Off-grid energy storage trinidad and tobago

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The roof-mounted solar PV system is located in a heavily forested area east of Trinidad. The climate in Trinidad is characterized by a humid tropical environment with significant rainfall and consistent temperatures throughout the year [10]. The solar PV system will power equipment and fixtures in an existing structure that is used for the care and rehabilitation of local reptiles and birds, in particular reptiles and birds that are affected by onshore and offshore oil and other chemical spills. The site is remote and not connected to the electrical grid. Diesel-powered generators met the site"s electricity needs.

A site visit was conducted, and the slope and orientation of the roof were measured. The tilt and azimuth of the roof were measured as 200 and 0, respectively. The electrical load was calculated by recording the power consumption of the electrical appliances and their usage patterns. The average daily consumption was calculated as 10.1 kWh/day, and the daily average electrical consumption pattern is provided in Fig. 1. The site was unaffected by shading at the time of the site visit.

Using information from the site visit and the National Solar Radiation Database (NSRDB), which provided solar irradiance data for the site, the off-grid roof-top solar PV system was designed using the industry-leading software PVsyst. The solar PV design was then used to inform a request for proposals, which resulted in the purchase of solar PV equipment and the contracting of a solar contractor to install the system. The system was installed to meet National Electric Code (NEC) 2020 standards. The performance data for the solar PV system was logged by the energy management component of the system for every 5-minute interval from September 2023 to March 2024. This data was used in the analysis that follows.

The results of the solar PV design and simulation are provided in this section, along with the data logged during the 6 months of operation of the system. The design performance is then compared against the real-life performance of the system. The main components of the system and their rating are provided in Table I.

The single-line diagram of the system is provided in Fig. 2. The system meets NEC 2020 requirements.

This section focuses on the presentation and analysis of actual performance data taken from the data logging and energy management system of the solar PV system.

Fig. 4 presents that daily variation of solar irradiance data over the data collection period. It should be noted that during the reporting period, 1000 W/m2 irradiance levels were never attained. Fig. 5 presents the Cumulative Frequency Distribution (CFD) curve and the calculated median solar irradiance value of 423 W/m2. The histogram in Fig. 6 illustrates that the highest frequency of solar irradiation observations falls within the 100 to 500 W/m2 range, suggesting that these are the most common irradiance levels during daylight hours.

The average daily yield (kWh) value from October and November 2023 is presented in Fig. 7. The mean value is approximately 11.86 kWh. This is 49% of the simulated average daily yield value of 24.15 kWh. The daily variation in solar PV power is presented in Fig. 8. During the reporting period, the system rarely reaches or exceeds its installed capacity of 5.34 kW. Fig. 8 also illustrates that PV production peaks between 9 am and 10 am regularly.

The daily variation in electrical demand is presented in Fig. 9, and the corresponding electrical demand histogram in Fig. 10. Fig. 9 illustrates that the electrical demand is fairly consistent throughout the reporting period, and the histogram in Fig. 10 highlights that the highest bin covers the range from 219.8 W to 303.6 W, indicating this is the most frequently observed range of AC power consumption. The second highest bin covers the range from 136.0 W to 219.8 W, showing this as the next most common range of consumption.