Integrating a Solar PV System with a Household based backup Generator for Hybrid Swarm Electrification in sub-Saharan Africa: case study of Nigeria

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Abstract

Today most of the electrification grids in sub-Saharan Africa (SSA) are found in the urban areas. However, these grids experience erratic and frequent power outages for long hours, on average 4.6 hours in the whole of SSA. Due to this problem, many of the African population rely on unclean options like backup diesel/petrol generators for lighting, phone charging and other electrical appliances. In Nigeria, millions of people own power generators. These generators are not only noisy but the fuel they use are also costly and result in greenhouse gas emissions like carbon dioxide. In order to optimize fuel consumption and gradually reduce use of backup generators while increasing share of renewables, a strategy is proposed in this paper to interconnect the existing backup infrastructure to form a bottom-up swarm electrification grid with step by step integration of alternative storages and renewable energy sources. In the swarm-grid excess energy can be generated, sold among grid participants and even at later stage to the national grid. This study focused on the integration of a solar PV system to the existing individual backup generators for the household and the retail shop end users. Out of three systems designed, and the hybrid system is found to be the most suitable system for the household user with fuel savings of 39%, excess energy of 27% and reduced cost of backup electricity by 34%. For the retail shop, the hybrid system is also found as the most suitable system with fuel cost savings of 53%, excess energy generation of 28% and reduced cost of backup electricity by 45%. The study found that integration of a solar PV system has a high potential to reduce fuel costs for the backup generator end users and could contribute to a hybrid swarm electrification approach.

Key Words: National Grid; Stand-alone System; Swarm grid; Renewable Energy; Excess Energy

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