Name: Godiana Hagile Philipo

Title: Analysis and Demand Side Management of East African Rural Microgrids: Modelling and Experimental Study

ABSTRACT

Energy access is essential in achieving healthy and productive households. However, poor electric access with pronounced outages and high transmission costs are still articulating in rural areas of Sub-Saharan countries with particular interest in East Africa. Microgrid technologies offer reliable solutions for improving energy access. However, their sustainability has been questioned and doubted due to the ever-increasing demand and uncertainty, leading to pronounced unscheduled power outages and uneconomic operational ways of the microgrid. Demand-side management (DSM) is an essential tool which addresses the challenges. DSM techniques have been adopted but do not guarantee global convergence as the studies are limited in developing countries. In addition, the lack of tailored demand-side management strategies that align with the region's socio-economic context makes it hard for the established microgrids to be sustainable.

This study investigates and optimises demand-side management (DSM) strategies within solar microgrids in East Africa. Three microgrids in Tanzania, Uganda, and Kenya were used to detail the region's specific microgrid technical challenges and propose DSM strategies for optimising the microgrids. Results show that the incentive-based DSM strategy achieved a power reduction of 14.01% by providing incentives to maximise utility benefits. Also, the presence of deferrable loads has been considered to bring more flexible demand-side management with a reduction in peak demand and peak-to-average ratio of about 31.2% and 7.5%, respectively. Load shifting efficiently reduces energy consumption during the unavailability of the sun, hence promising more flexibility to customers. A notable association was observed between refrigerator and freezer inefficiency and failure in temperature control. The findings underscore the significance of addressing energy efficiency in these appliances to enhance overall performance and reliability. Potential cost savings were evident, revealing that replacing only two refrigeration appliances could yield substantial financial benefits, estimated at $1325 in five years. The findings hold significant implications for the broader field of energy engineering, offering a tailored approach to microgrid design and operation in regions with similar energy landscapes.