Remote Power Generation and Storage

Interview Report

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1.0 Our Idea

Our idea addresses the problem of the lack of reliable power generation for communities located in rural areas. Access to electricity has proved vital to upholding a healthy standard of living, and is one of the largest humanitarian efforts today. We were contacted by Zen's Outdoor Leadership Camp for Youth (ZOLCY), who donated 20 laptops with specialized education software to two villages in the province of Dhading, Nepal. Due to recent landslides, these villages did not have a consistent source of electricity to power their education equipment. ZOLCY asked us to find a solution, and to create a method of generating and storing electricity in their villages in order to help them teach members of these Nepalese communities English and computer literacy. Upon further research, it became apparent that there are many areas located off the grid around the world, where children are at a disadvantage because they do not have access to the educational resources they need. Our project idea is to develop a portable power generation source that can store enough electricity to power devices that enhance the quality of life in rural communities. The product needs to perform two functions: generate and store electricity.

2.0 Interview Process

We prepared a set of specific questions for each interview candidate, and asked additional questions based on the feedback we received. The goal was to gain a better understanding of the technical constraints of energy generation. Based on the interviewee's area of expertise, we asked questions that would give us necessary background information to develop our initial specifications. We also asked for their input on a few preliminary solutions that we had come up with.

3.1 Selecting Subject Matter Experts

We wanted to consult professionals who fit the criteria of having hands-on experience in their field, an established reputation, and in depth expertise in their field. The goal of this was to broaden our understanding of different technical options that we could approach our project with. The subject matter experts could also evaluate our possible preliminary design interests and inform us of potential issues.

We chose to interview Noboru Yonemitsu, a Civil Engineering Professor at UBC specialising in hydrotechnical engineering. His experience in hydroelectric power

generation would allow us to conduct an indepth discussion about how hydropower works and assessing its feasibility for our project. Additionally, we interviewed Matt Amyotte, a master of applied science student and research assistant at UBC. He studied electrical engineering and has three years of design experience with the Sustaingineering Team, at all the stages of the product lifecycle - from prototyping and conceptualization to manufacturing the product. Finally, we interviewed Prakash, a mechanical engineer in Nepal whose career is focused on the construction of hydropower infrastructure. He has detailed experience in the implementation of engineering projects in the country, as well as comprehensive knowledge on renewable energy installation. His experiences in dealing with the processes of installing renewable energy sources will provide insight to the implementation stage of our project.

3.2 Selecting Potential Customers

Finding potential customers for our product proved challenging. We were all very fortunate to grow up in areas which had stable access to electricity. However, we wanted to find members of rural communities who would ultimately be using our electricity powering techniques. We looked to those that had experienced occupying a leadership role in a humanitarian capacity in these communities. We contacted Jackie Chan, founder of ZOLCY, to gain further information about how a particular application of our product could be used by powering his organization's education equipment.

3.3 Selecting Online Forums

Several online forums were consulted including /r/Nepal, a subreddit used for anything related to Nepal, PhysicsForum's Electrical Engineering sub-forum, and Engineering360's electrical engineering community forums. The r/Nepal forum was chosen to gather input from people who are knowledgeable of the conditions on the ground and of the local culture in Nepal. The questions directed to this forum revolved around the ease of locally sourcing parts and components, the current state of power and infrastructure in the Dhading district, and the culture and politics of the region. PhysicsForum and Engineering360 forums were chosen in order to explore possible solutions and objectives of this project using the input of other engineers, and scientists.

4.1 Expert Feedback

Nobo explained the basic principles of hydroelectric power generation. Specifically, he talked about the relationship between water flow rate and power generation, what systems were used to achieve this, and how we could maximise this. He gave us examples of options we could explore that were already in use like impact turbines and micro-hydro systems. Nobo also talked about using rainwater as a power source and how we would need to evaluate the IDF (intensity x duration x frequency) values to determine if it was a viable source. He also shared some of his experiences in developing hydroelectric systems and the potential issues we would encounter.

