DEVELOPMENT OF AN OPTIMIZED STAND-ALONE HYBRID RENEWABLE ENERGY SYSTEM FOR SUSTAINABLE POWER GENERATION: A Case of Mpale Village in Korogwe District Tanzania.

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Abstract.

Electricity is a necessity for daily life. It is a driving force behind all social, human and sustainable development. Most of the electricity is generated from fossil fuels such as natural gas, coal and diesel. These sources emit greenhouse gases which are the causes of global warming and climate change. The replacement of fossil fuel generators with greener alternatives is a solution to reducing the impact of global warming and climate change replacing fossil fuels with renewable energy sources such as solar and wind is the best option.

Maple Village with a population of about 3,000 residents is located in a remote ward in the Korogwe district. The village is not connected to the national grid despite being a vibrant village with many socioeconomic activities. In 2015, a 48 kW Solar Photovoltaic system with a diesel generator worth $ 580,000 was installed while the cost of electricity (COE) was TZS 1,100 per kWh. The cost of electricity was a barrier to many residents which led to low connectivity, hence reducing the return on investment, and profit, and affecting the economic activities of the village.

This study aimed at developing an optimized stand–alone hybrid renewable energy system for sustainable power generation in the village. An assessment of the electrical load profile and the renewable energy potential in the village was conducted. Studer system software and The National Aeronautic Space Administration (NASA) database were used to determine the solar insolation, wind speed, temperature and humidity of the village. From the assessment, the solar insolation level of the village was established to be 5.454 kWhr/m^2/, an average wind speed of 4.8m/s, temperature of 31.3 C, humidity level of 80%, and electrical load demand of 32Kw. The solar insolation level and the wind speed are enough to generate electricity and supply the whole village.

The Hybrid Optimization Model for Electric Renewables (HOMER) pro software was used in the design, modelling, simulation, optimization and sensitivity analysis using the load demand, solar insolation, and wind speed from the assessment. The optimized cost of electricty9COE) after simulation was $ 0.13 per kWh (TZS 303.40) with a net present cost (NPC) of $ 88, 140 (TZS 205.21 million). The optimized system uses 100% renewable energy resources.

The objective has been achieved by reducing the cost of electricity from TZS 1,100.00 per kWh to TZS 303.40 per kWh a reduction of about 72.40%. it is recommended that wind turbines should be integrated into the existing system comprising of Solar PV, diesel generator, and battery. The existing diesel generator will remain as a standby but not participate in the generation of electricity.

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