**Backstory**

A journey towards Energy Swaraj (independence): Energy by locals for locals

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My (Chetan Singh Solanki) story began when I was born in the small village of Nemit, Khargone district, Madhya Pradesh, India. Having studied by the kerosene lamp dim light, I became committed to providing energy to all locals, specifically cleaner energy. Initially I started out with a small solar lamp project in Madhya Pradesh; however, because of a lack of community involvement for its implementation, it failed.

Based on this preliminary experience, Prof. Jayendran Venkateswaran, Prof. NC Narayanan, and I started with the Million Solar Lamp Project where the local communities assembled, distributed, and repaired the lamps. Prof. Jayendran looked after the entire operational aspect of the project, while Prof. Narayanan was more involved in the socio-economic research of the project, and I worked on the technological and funding aspects of the project. This project was very successful and based on this success during the completion ceremony, the then Minister of New & Renewable Energy sanctioned 70 lakhs Indian rupees for the solar lamp project. We named it Solar Urja (energy) through the Localization for Sustainability (SoULS) initiative.

Under this project, solar study lamps were provided to more than 7 million students who had no or unreliable electricity supply. During this project, Prof. Jayendran and I were deeply involved at all fronts:

*Small things are bound to bring big changes, the solar study lamp that has reached 7.5 million families across India.*
operations, research, enterprising, and product development. This project was coordinated during 2015-18 by training about 9,000 local women, who assembled, sold, and maintained these solar lamps regionally reaching nearly 40,000 villages across 7 states. As a result about 1,000 women are now self-employed and running their own solar shops. For this work, our team won the Empowering Billion Lives competition organized by IEEE in 2019 and received a global grand prize of $100,000 USD.

Having worked within the renewable energy sector for the past 20 years serving as an academician and Professor at the Indian Institute of Technology (IIT) Bombay for 16 years, I have realized one thing: without collective public action and engagement, climate changes cannot be driven or enforced, and in order to reach out to masses, a multidisciplinary approach must be adopted so that people irrespective of their backgrounds can take concrete steps in this direction.

With this realization, in 2019, I founded the Energy Swaraj Foundation (ESF), which literally means achieving energy independence, to transform the concept of Energy by Locals, from locals to the world level. At ESF, we have set a target of making a billion people energy and climate literate, and thereby encouraging a million people to surrender electricity connection through nurturing 100,000 entrepreneurs. Currently, I have taken a long service leave from IIT Bombay to pursue the Energy Swaraj Yatra (journey) until 2030.

In this backstory, I will be sharing our story of technology deployment and reaching out to 7 million students and moving toward Energy Swaraj, together with a description of my team’s efforts and contribution of our affiliates. I, Prof. Chetan Singh Solanki, will be narrating the entire story on how the interdisciplinary approach has worked in our favor for us in replicating the entire project simultaneously across 5 diverse states.

BEGINNINGS
How did you promote your key messages amongst the community and engage the broader public?

Energy Swaraj is an idea, a concept that is over and above a product or ideology in recent unprecedented times. Energy Swaraj is based on the Gandhian Philosophy of Gram Swaraj, wherein the villages consume and produce their own needs becoming energy self-sufficient. Energy self-sufficiency can only be achieved through solar energy. We call it the AMG Principle, or the Avoid - Minimize-Generate Principle. We can avoid $\frac{1}{3}$ of the energy that is currently used in terms of air conditioners, geysers etc. Using the super-efficient DC appliances, we can minimize $\frac{1}{3}$ of the energy consumed. Although the remaining $\frac{1}{3}$ of the energy requirements, we can generate using solar energy. The AMG principle is the key for achieving energy self-sufficiency.

We have drawn inspiration from Gandhian Philosophy and derived two laws of sustainability or even I call them as ‘fundamental laws of human existence’.

