NUS Resilience and Growth (R&G) Innovation Challenge

Power and Energy Group, ECE, NUS

Proposal: Empowering Communities with Rural Electrification

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Project Field: Power Systems

Scope:

Theme 3 of NUS R&G Innovation Challenge: Make the world better

Students (3-5) will team up for the NUS R&G Innovation Challenge for the development of innovative solutions for the needy community. In this challenge, NUS will fund **115** projects and selected projects will receive a grant for **up to $50,000** for **6 months**. Besides, the grant will allow for a stipend of up to **$1,200 per month per project member** for the duration of the project. You may refer to the given link for more information on the NUS R&G Challenge. http://nus.edu.sg/CFG/RG/InnovChallenge

Methodology:

Globally, about three billion people are living in acute energy poverty, and over one billion people have no access to electricity. Availability of electricity is critical for health care delivery, access to clean water, advancing education, facilitating safe and inexpensive lighting, economic empowerment, etc. The unprecedented COVID-19 crisis has overwhelmed the health systems and economy worldwide. It has also revealed the immense vulnerability of economically deprived and rural communities, who have limited access to healthcare, hygienic environment and secure employment. 'Energy' is one of the major sustainable development goals (SDGs) of the World Bank's 'Agenda 2030', and in the current world paradigm it will play a vital role to support the vulnerable energy-poor communities all over the world. The traditional model of electrification (i.e. extending the grid) may not be suitable for the remote and rural regions in developing countries because of high infrastructure costs and dependence on fossil fuels. To address this challenge of energy poverty, there is an urgent need for an innovative and novel off-grid electrification solution that is scalable. Microgrids and Distributed Energy Resources are known to directly enhance the resilience of the communities in case of natural calamities.

'Power@NUS' team, comprising of researchers in the Department of Electrical and Computer Engineering, NUS, participated in the IEEE (Institute of Electrical and Electronics Engineers) Empower a Billion Lives (EBL) Competition, 2018-19. This project focused on elevating the living standard of the energy-poor eastern-segment of Sumba Island, Indonesia, by leveraging

on the electrification potential with the objective of supporting community empowerment and won the "Best Overall Student Team" Award at the South Asia Regional Round. This proposal aims to build on the IEEE EBL work by 'Power@NUS', and includes study of the technical, business and social aspects of setting up a community-level microgrid. The microgrid should be based on renewable energy sources, as off-grid electrification has to be evaluated based on region-specific energy resources, occupational demand of inhabitants and the prevalent challenges.

The innovative aspects to be explored for the final proposal are:
1. Addition of smart meters and remote monitoring of electricity generation and consumption patterns in rural microgrids
2. The proposed microgrid would be designed to be future proof (can be easily connected to the local utility in the future)
3. 'Voluntourism' – Volunteering for Tourism to enable Social Change. Getting volunteers to fully/partly fund the project infrastructure and go to the village to learn about renewable energy, rural life, and community work. These volunteers will also become part of the manpower to deliver the project.

As soon as funding is awarded in November 2020, the team should proceed according to the pre-planned field-testing timeline, which should involve purchase of equipment, setting up the remote data acquisition system at NUS, installing equipment at the target location and enabling the operation. This will involve the team to travel to the target location for the installation and deployment part for a few days and may be a few times. An important component of this installation would be to install the on-site smart-metering solution with communication capabilities. Subsequently, the team should develop suitable data analysis tools, that can leverage the data collected through the acquisition system and perform validation of the proposed technical solution, demand-side management, deliver insights on the consumption pattern, etc.

Analysis of the data collected from the microgrid site and subsequent discussions with energy experts as well as target population will lead to a more concrete understanding about (i) the required technological contributions that can help to develop a future robust community microgrid, (ii) social impact through economic empowerment, healthcare facilities, safe and hygienic environment, etc. (iii) the renewable energy generation patterns and rural electricity consumption patterns.

Draft Timeline:
July 1 – Sept 15: Brainstorm, simulate and formulate the innovation plan (mentored by Power

and Energy Group, ECE, NUS)
Sept 15 – Sept 30: Finalise and submit proposal for R&G Innovation Challenge
Month 1 – 3 (after funding): Install equipment on-site and deploy technology
Month 3 – 6 (after funding): Data Analytics and Impact evaluation