Determination of Solar Radiation Patterns for Implementing a Photovoltaic Based Micro Grid Power Generation in Geidam Area

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Abstract

In this study, a determination of solar radiation for solar implementation was carried out to assess the solar system potentiality of Geidam. The town despite having the potential to produce its own power through abundance of renewable energy sources is left without electricity for many years and with a population of more than 157thousand people (according to 2006 census), Geidam community have been facing a lot of problems with regards to electric power supply, the cost of maintaining the transmission line that connect Geidam to the national grid every year make the supply to Geidam community unaffordable to both government and business owners. This study was carried out to look at the possibility of supplying the study area with renewable energy using one of the abundant renewable energy sources in the area through microgrid.

Keywords: *Solar radiation, renewable energy, Microgrid,*

1.0 Introduction

The ever increasing and continuously unpredictable fluctuation of electric power has negative impact on the people in an area that is struggling to recovery from conflict situation to an economic growth. A microgrid can be used as a distributed energy sources that can operate independently or tied to the grid to ensure a reliable supply while preventing greenhouse gas (GHG) emissions.

According to (Hussain, M, Rahman, L and Rahman, 1999) The solar radiation at the study area is the most important input parameter in the design of solar energy device. Knowledge of the amount of solar radiation can best be obtain by installing a pyranometer at locations and recording day to day irradiance values. (Medugu D. W. et al., 2011)

Due to lack of measured data obtained using measuring instruments, theoretical predictions and meteorological data were used by many researchers using different models to compute average irradiance of solar radiation for different locations. (Abdilahi et al., 2014; Abdulsalam et al., 2012; Adejumo et al., 2017; Bahramara et al., 2016; Garba et al., 2018; Osinowo et al., 2015)

2.0 Problem Statement

Geidam community have been facing a lot of problems with regards to electric power supply, the cost of maintaining the transmission line that connect Geidam to the national grid every year make the supply to Geidam community unaffordable to both government and business owners.

Most businesses if not all rely on diesel generators which is also not affordable in recent years. The town despite having the potential to produce its own power through abundance of renewable energy sources is left without electricity for many years.

3.0 Objectives

The main aim of this research is to determine solar radiation patterns for the implementation of a Photovoltaic power based micro grid system in Geidam area.

The specific objectives are:

a) To measure, evaluate and analyzed the original data for solar radiation of Geidam area
b) To asses the use of solar based micro grid in Geidam local government.
c) To design a micro grid for the study area using HOMER and MATLAB softwares.

4.0 Methodology

Geidam is the headquarters of Geidam Local Government of Yobe State, Nigeria. It is located at a geographically favourable location with unlimited sunshine which can be utilized to obtain a dependable renewable energy source. The daily irradiance data was collected for a period of six months with using pyranometer. The weekly mean values of sunshine duration were also determined for the period. The result was then used as input to the solar based micro grid to be designed using the HOMER software.

The software was use for microgrid modeling, simulation, optimization and sensitivity analysis. The microgrid system was simulated for long-term operation and variety of system configurations.

In this study also a model of the load demand of the study area was proposed. A survey of the typically contemporary Geidam rural household load was carried out. After which the usage of electric power in these houses were determined.

The qualitative approach of the study design was used during the research in getting the idea of the load demand of Geidam and its environs. The target area (Geidam) is located

in the north east Nigeria with a population of about of 157,295 as at 2006 census. The stratified sampling method was used to sample the residential and commercial loads. After getting the rough idea of the load then a HOMER Pro version software was then used to carry out the design simulation, optimization and sensitivity analysis of the micro grid.

5.0 Results and Discussion

The Energy Consumption of the study area on average was 165.4 kWh/day and 5,374.6 kWh/month as simulated using the load model, with an annual Peak Demand of 21.61 kW. see figure 1. A base case scenario of solar-based microgrid system was simulated by HOMER and then compared with the solar potential of the area under study and the possibility of hybrid microgrid system with PV was also analyzed.