Matt talked about the feasibility of using different energy forms such as mechanical, solar, hydroelectric, and thermal to generate electricity, and about the different battery options available. He explained that generating hydroelectric power is usually not very efficient and could only be an option if the efficiency is maximized. Similarly, when it comes to mechanical energy, there are several factors that must be considered. For example, a bike generator would only work if there are enough people using it, while, using farm animals that plough the land could be challenging in terms of the mechanics of the design; for example, a wheel would need to be geared to produce enough power. Matt recommending researching a company called Biolite, which produces thermoelectric generators that use heat differentials. We additionally discussed the different battery options available. Lead acid batteries are cheaper but heavier, while Li ion batteries are lighter, have a higher energy density, but are more expensive. Nickel metal hydride batteries, on the other hand, have the advantage of being reusable, but are less efficient for large scale use. Matt warned us that the more batteries or “transitions” we use, the less efficient our power generation becomes. Matt ended the interview by recommending researching AC-DC converters.

Prakesh gave detailed insight into the installation of hydro systems in Nepal and the common constraints that limit the expansion of these types of generators in the area. Hydro systems are common in Nepal due to its mountainous and water rich terrain. However, there are several challenges that inhibit the Nepal government from expanding these systems. Some of these include frequent seismic activity, large quantities of silt in the Himalayan rivers, and a complicated bureaucracy. Prakesh outlined preliminary steps to installing a micro-hydro system in Nepal to give us an idea of the bureaucracy we’ll be

facing. First, the installation must be designed for the specific location which must be surveyed beforehand. Afterwards, environmental impact studies have to be conducted. Permits must be acquired to make changes to land. Rights permits will also have to be acquired before hiring any labour. Reports must be submitted for transporting equipment and materials. Given these constraints, Prakesh reminded us to have a look at wind energy, especially because the Dhading district has constant wind with high speeds. Small scale wind turbines also take a much shorter time to come online than micro-hydro systems. However, many regions in Dhading that are good contenders for wind energy are also extremely difficult to access and to transport materials to. He concluded the interview with the advice that we should put more emphasis on implementation before moving too far ahead with the designs.

4.2 Potential Customer Feedback

Jackie was helpful in his interview offering detailed insight into the situation in Nepal as well as the physical area. He went into detail about how long his education equipment needed power, and the duration of the power needed. We were able to learn a lot about the climate in his village, and realized that our design needed to be resilient to water damage as well as potential landslides. He also gave us a thorough understanding about how members of the village live, and went into detail about their daily routines. This gave us an idea of the lifestyle and conditions in remote villages.

4.3 Online Forum Feedback

Nine people responded on the Nepal subreddit, who provided perspective on various types of power generation, as well as general tips on where to go from a general design base. Through private message, half of these redditors gave their opinion on what they thought was feasible as a power source given our constraints. Some users gave tips on who to contact for more detailed information, while others provided local insight on sourcing supplies in Nepal.

The feedback from the eight people on the Physics Forum and Engineering 360 forums suggested solutions, which included steam engine powered by burning waste and biofuels from the farms, using oxen to drive dynamos or alternators to charge batteries, thermopiles in the fire, human power using bikes, or dropping a heavy weight used to run

a dynamo. These solutions were discussed among the posters and biofuel steam engine, microhydro, and solar energy were the most popular. One user poster a paper from Kathmandu University, which states that most popular form of generators in Nepal seem to be microhydro generators given the mountainous topography of the land.

5.0 Implementing Feedback

After consulting stakeholders, we reflected that we were too fixated on the village in Nepal. The feedback on micro-hydro systems showed us that these are a lot more complex than we initially believed to be which has discouraged us from pursuing this solution. As a group, we pivoted our focus - we should not be developing a product that functions as a power source for the laptops in this school in Nepal; we needed to widen our scope. We are developing a product that is portable, extremely user friendly and able to generate and store electricity on a small scale, which can be then sold to non-profit organizations and used in various applications, including schools in developing countries. Such a device would escape the hurdles of having to apply for permits before being set up as it does not significantly alter the environment around it. Making it portable also reduces transportation and logistic costs making our product valuable to NGOs. The product should also be relatively easy to install and maintain.