Fundamental Law of Sustainability 1: “In an ecosystem of finite resources there must be finite consumption”

Fundamental Law of Sustainability 2: “In an ecosystem of finite resources there must be distributed production”

Based on the above, “Limited Consumption” and “Localized Production” are the key aspects of sustainable living or sustainability of life on the planet. Energy Swaraj Foundation has set ambitious targets for itself and in order to achieve those targets, there are various campaigns and initiatives. One of the main initiatives toward Energy Swaraj is the Energy Swaraj Yatra which is a journey that has been undertaken to promote these fundamental laws and the overall concepts of Energy Swaraj.

We ensure three levels of interaction for our solar project:

- Through various products starting from solar study lamps, solar torches, and solar lanterns that give the first level exposure to the users. These products will be assembled at the local units wherein locals will be given an opportunity for skill and job creation

- Through creating a network of solar entrepreneurs who will promote the idea of energy independence through the robust supply of solar products and home systems for their vicinity by imparting proper training
All the products promoted by the entire team of Energy Swaraj Foundation have one and only one sole motive to promote “Energy by Locals for Locals”. Energy Swaraj Foundation works completely in a decentralized manner, wherein we train solar entrepreneurs at the grassroots level to deliver to the last mile. Solar projects have been taken to the rural communities by many stakeholders and philanthropists, but their life and durability remain limited owing to the lack of the implementation model that involves communities who are not adept to repair and maintain them. With the Localization model, we have involved the local communities to maintain and generate their own energy needs, with communities at the center stage.

RESEARCH METHODS

There are countless options for renewable technologies, why do you think the answer is solar power, and why does the change need to be enforced now?

Sun has been at the center of the universe, and it is high time that we get it back on focus. Our life - the human life - is powered by the sun; then why cannot our energy needs be fulfilled with solar energy? It is sad to see that when I generally ask people during my talks, “Do you use solar energy?” The answer mostly is “NO” or albeit comes, yes we have used “Solar Panels”. In retrospect, the crops we eat need solar energy, the clothes we dry are because of solar energy; then, how can we have still not used this energy? The perspective and the philosophical understanding needs to change, and people need to stop treating solar energy as an alternative. It is the primary energy that empowers our lives, and there is nothing alternative about it.

Similarly with the advancement in technology and the viability in terms of price reduction has made it possible to completely switch to solar energy. The efficiency of solar panels has gone up considerably and the battery costs have been reduced drastically. It is the most modular form of energy that can be used not only to power smaller lamps and entire houses, but also factories and big power plants.

PROXIMITY

Who are the key players in this project, and how did you bring everyone together?

There are many individuals whose support and contribution has been instrumental throughout. Dr. Jayendran Venkateswaran is a Professor at the Industrial Engineering and Operations Research at IIT Bombay. His interests are in systems thinking, operations research, supply chain management, and simulation. Prof. Jayendran immensely contributed to operationalizing localization, supply chain management, standardization of operations, and implementing the best practices for overcoming the supply challenges in rural areas. Through system dynamics modeling, he helped us to understand the barriers and enablers in effectively establishing local supply chains.

Prof. N C Narayanan, faculty, CTARA, IIT Bombay has also helped in the aspects of policy and governance with normative concerns of sustainability. His expertise in research and impact evaluation helped in taking corrective measures during the implementation of the one million solar lamps project.

In addition, Prof. Praveen Kumar from Boston College also helped immensely in designing and implementing the research methodology to understand, and analyze the impact of the SoULS Initiative on the providers (locally trained people) and the users (of solar). Because the methodology and tools involved in measuring the social impact of the project were a completely new area for us, the collaboration with Boston College was pivotal in conducting the study and obtaining unbiased results. The team of experts from Boston College including aforementioned Prof. Kumar, Prof. Gautam Yadama, and Kelsey Werner in collaboration with our in-house research team devised robust methodologies to measure the impact of the project at all levels of intervention - including the customers, enablers, and the implementers.
Here, I would also like to mention the supporting role of institutions that was essential for the success of this project. The entire team of IIT Bombay was highly supportive and flexible in giving us the infrastructure and space to try out pilots that did not focus only on research but also on using the technology for entrepreneurship and social development. Further, the key players for the project were the Ministry of New and Renewable Energy and other philanthropic partners for funding the program, such as Energy Efficiency Services Limited for procuring the raw materials, and State Rural Livelihood Missions and NGOs that have supported us for on-ground implementation.