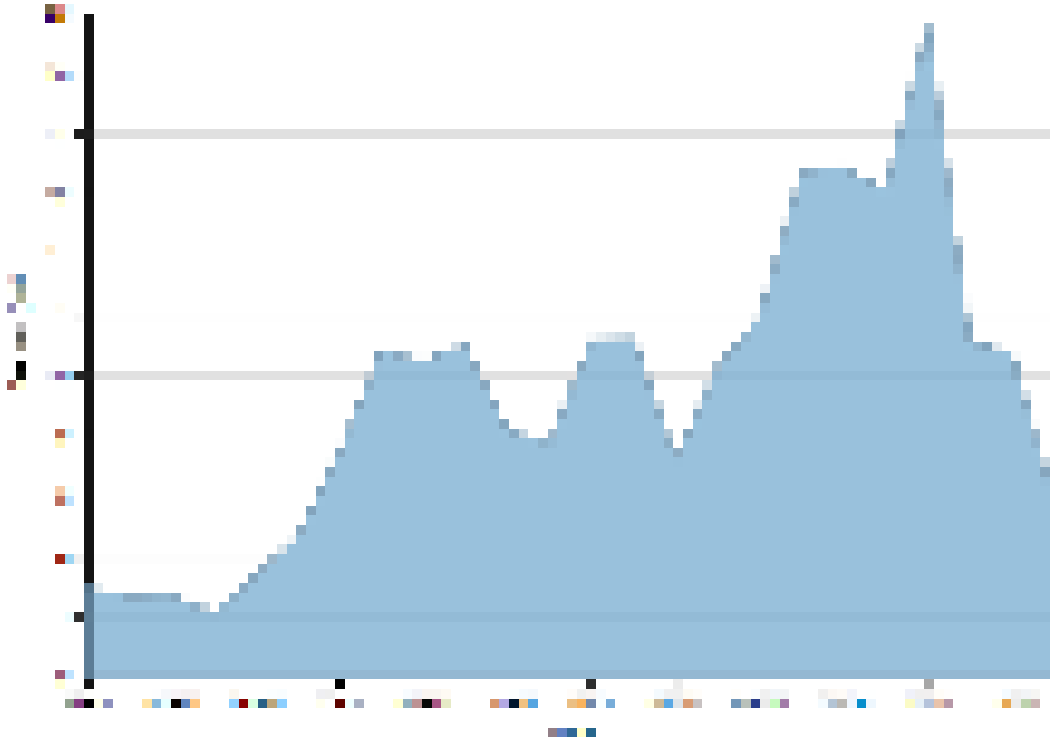


Figure 1. Typical Load Profile of the study area

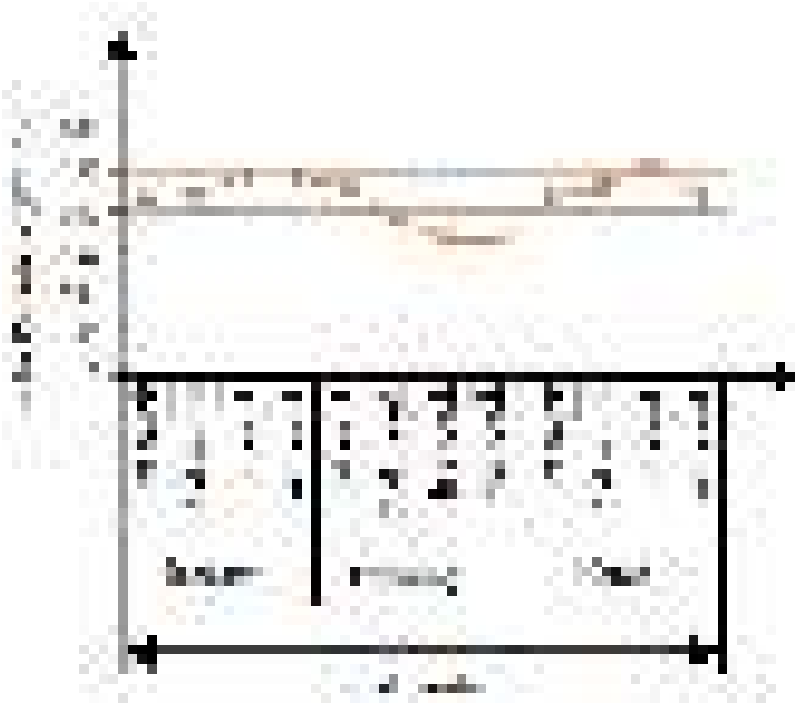


Figure 2. Quarterly averages of solar radiation for the first quarter of 2023.

