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# Hybrid renewable energy supply for rural healthcare facilities: An approach to quality healthcare delivery

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ABSTRACT

The lack of modern electricity supply has been a major impediment to proper functioning of the healthcare centers in the rural areas, contributing to high maternal and child mortality rates in a country. Therefore, this study focuses on how to address the identified problem so that the healthcare centers or clinics in the remote areas can provide timely delivery of medical services for the concerned people. This paper, then, presents the analysis of stand-alone hybrid renewable energy systems for basic healthcare services in the rural areas, where there is no grid energy supply or the supply from the existing grid is erratic and unreliable. One major factor that informs the selection of the hybrid energy system in this study is that it promises high reliability compared to a single energy system. The research presents a statistical analysis of the potential of wind and solar energies for a selected rural locations in Nigeria based on the available long-term hourly and daily meteorological data. It employs an optimal technical and economic design and sizing of hybrid electrical power systems' components such as the wind, PV, battery and inverter systems, using the hybrid optimisation software (HOMER). Results show that Sokoto and Jos sites exist in the high wind potential regions, while the remaining sites are only suitable for small wind applications. Values obtained for global radiation show that all the sites enjoy considerable solar energy potential suitable for varying degree of solar energy applications. PV/wind/diesel/battery hybrid system configuration is considered optimum for rural health center at Iseyin, Sokoto, Maiduguri, Jos and Enugu, while hybrid systems involving PV/diesel/battery is considered ideal for Port-Harcourt, due to the quality of renewable energy potential. Hence, it was concluded that, the abundance of wind and solar resources in the country create an ideal environment for inclusion of renewable energy systems in the design and implementation of standalone power supply systems to improve rural healthcare delivery.

## Introduction

Reliable electricity access is a pre-requisite for improving the social and economic lives of the people in rural areas. It enhances healthcare delivery, education as well as other developmental growth within the local communities. At present, 17% of world population have no access to electricity, 85% of which lives in rural areas of Sub-Saharan Africa (SSA), South Asia and other developing countries, with SSA having the largest share of the electricity deficit rate [1].

The majority of these people have limited prospects of gaining access to electricity in the near future. The implication of this can be translated as close to 1 billion people around the world are being served with healthcare facilities with no electricity access [2]. This deficiency implies that medical equipment such as ultra sound, autoclave, centrifuge and medical x-ray cannot be used in such places as presented in Fig. 1. Surgery services sometimes delivered by depending on the ambient light from windows or kerosene lamps at nights. Reports indicated that, quite a number of women die on a daily basis during pregnancy and childbirth in rural places due to poor medical care. By providing at least a minimum lighting and electric power supply to minor surgical equipment could reduce the high maternal mortality rate by 70% [2].

Diesel generators have traditionally been used to power most off-grid clinics and hospitals for supplementing the unreliable grid supply for grid-connected facilities, but this is associated with attendant costs of diesel fuel and unreliable delivery as well as high $CO_2$, CO and particulate emissions contributing to air pollution and climate change.

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