Assessment of Solar and Wind Power Resources in a Tropical City in SW Nigeria – (7°47''N, 4°29''E) for Viability of Hybrid Power Applications

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The solar radiation over Osogbo (7°47′′N, 4°29′′E), a typical town in South West Nigeria, was estimated from measured sunshine hours with a view to determining the available solar energy for deployment of solar photovoltaic technology applications. The sunshine hours' data were obtained from Nigerian Meteorological Office (NIMET), Osogbo. The monthly average solar radiation ranges from 12.55MJm^{-2}day^{-1} in August to 18.63MJm^{-2}day^{-1} in December. In fact only July and August have values less than 15MJm^{-2}day^{-1}. This is due to the heavy cloud cover at the peak of the rainy season which prevents sunshine from reaching the earth's surface. However, similar analysis of daily wind speeds at the same location shows an annual mean wind speed of 3.5m/s at 10m height with peak values of about 4.9m/s occurring correspondingly at the peak of the rainy season (July/Aug. - time of lowest solar radiation). This study therefore shows that wind power can properly compliment Photo Voltaic (PV) applications since maximum wind power resources occur at a time corresponding to lowest PV performance resulting from heavy cloud cover. Energy Storage Systems (ESS) in form of Battery Bank accumulator can be used to overcome the well-known variability of wind power by storing energy at periods of high wind speeds which occur, albeit sporadically, but usually at night times when solar energy becomes unavailable. In a pilot scheme, a modern wind turbine with low cut-in speed of 3m/s was installed at 18m height at College of Science, Engineering and Technology (SET) Osun State University Osogbo to compliment a 400Wp Solar Module and a 4.8KW-hrs Battery Bank/Inverter system to form a robust and more reliable hybrid alternative power system. This system has been used successfully to support emergency power requirements of college laboratory and office equipment during periods of grid power outages. The study establishes that wind resources of wind power class (WPC) 2 and above can properly compliment small-scale PV systems to overcome lower performance challenges during periods of heavy cloud cover. While available solar radiation and its variation in Osun State and SW Nigeria in general is better known, on the other hand, there is a need to embark on a state-by-state wind resource mapping of the entire country (through long-term measurements of wind speeds with anemometers across the entire country) especially for other areas of greater reliefs which abound in the country and which are expected to have higher wind speed regime potentials than this particular study location.

Development of an Improved Concrete Roman Tile Alternative Roofing System Using Waste Raw Materials (Paper and Saw Dust) as Additives

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Since the early civilizations in China (Neolithic) and the Middle East, humans have recognized the dual desirable roles of clay tiles, as roofing material, which remain valid today - First, it was an effective means to shed water from buildings and secondly it reduced the spread of fire. The Standard Double Roman tile (SDRT) was the first roof tile to be mass produced in South Africa. The Double Roman can trace its shape back to Roman engineering principles where it was discovered that arches have an ability to withstand greater pressures as the arch distributes the weight more evenly down to the base of the structure. However, after the initial introduction of the concrete tile to Nigerian roofing market, architects began to express displeasure with its unusually heavier weight than other competing roofing materials. Suggestions were made to original manufacturers for product improvement by reducing the overall product weight. Concrete tiles are composite materials made from mixture of Portland cement, sharp sand, smooth sand and natural fibre. Bolyn Industries [7] has established that a mix ratio by volume of 1(cement):11/2(sharp sand):11/2(smooth sand) with some fibre makes a good concrete tile product. The sharp sand provides strength while smooth sand provides smoothness to the concrete surface. This study seeks to improve the current Double Roman product by reducing its overall product weight which is currently at about 5.0 kg to about 4.0 kg. Going by the previous experience with Polycrete invention [2], it is hereby conceived that replacement of smooth sand with lighter waste materials such as paper or saw dust in the concrete tile constituents may achieve the desired product weight reduction. The study investigates the most economic mix ratio of the concrete tile constituents to achieve the desirable engineering properties of light weight, strength, durability, water tightness and rust-proofness. Results with preliminary mix trials indicate that replacement of smooth sand with paper or sawdust in the concrete batch may achieve the desired results, but paper produces a better ductile and more workable material while saw dust produces a brittle and more crack-prone product. It is established in this study that 16-18 Products of Improved Double Roman Roofing Tiles (IDRT) of approximately 4.2kg each, are achieved in a batch mix of 1 head-pan of Portland cement, 2 head-pans of sharp sand and 4kg of waste paper compared to the average weight of 5.0kg achieved for the Standard Double Roman Tile (SDRT). Comparative market survey of existing roofing systems in Nigeria shows that there is a wide range in cost of N450.0 per m^2 for Galvanized Iron sheet, N1500.00 per m^2 for Aluminium Long span and N3, 500.00 per m^2 for Classic Stone-Coated roofing sheets respectively compared to N1, 000.00 per m2 achieved for the IDRT; thus the second objective of this study to achieve a competitive product price in the median of the above-reported cost range has also been achieved.