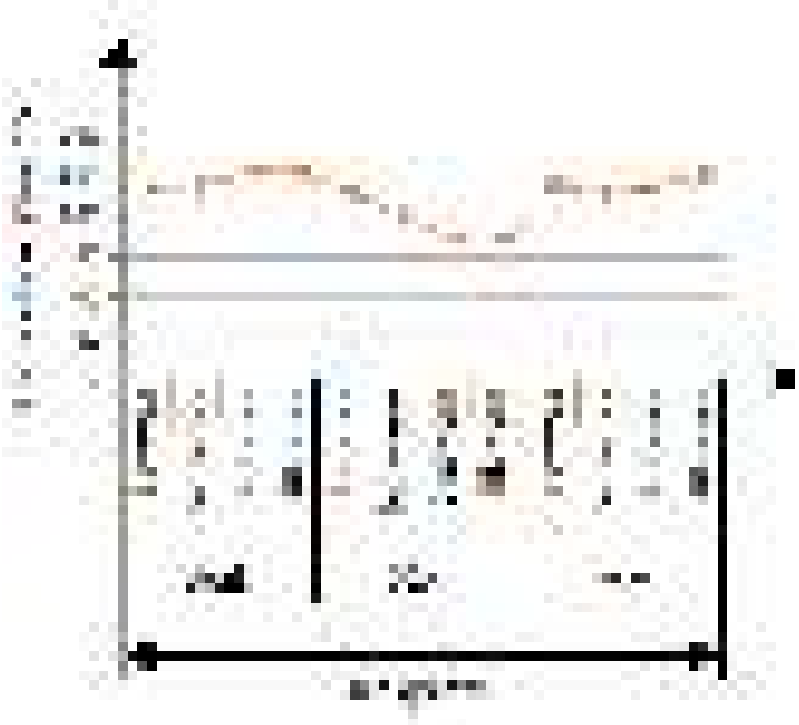


Figure 3. Quarterly averages of solar radiation for the second quarter of 2023.

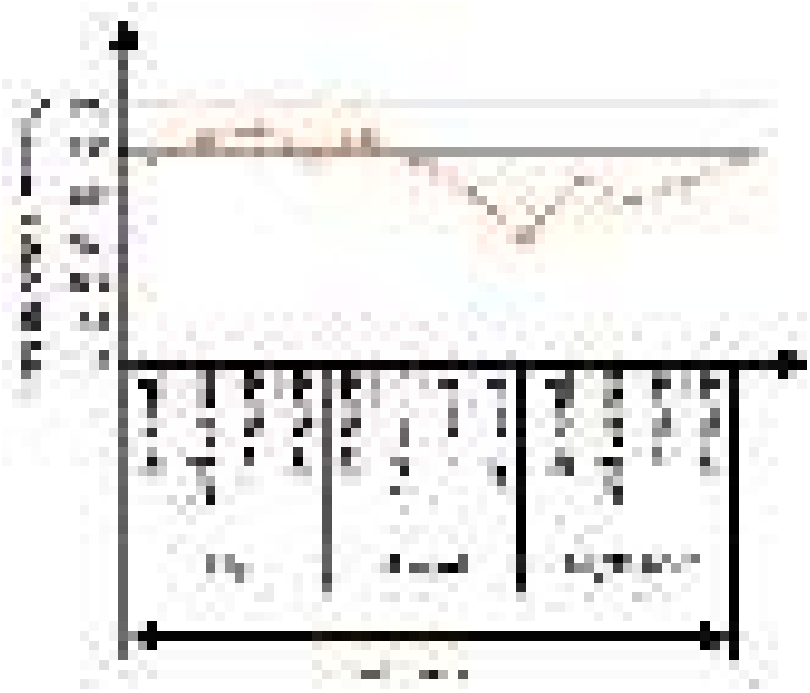


Figure 4. Quarterly averages of solar radiation for the third quarter of 2023.