Is your team or work interdisciplinary and how is it proving to be useful?

We have a diverse team that looks at the implementation. Prof. Jayendran and I, led the IIT-B’s team, with specialization in solar technology and experience from the recently completed million solar study lamp program. I have over 20 years of experience of working on rural energy problems of tribal and non-tribal communities of India. My idea was simple. The technology should be such that anybody and everybody can make use of it on their own. It should also be open-sourced so that mass-adoption of the technology can be promoted. Furthermore, the product design was made to withstand the difficult conditions of the rural settings. The rough and tough use of the lamp was encouraged. Our approach has always been community-based and rests on understanding the barriers and enablers of clean energy technologies.

With Prof. Jayendran’s expertise in Operations Management, he designed the entire plan for execution, and handled how the information and money will flow across the stakeholders. In addition, careful planning was done by him to understand the variety of the states, blocks selected and include them in the entire implementation model. He planned out the replication model in a simultaneous manner. Prof. Jayendran and I had prepared a full-fledged plan and piloted it before the implementation of the 1 Million solar lamp program, and building on that experience, the 7 Million solar lamp programs. A team from IDC, IIT Bombay also helped in designing and making the lamp robust for rural conditions, based on our experiences of the 1 Million lamps Program. We had a team of 50–60 people from various fields working on-field and in the back end of the office to manage the planning the operations, implementation of the project, training, enterprising, IT, documentation, and research.

Further research support was provided by Prof. NC Narayanan during the 1 Million lamps Program while Prof. Praveen Kumar from Boston College in coordination with Prof. Jayendran helped in monitoring and evaluating the program. There was a special team that tried to capture the socio-economic effects and feedback from our users. They worked toward developing case studies and stories around how the lives of people have been impacted by the adoption of solar energy. The impact studies have been conducted since the inception of the program be it Million SoUL Program or SoULS Initiative. The idea of all these documentation and success stories is to leave an institutional memory. So let us suppose, if somebody wants to replicate the same elsewhere, say in Africa, they can do that.

Did you encounter any challenges or any benefits of working with people from different backgrounds and expertise? How did you bridge the language or other gaps among different disciplines/regions?

Yes, there were both challenges and opportunities of working within an interdisciplinary team. The benefits include that with their varied experiences and expertise, we get to have an all-encompassing approach to a problem.

Any issue or any challenge that is faced during the deployment, and thus the adoption of solar energy is looked at not only from a technical standpoint but also from the social science perspective. In that way, we get to have a multi-disciplinary approach to any problem we are looking at.
An additional point that is interesting to consider is implementation across different regions, the reception to the program and to the technology was the same, but however, we had to ensure proper inclusion of locals and that meant that the delivery of the training had to be in the local language.

Considering further challenges, the interdisciplinary perspective can also lead to intense variation in the thought process. Getting all disciplines on one page can be quite difficult. It is quite difficult to get team-members to agree on one point, especially considering their deep-rooted disciplinary training. But whenever they agree on a single point, which is the best outcome as it has come from intense sessions of discussions and deliberations.

There were many challenges faced during the data collection. Because the population was vast, hence the sample size was also large enough, representing the given regional population size at hand. Furthermore, the language and cultural barriers were immense for data collection and we had to rely on the implementation stakeholders for collecting the data. Because the sample was collected from rural areas, hence the willingness to share the information was relatively low. Because of the large sample size, the data cleaning was also a time-consuming challenge. Finally, we were new to the field analysis and therefore, we faced difficulties in getting the relevant results.

