RENEWABLE ENERGY FOR EDUCATION PROJECT

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ABSTRACT

The Renewable Energy for Education project is an intervention by WITS university and PeCo Power. The project seeks to identify and aid students from energy-poor households that do not have the electricity to power their hardware required for accessing online education during the COVID-19 pandemic.

Introduction

Despite 26 years of democracy in South Africa, inequalities persist in access and success in higher education (Walton & Osman, 2015). These fault lines were exacerbated by the COVID-19 pandemic that led to many universities around the world transitioning to emergency remote teaching.

The adoption of emergency remote teaching in the School of Electrical and Information Engineering at the University of the Witwatersrand (Wits University) in South Africa has foregrounded the issue of energy poverty. The aim of this project is to assess the impact of energy poverty on emergency remote teaching at a South African university and to investigate to what degree the impact can be mitigated by an off-grid electrification solution. This project could inform the adoption of online teaching in countries and communities where energy poverty is an issue

For many years, there has been talk at the Wits University of the Witwatersrand about shifting from face-to-face lectures to blended or online learning. The issue became more urgent when some universities were shut down during student protests in South Africa in 2015 and 2016 (Czerniewicz, Trotter, & Haupt, 2019). The reality, however, is that most academic staff continued to teach in the same way that they have done in the past. The COVID-19 pandemic forced lecturers to adopt online modalities. Hodges *et al* (2020) make the point that emergency remote teaching is not the same as online learning. Online learning requires careful design of learning outcomes and assessment. In contrast, the emergency remote teaching, was rolled out rapidly, without careful planning and coordination.

There are valuable lessons that we can learn from the emergency remote teaching that can help us design future online teaching. One of the questions we should ask is how student engagement was affected by technological challenges. In South Africa, energy poverty hampered some students from participating effectively. Hodges *et al* (2020) consider questions around technology to be important as we reflect on universities' response to COVID-19. Laura Czerniewicz (2020), raises social inequality as an issue in moving to online learning at the University of Cape Town in South Africa during student protests in South Africa in 2015 and 2016.

In this narrative, I will define what I mean by energy poverty. This will be followed by a proposed methodology for the project and a brief rationale for piloting an off-grid, distributed renewable energy system as an energy intervention.

Energy poverty

According to the World Bank's data (World Bank, 2020) only 47.7% of the population in sub-Saharan Africa has electricity. This compares poorly to the world average of 89.6% and to the European Union, where 100% of the population has access to electricity, making Africa the least electrified continent in the world.

Oswald *et al* (2020) calculated the energy footprints across income categories in 86 countries and confirmed that large energy inequalities exist. They linked the energy inequalities to inequalities in income, because people with high incomes have a growing demand for energy intensive goods. Oswald *et al* (2020) predict that in the future, the income gap between rich and poor will increase and, with it, energy poverty will become worse. They do, however, also predict that (Oswald *et al* (2020): p 236) "persisting inequality can be prevented through appropriate intervention." We believe that the Personal Consumer Grid solution (Aswat, Dangor, & Cronje, 2019) that was developed at Wits University, could provide such an intervention.

South Africa is currently facing an energy crisis, with loadshedding and random power outages due to corruption and financial mismanagement at the power utility Eskom and ageing infrastructure that was not properly maintained.

Eskom follows a model of centralised generation that consists of large-scale power generation from fossil, hydro or nuclear sources at power stations, often located far from the eventual region of use. A transmission network transmits power over a great distance from the point of generation to the eventual point of use. Centralised generation may have a high power capability but it is expensive to run and the use of fossil fuel is harmful to the environment.

There has been a rise of interest in off-grid or stand-alone renewable energy systems. Stand-alone renewable energy systems are based on the distributed generation model where power is generated from a renewable energy source at the point of use and stored in batteries. Stand-alone renewable energy systems are low cost and can be rapidly deployed since large scale infrastructure and a transmission network are unnecessary. This makes them easily accessible for sparse populations of off-grid households. Furthermore, renewable energy technologies address the environmental concerns with respect to fossil fuels. Solar photovoltaic (PV) technology has witnessed a rise in popularity and a reduction in cost which makes a strong argument for modern stand-alone systems that use solar PV.

Energy poverty in South Africa

There have been several efforts made towards measuring, monitoring and tracking energy poverty in South African households.

