Are micro-grids the future of power for the people in the remote villages?

The agriculture sector contributes 16.4% to India's GDP, but the major population involved in agricultural activities live in remote villages and are still not connected to electrical power. These villages are deprived of grid connection and solely depend on firewood, kerosene, diesel to meet their energy requirements. A possible solution to power the remote community is to develop reliable and resilient Microgrids (MG) with renewable energy sources.

Firstly, ensuring reliable power supply with the random renewable energy sources (RES) is a tedious task due to the high degree of uncertainty in power generation and demand. The reliability of the system is to be ensured by maintaining a power reserve of 5% to 10% of the total system capacity. Secondly, a resilient microgrid has to recover from any contingency event, for that the high inertia provided by synchronous machines in a conventional grid has to be mimicked by an entity in the microgrid. In a conventional power grid, the Pumped Hydro Storage System (PHSS) is used to store the humungous energy during the off-peak hours and inject power during the peak hours, black start. Similarly, energy storage systems are required in a microgrid to inject power during the low generation or high demand and absorb power during the high generation or low demand periods.

There are however, many challenges. The small scale solar PV or wind energy based microgrids primarily employ Battery Energy Storage System (BESS) to mitigate fluctuation in the power generation. But the BESS suffer from various drawbacks such as high life cycle cost, low lifecycle, frequent maintenance and failures as compared to PHSS. Achieving higher energy storage autonomy with BESS is a costly proposition compared to PHSS which has higher energy density. The PHSS has lower cost of energy than the BESS for lifetime greater than 10 years.

A current thinking is to have a downscaled version of the conventional Pumped Hydro Storage System and called as Pico Hydel Energy Storage System(PHESS). However, various control strategies are to be developed and pilot-tested at different levels for variable speed operation of PHESS, which has a high degree of flexibility than the fixed speed PHESS. The PHESS is modelled independently of the type of renewable energy source so that it can be plugged to any microgrid with various renewable energy sources.

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(Reference and more reading: Modelling and simulation of variable speed pico hydel energy storage system for microgrid applications, Journal of Energy Storage, Volume 24 August 2019, V Krishnakumar R., K. Ramachandaramurthy V, V Gomathi, J. B. Ekanayake, S. K. Tiong)