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Swarm Electrification

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789 million

The U.N. estimate this number of people lack access to electricity worldwide. Energy poverty adversely impacts health, education and economic development.

What is a swarm grid?

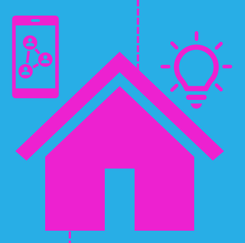
A swarm grid is an ad-hoc network of electrical generation and storage devices, such as solar panels, batteries, generators etc. Unlike a typical microgrid it does not adhere to a predefined design, rather it grows in a more organic fashion, simply connecting available equipment via a controller, adding to the grid as more resources become available. This key difference gives the swarm grid greater flexibility and can lower the cost of entry. Swarm grids provide the potential for electrification to reach those that may never be connected to a national grid and cannot afford to buy in to a microgrid system.

Why swarm grids?

Swarm grids offer the following advantages:

- Owners of solar systems can sell any excess generation capacity via a P2P energy trading platform creating a source of income.
- Tremendous flexibility, the grid can be reorganized at any time.
- They can leverage existing equipment.
- lower capital expenditure than micro grids, this can enable increased inclusion.
- Greater robustness through redundancy.
- Maximizes the potential of existing solar systems.
- Provides cheaper electricity than diesel generators.
- Allows for older equipment to be interconnected with newer equipment helping to prevent stranded investment.
- A swarm grid could sustain larger equipment empowering small businesses to run equipment they previously could not.

Challenges



The concept of swarm electrification is relatively new and therefore there are still considerable challenges to overcome.

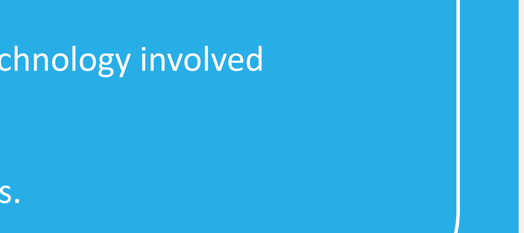
- Controllers developed to date are proprietary which may prevent a true ad-hoc network being created as devices from different developers cannot communicate with each other. An open standard could improve the rate of adoption.
- Communications systems must be examined, the current technology requires an internet connection. In developing countries this is not always available.
- Education and training, system installers and will need an understanding of electrical systems and the technology involved
- Safety, these systems need to have adequate protection against short circuit and overloading.
- Energy theft detection.
- Energy monitoring to build power generation and consumption profiles to best utilize available resources.
- Suitable business models need do be designed.

Case study

Currently the largest implementation of swarm electrification is in Bangladesh. Following a government initiative providing microfinance for home solar systems, more than 5 million solar home systems have been installed across Bangladesh [1]. A small startup, ME Solshare, began connecting these devices to maximize their potential as it was estimated up to 30% of the power generated was not being utilized [2]. There are now 12 grids with a total of 216 connections, this is a mix of consumers and prosumers. The prosumers benefit as they can sell the excess energy they generate but don't use while the consumers get an electrical connection without the capital costs of a solar home system.

Motivation

Swarm electrification could platy a part in achieving five of the U.N. sustainable development goals. A simple electric light can transform lives, enabling people to study and improve their education, or work on a cottage industry after the sun has set. This can help lift them from poverty. Currently a lot of houses in the developing world are using kerosene lamps which can cause adverse health effects. The U.N. note the effect energy poverty has fighting Covid-19 where 1 in 4 hospitals are not electrified in some countries [3]. By maximizing the potential of solar home systems, more people can gain access to clean, renewable energy instead of burning fossil fuels in lamps or generators.



References

[1] H. Kirchhoff and K. Strunz, "Key drivers for successful development of peer-to-peer microgrids for swarm electrification," Appl. Energy, vol. 244, pp. 46–62, Jun. 2019, doi: 10.1016/j.apenergy.2019.03.016.

[2] P. Hollberg, "Swarm grids – Innovation in rural electrification," Masters Thesis, KTH, School of Industrial Engineering and Management (ITM), 2015.

[3] "Goal 7 | Department of Economic and Social Affairs." https://sdgs.un.org/goals/goal7 (accessed Mar. 12, 2021).

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