The Department of Energy (DOE) considers a household to be energy disadvantaged based on an energy expenditure approach which states that: "A household is energy poor if 10 % or more of its expenditure is on energy facilities" (Ismail & Khembo, 2015) (Olawumi Israel-Akinbo, Snowball, & Fraser, 2018). The issue is, however, more complex than a simple percentage of expenditure. Consider two households A and B. Each spends 12% of their expenditure on energy and are thus both classified as energy disadvantaged. However, if A relies primarily on burning biomass for energy and B uses an electricity connection, then A obtains less useful energy from their energy source and should thus be classified as more energy disadvantaged than B. If cost is the only variable considered, then all households can be made less energy disadvantaged by reducing the cost of the energy supply.

Another measure of energy disadvantage is the rate of electrification. The 2018 General Household Survey revealed that 87% of households in South Africa have access to electricity compared to only 34% of households having access to electricity in 1994 (Stats-SA, 2019). According to the electrification statistics for March 2018, 2.2 million households still do not have access to a utility electricity connection (INEP, 2020). Rate of electrification is a crude proxy and simplistic approach that does not provide enough information to fully understand the extent of energy poverty.

If the use of the energy as well the adequacy, quality, reliability, safety, legality and convenience of the energy supply along with affordability are considered, it will provide a better understanding of the level of energy poverty. Energy poverty is a multi-faceted concept that requires a multi-dimensional indicator for measurement. This project will contribute to knowledge on energy poverty.

Energy in Education

The provision of lighting and access to information and communication technology (ICT) are momentous educational benefits of energy (Sovacool & Vera, 2014). The provision of lighting improves the quantity of education by enabling for learning to take place during parts of the day when sufficient natural lighting is unavailable such as during the early morning, night time and during cloudy and rainy days. Electrical lighting further mitigates the health and safety concerns of using candles or kerosene lamps. Using an open flame for lighting provision is a fire hazard and energy poverty impedes access to safe electrical lighting. This is a key contributor to burn injuries and fatalities in South Africa when fires are started from knocked over candles or kerosene lamps (Kimemia & van Niekerk, 2017).

Energy is required to power ICT's such as computers, mobile-phones and the internet. These ICT's are specifically mentioned because they are the key hardware that facilitate online learning. Online learning can have the most transforming impact on education in developing countries because it affords exposing students to multiple sources of readily available learning material and information delivered by a variety of teaching methods which can be easily accessed without the need to attend an institution in-person. The importance of ICT use in education and impact on emergency remote teaching highlights the need to continue to develop ICT skills post pandemic as a means to bridge the digital divide at home and at institutions (Montoya & Barbosa, 2020).

Perhaps online learning and the ICT that facilitate the process are the sought-after solution to revolutionise education in developing countries. Interventions aimed at improving access to education in an energy-poor setting must therefore ensure focus on energy is not neglected to ensure success.

Methodology

The project will be conducted as follows:

1. Survey students:
   - Online education energy assessment
   - Gain a broad overview of the energy requirements for online education
   - Gain a broad overview of how energy poverty affects access to online education
   - Identify 20-30 students whose online education were impeded by energy equality

2. Conduct focus group sessions with the students identified in step 1:
   - In depth investigation of the effect of energy poverty on emergency remote learning
   - Identify 5 students willing to participate in a field trial

3. Interview 5 participants identified in step 2 to determine a technical solution to improve energy access for online education for each participant.

4. Field trial:
   - Deploy technical solution at each student residence
   - Remotely monitor technical performance of each system

5. Post-trial interview to obtain feedback on student experience

Technical solution

The School of Electrical & Information Engineering at Wits University recently developed a plug-and-play, off-grid, renewable energy electrification solution that is expandable, safe, fault tolerant and low maintenance, called the Smart Electrification System (PeCo Power, 2020) (Aswat, Dangor, & Cronje, 2019). This project will give the School an opportunity to pilot five installations of the Personal Consumer Grid solution. The School has the technical expertise to design and install this off-grid solution.

Conclusion

This project will contribute to knowledge in the area of energy poverty by examining its effect on the ability of students to access the emergency remote learning that was rolled out during the COVID-19 pandemic. It will assist sub-Saharan countries to plan online education in the higher education in the future.

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