbs Ceiling Fan	20 55	5 12	0.7 4.62
Farmers	315,000	Low Energy Light Bulbs	20	5	0.7
Households	503,000	Charging Low Energy Light Bulbs Ceiling fan	5 20 55	2 5 12	0.07 0.7 4.62
Total Energy needed					3,350,500 kW per week

Table 1: Electricity needed to be generated

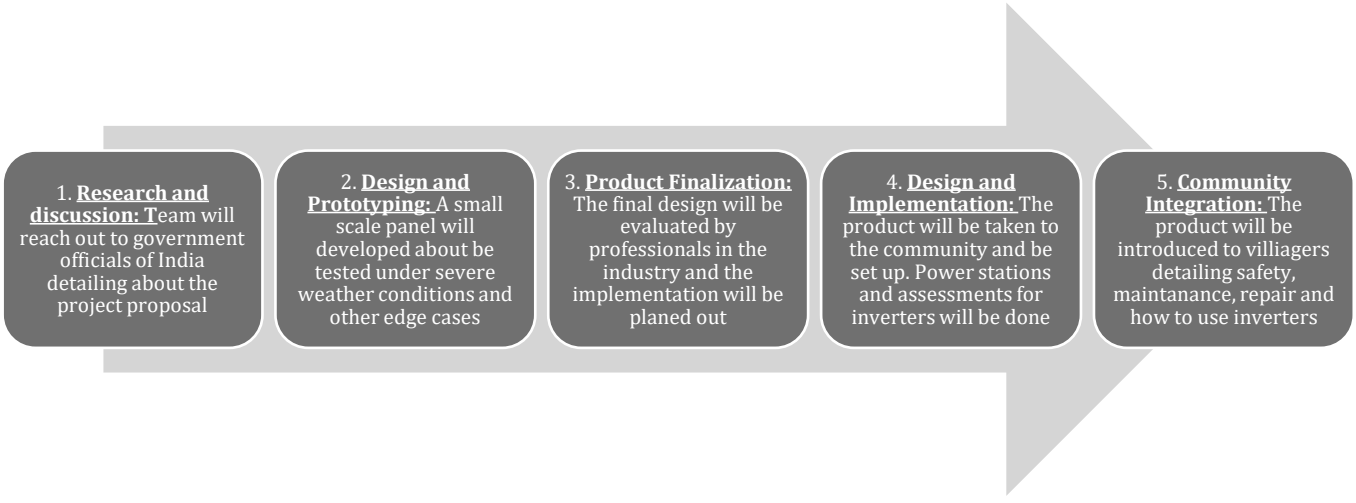
Proposal: Since a *40 by 40 cm* plate produces 10W *on average* per step when *an average 50 kg person steps, with approximately 5000 steps and a about $15,000 steps on these panels per day, this will generate over* 5,250,000 kW of electricity produced per week, almost double the amount of power needed to be produced. The excess power will then be sold back to the national grid.

BUDGET

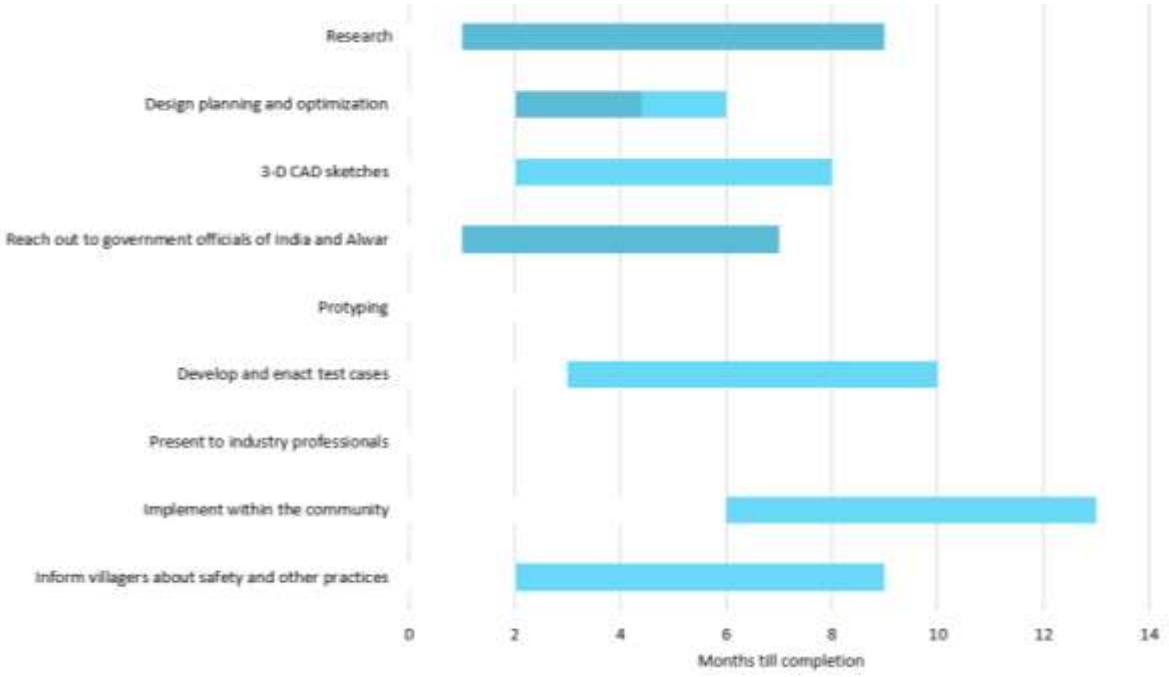
SOURCE	COST	ALLOCATION
Workers- Land Surveyors Data Analysts Optimization specialists Engineering Designers	Installment $50,000 Repair $25,00 Integration - intern students Analysts -$100,000	**Partner with ABB India**

Interface Malfunction Engineers (C++) Repair workers Management of charging station	Optimization - $200,000	
Inverter Units	$250 per unit $250,000,000 to provide for everyone	**Shakthi Sustainable Energy Foundation** Recent Focus: "Off-Grid Distributed Renewable Energy Based Rural Electrification" **Union Minister of New and Renewable Energy** Piyush Goyal stated that "$100 billion would be invested in the renewable energy sector."
Piezoelectric panels (lifespan 20 years+)	5000 panels ($295 per panel)--- total cost $177,000 Land Surveying +equipment -- $50,000 Land Surfacing ---->$40,000	Initial cost from our company Approximately $1,475,500 investment from our company **We will break even and be generating economic profits in approximately 3 years. Request funding from the United Nations Climate and Disaster resilience program
Storage	Charging station Maintenance workers $1000/un	With 5 units in the community its about $5000.
Transmission lines to supply back to grid	Free of cost	For the past 8 months, the Indian government has been in its best efforts to reinstall transmission lines

WORK PLAN



PROJECT SCHEDULE



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