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Energy management strategy for a remote area power system in rural application

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Remote area power systems that are based on renewable energy sources have proven to be an effective way of providing energy and improve livelihoods in remote rural areas. However, the stochastic behaviour of renewable energy sources (i.e. solar) and consumption by energy users leads to a mismatch between generation and consumption. To mitigate these effects, energy storage systems such as batteries are necessary to improve the system efficiency, to store excess energy and to maintain the quality of the grid voltage during instances of power fluctuations. Therefore, an optimal energy management strategy for control and coordination of energy flows to maintain healthy battery state of charge and improve its lifetime is required.
A grid-ready microgrid system that is configured for rapid deployment in rural applications was developed and deployed at Nelson Mandela University Outdoor Research Facility. The microgrid is powered by two photovoltaic (PV) energy generators, namely, 1.57KW_p DC coupled monocrystalline silicon and 3.2KW_p AC coupled polycrystalline silicon arrays. The balance of system consists of a 5000VA EasySolar bi-directional grid forming inverter plus MPPT charge controller from Victron Energy and a Sunny Boy 3000TL grid-tied inverter (AC side) from SMA. The loads were prepared using programmable loads connected to the EasySolar inverter distribution boards and controlled using a LabVIEW program. Literature based consumption profiles of various levels (low, medium and high) for a simulated village were developed and tested on the microgrid. In this paper, preliminary results before fully simulating the village are presented on the monitoring of the microgrid system's ability to coordinate energy flows and maintain a healthy state of charge. An investigation of the effects of different consumptions by typical household appliances on the microgrid was carried out during sunny and cloudy days. The effectiveness of a user compliance-based energy management strategy on maintaining grid integrity and a healthy state of charge was shown. In addition it has also been demonstrated that consistent remote monitoring is an effective way of managing system abuse by users.

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MSc

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