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Application of Homer Optimization to Investigate the Prospects of Hybrid Renewable Energy System in Rural Area: Case of Rwanda

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Abstract : The development and utilization of renewable energy (RE) can not only effectively reduce carbon dioxide (CO2) emissions, but also became a solution to electricity shortage mitigation in rural areas. Hybrid RE systems are promising ways to provide consistent and continuous power for isolated areas. This work investigated the prospect and cost effectiveness of hybrid system complementarity between a 100kW solar PV system and a small-scale 200kW hydropower station in the South of Rwanda. In order to establish the optimal size of a RE system with adequate sizing of system components, electricity demand, solar radiation, hydrology, climate data are utilized as system input. The average daily solar radiation in Rukarara is 5.6 kWh/m2 and average wind speed is 3.5 m/s. The ideal integrated RE system, according to Homer optimization, consists of 91.21kW PV, 146kW hydropower, 12 x 24V li-ion batteries with a 20kW converter. The method of enhancing such hybrid systems control, sizing and choice of components is to reduce the Net present cost (NPC) of the system, unmet load, the cost of energy and reduction of CO2. The power consumption varies according to dominant source of energy in the system by controlling the energy compensation depending on the generation capacity of each power source. The initial investment of the RE system is $977,689.25, and its operation and maintenance expenses is $142,769.39 over a 25-year period. Although the investment is very high, the targeted profits in future are huge, taking into consideration of high investment in rural electrification structure implementations, tied with an increase of electricity cost and the 5 years payback period. The study outcomes suggest that the standalone hybrid PV-Hydropower system is feasible with zero pollution in Rukara community.

Keywords : HOMER optimization, hybrid power system, renewable energy, NPC and solar pv systems
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