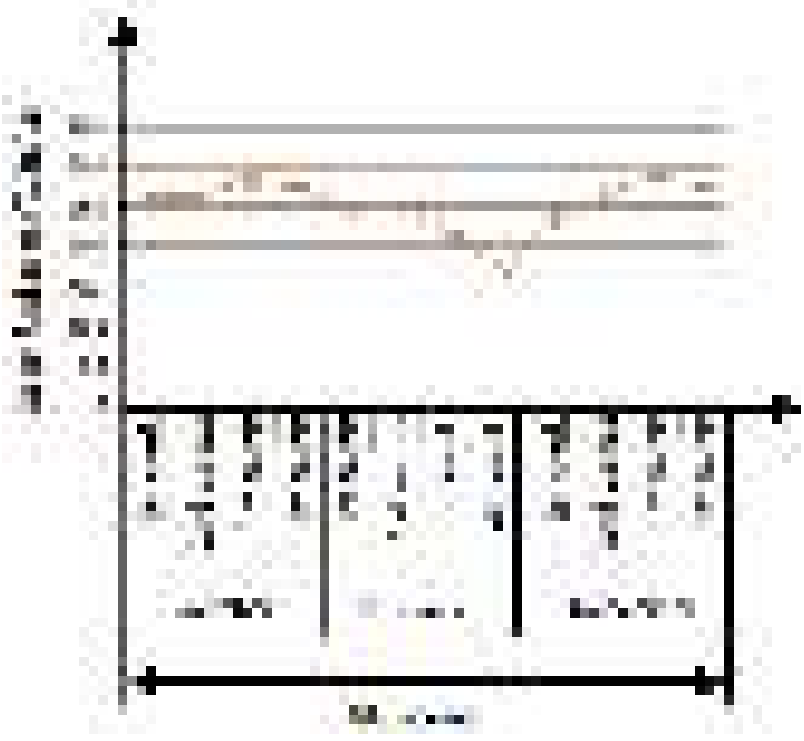
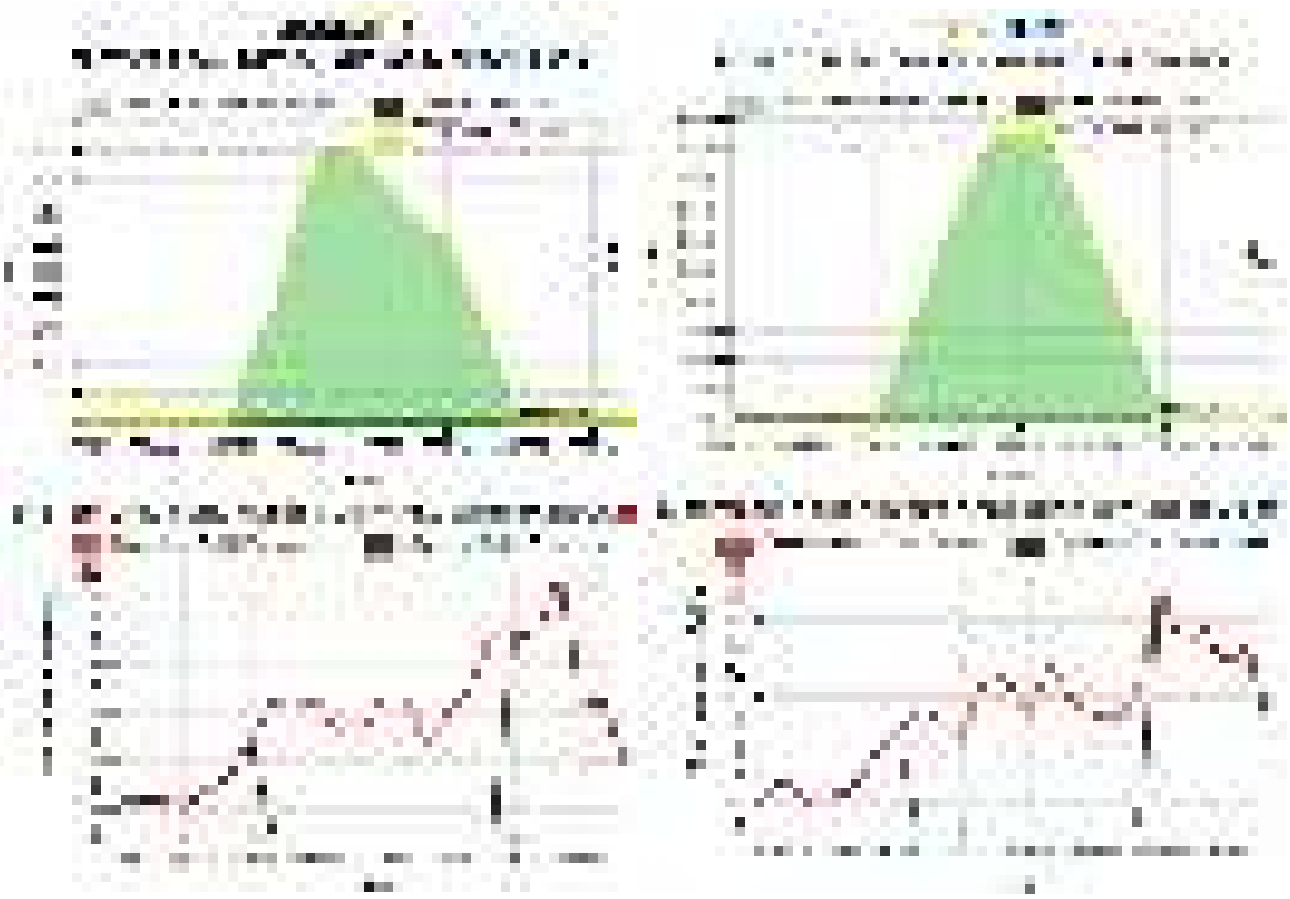
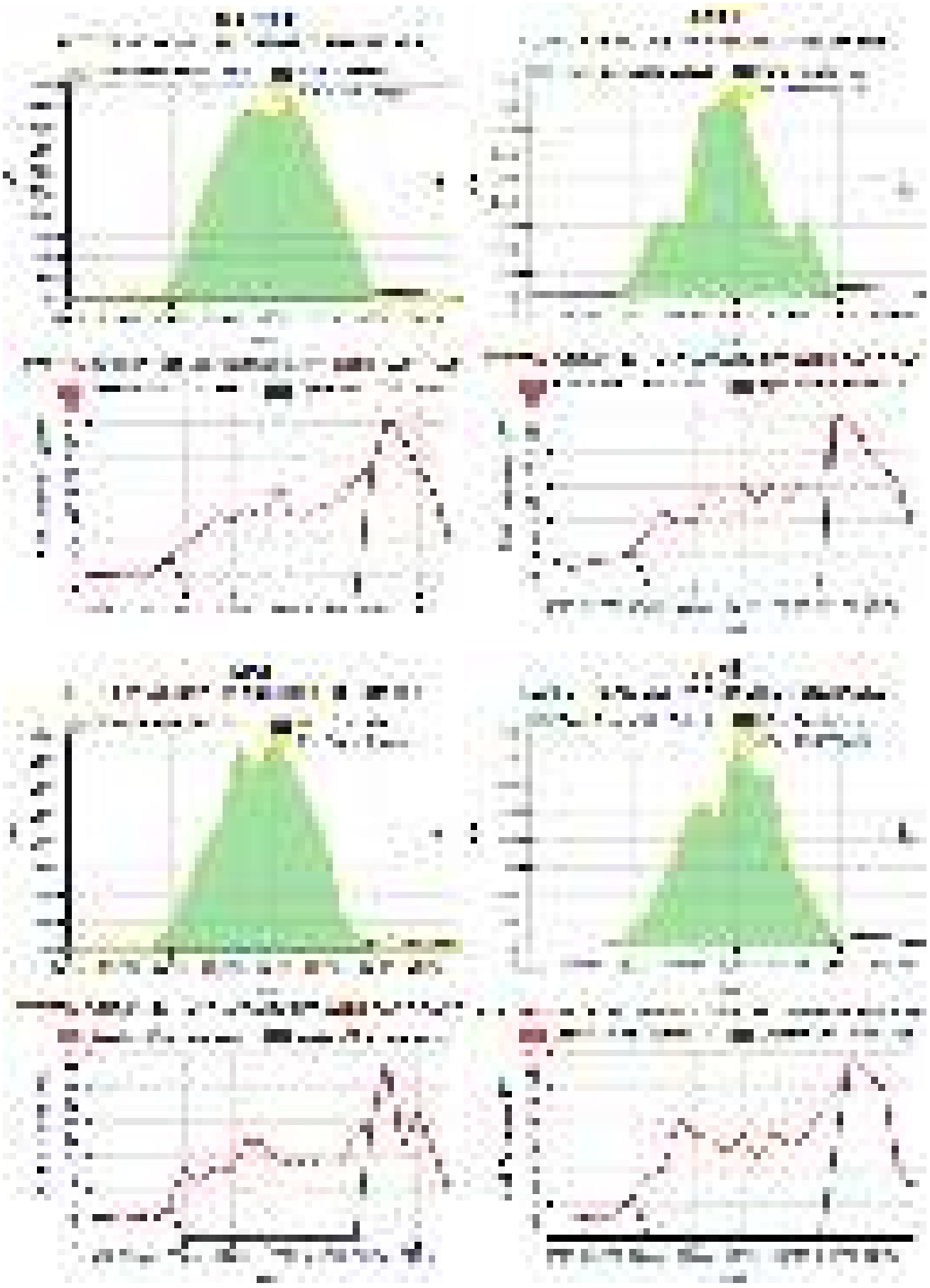
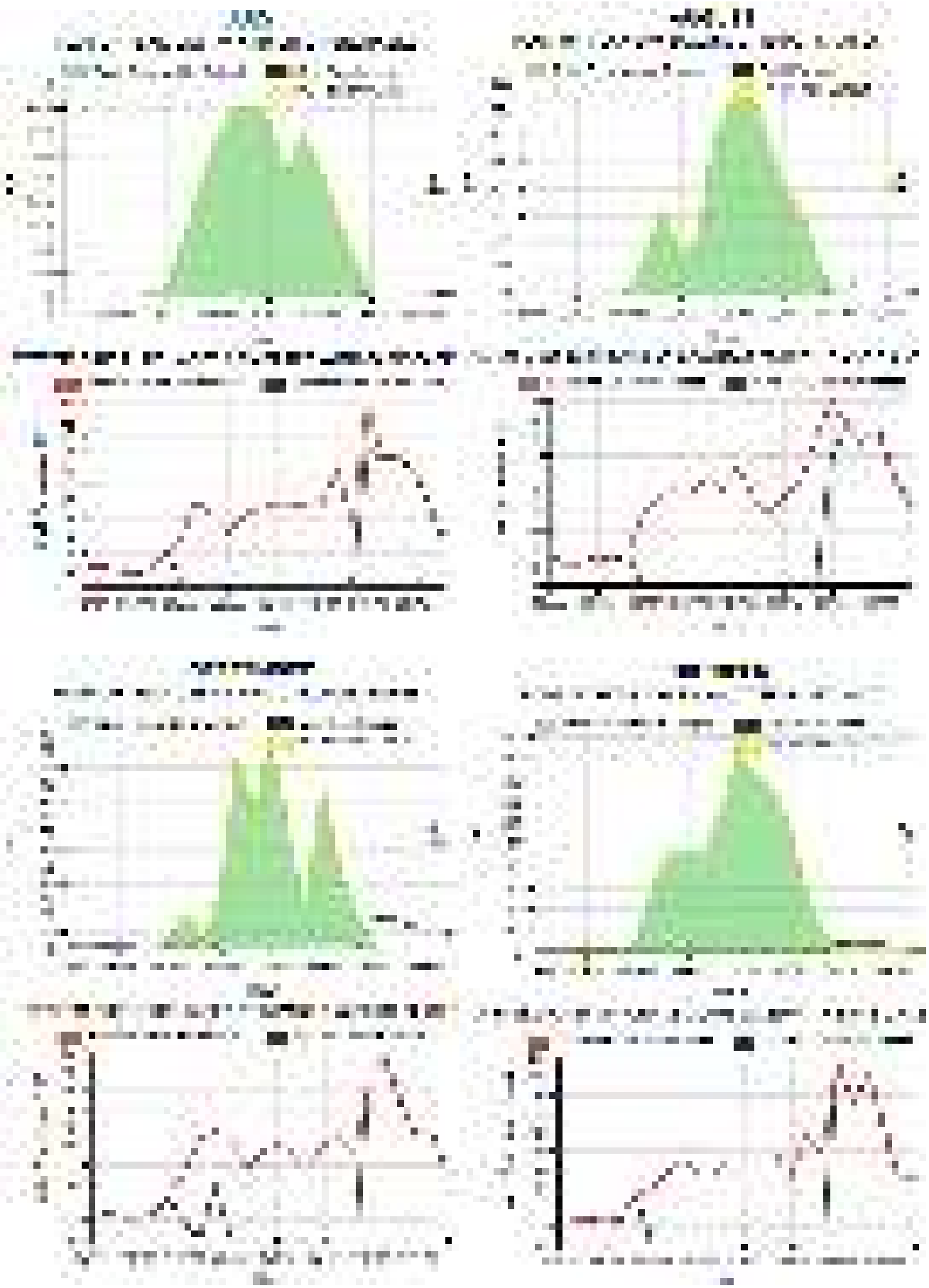


Figure 5. Quarterly averages of solar radiation for the fourth quarter of 2023.







6.0 Conclusion

The yearly irradiance data of the area in question shows the capability of PV system to produce enough power to meet the load demand of the study area and the research will contribute to the knowledge of RE potential of the area.

7.0 Acknowledgement

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