These were in-house challenges that we had faced. In terms of external challenges, the electricity connections were also improving at an unprecedented rate. This was the cause of concern as it created a bias for the data collection and diluted the impact of the solar product. It also raised concerns in the funding agency to support the project.

GOVERNANCE

How did the decision of branching out from your (academic) fields come about? What implications did it have on your careers? (Recognition, funding, and etc.?)

It has been difficult to leave academia after working in it for 17 years. There is always a risk involved in branching out from the core research area to the implementation of the technology, which is a relatively
new and less traditional path. However, for solar technology, my aim has been to make it accessible to all rather than focusing on the scientific value.

Because we were employing a methodology that considered the social impact of the project, this affected the rate at which the publications were happening, and therefore, had a severe effect on my career as an academician. Owing to this, I was rejected in my first attempts to transition from Assistant to Associate Professor, and thus from Associate Professor to Professor. All three of us had to manage our academic responsibilities along with the assigned share of administrative tasks along with managing the entire operations. Sometimes, all three of us used to sit late evenings for brainstorming sessions. During free time from our academic responsibilities, we used to travel to the remotest parts of India to monitor and oversee the project implementation. All three of us during our field visits, would look at the implementation of the project from our expertise point of view and thus during our brainstorming sessions would devise a plan to make mid-course corrections.

In terms of funding, it did not have any implications. In fact, since the project has a significant social impact, the chances of funding were higher. This was also because we had a multidisciplinary approach to the project. We had received funding from the Ministry of New and Renewable Energy for both 1 Million Project and 7 Million Project. In addition, a few big corporations like Aditya Birla Group, L&T, ONGC, and others also contributed to the 1 Million Project. We won the award money from IEEE Global Grand Prize of USD 100,000, which both me and Prof. Jayendran donated for founding Energy Swaraj Foundation.

CONCLUSIONS/FINAL THOUGHTS
What did you learn about interdisciplinary research from the project and what tips would you give to anyone considering undertaking such work? Are there any other challenges you encountered that aren’t discussed here?

Good planning and having on-board the experts from the various branches is essential for supporting the interdisciplinary research. We needed to have partners that cover all the aspects of interdisciplinary research. Fortunately for us, we had an expert team that was proficient in technology, industrial operations, and socio-economic monitoring and evaluation. The research was an important part of the implementation and careful methodology was applied to measure the impact.

Furthermore, interdisciplinary research, in our view, can be used to focus on the topics that are the need of the hour for society and communities. If this approach is used to cater to a problem in a manner that the solution thus provided is cost-effective, replicable at a large scale, and is community-inclusive, then it will have more impact.
Interdisciplinary research gives an opportunity to look at things in a different direction and with a broader perspective. Through the implementation of the solar lamp project, it has brought an understanding to the energy problem of a community, country, or world not only from the technological point of view but also from the socioeconomic perspective.

It has dawned on me that the energy solutions in a centralized manner without the community inclusive aspect will not work in the long run as it has adverse implications for the very environment that nurtures our life. With this thought in mind and with the means to spread the idea of Energy Swaraj - a principle based on Gram Swaraj, I undertook Gandhi Global Solar Yatra on 25th December 2018, traveling to 30 countries within the span of 9 months, mostly in Asia and Africa. During my travels, I realized one thing, despite our cultural and regional diversities, the problem of climate change, energy access, energy security, and energy sustainability is the same across. After thorough discussions with policymakers, academicians, students, people working in community services, and other people across the countries, we found that Energy Swaraj can be applied in all terrains and in all situations in different parts of the world. My Gandhi Global Solar Yatra culminated in the Students Solar Ambassadors Program wherein 0.9 Million students across the globe participated in the program to make their own solar study lamps. Eventually, I founded the Energy Swaraj Foundation with the view to spread the idea of Energy Swaraj across India.