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Original Research Article

Hybrid renewable power supply for rural health clinics (RHC) in six geo-political zones of Nigeria

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ABSTRACT

The potentials of major renewable energy sources (wind and solar) in selected locations across the six geo-political regions of Nigeria, based on long-term daily meteorological data spanning between 18 and 39 years were reviewed in this study. In addition, the techno-economic feasibility of utilizing hybrid photovoltaic/wind/diesel with battery storage systems to meet the load of a typical rural healthcare facility at the selected sites were assessed. The optimum dimensions of the system are defined for the locations. Hybrid Optimization Model for Electric Renewable (HOMER) software developed by National Renewable Energy Laboratory's (NREL) was employed to conduct the study. Findings from the study showed that Sokoto and Jos exist in the high wind potential regions, while the remain sites are only suitable for small wind applications. Values obtained for global, beam and diffuse radiation as well as clearness index, show that all the sites enjoy considerable solar energy potential suitable for varying degree of solar energy applications. Monthly optimum tilt angle for Iseyin, Sokoto, Maiduguri, Jos, Enugu and Port-Harcourt lies in the range of 0–39.8°, 0–44.5°, 0–44.1°, 0–43.2°, 0–38.5° and 0–36.3° respectively thereby having the optimum angle to be equal to 0° in all sites in April, May, June, July and August. The simulation results from HOMER indicate that the hybrid system is the best option for all the sites considered in this study. The PV/wind/diesel/battery hybrid system configuration is considered optimum for RHC applications at Sokoto, Maiduguri, Jos and Enugu, while hybrid systems involving PV/diesel/battery is considered ideal for RHC at remote locations within Iseyin and Port-Harcourt, due to the quality of renewable energy potential. The diesel-only system provides the highest COE ($0.911/kWh), and emits 9211 kg of CO_2 per year in all the site considered.

Introduction

The reliability of electric power supply is considered a vital commodity towards the development of healthcare in rural/remote areas; the lack of which has limited its efficient delivery in many rural communities of the world, thus putting human lives at risks [1]. Modern advances in the distribution of vaccines and other cold-chain dependent drugs, as well as global push to deliver antiretroviral drugs (ARV) and services to HIV patients worldwide, have presented new demands for electricity in health centers where there are limited or even non-access to reliable power supply. Operators of rural healthcare facilities in Nigeria and developing nations in general, are challenged with many problems, which have hindered effective delivery to the rural populace. For example, unreliable power supply can render cold-chain activities inoperable, while a healthcare facility without means of illumination (lighting) can keep patients that arrive late in the night for medical attention, to wait until the following morning before medical attention can be rendered.

Electricity crisis in Nigeria

Nigeria is made up of six geo-political zones with total land mass of 923.769 sq. km (98.5% highland and 1.5% lowland) [2]. According to United Nation, the percentage of rural population in Nigeria is about 50.4% with mere 36% of this population have access to electricity, and the majority with less than 4 h a day [3,4]. Commercial electricity generation in Nigeria currently comes from seven power stations and various independent power

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