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LOCAL ENERGY GENERATION FOR FARM INFRASTRUCTURAL USE

BY

[1]Ishiak Y, [2]Murtala K. & [3]Lawal W.S.

[1]Geography Department, Kwara State Polytechnic, Ilorin.
[2]Computer Science Department, Kwara State Polytechnic, Ilorin.
[3]Agricultural Technology Department, Kwara State Polytechnic, Ilorin.
Email: ishiakyusuf@gmail.com

Abstract

This research explores the pivotal role of wind energy in enhancing farm infrastructure within Kwara State Polytechnic, Ilorin. As a sustainable and renewable energy source, wind power offers a promising solution to bolstering agricultural activities in the region. Kwara State Polytechnic, situated in a wind-abundant area, stands to benefit significantly from harnessing this natural resource to improve its farm infrastructure and overall sustainability. Through a comprehensive analysis of wind energy applications within agricultural settings globally, this study highlights the potential benefits, challenges, and opportunities of integrating wind power systems within the farm infrastructure of educational institutions like Kwara State Polytechnic. By utilizing wind energy technology, the polytechnic can reduce its dependence on traditional electricity sources, thereby lowering operational costs and mitigating environmental impact. Moreover, this research discusses the feasibility of installing wind turbines on the polytechnic's premises to generate clean electricity for powering irrigation systems, agricultural machinery, and other farm operations. By embracing wind energy, Kwara State Polytechnic has the opportunity to enhance its self-sufficiency, contribute to environmental conservation efforts, and serve as a model for sustainable development in the region. In conclusion, the integration of wind energy systems presents a compelling opportunity for Kwara State Polytechnic to revolutionize its farm infrastructure, promote sustainability, and foster innovation in agricultural practices. Embracing wind power not only aligns with global efforts to combat climate change but also positions the polytechnic at the forefront of sustainable development initiatives within the region.
Keywords: Wind energy, infrastructure, agriculture, sustainability, environmental conservation and power

Introduction

Global changes in energy production are occurring as a result of increased demand for clean, cheap, and domestic power coupled with rising consumption and a finite supply of fossil fuels. Wind energy is at the forefront of this transformation and is now the world's fastest growing source of electricity (EIA 2012). This trend is driven in part by goals such as the U.S. Department of Energy's (DOE) intent to achieve twenty percent (20%) of electrical power from wind by the year twenty thirty (2030) (U.S.E). The benefits of wind energy include low lifecycle emissions of greenhouse gases (Jacobson 2008), which support the perception that wind is a 'clean' alternative to fossil fuels such as oil and natural gas. However, focusing on emissions alone ignores the impacts of 'energy sprawl', or the increasing amount of land altered for energy production (McDonald *et al* 2012). Renewable energies are becoming increasingly cheap. By twenty fifty (2050) wind and solar energy are estimated to account for a staggering seventy percent (70%) of global electricity production (Arkolakis and Walsh, 2023, DNV, 2023).

The transformation requires a large expansion of decentralized infrastructure. Local residents, however, often object to the installation of wind turbines and solar parks (Economist, 2021, New York Times, 2022), and their resistance remains a key obstacle to a rapid energy transition (Jarvis, 2022).

Quantifying the impact of renewable energy infrastructure on residents' welfare is challenging. Anecdotally, residents are concerned about visual impacts, noise pollution, and potential adverse health effects, but how much these concerns affect their utility is unobserved. Energy shapes our lives and the Earth. Energy, which was used by people in the beginning only for vital and basic needs, is the cornerstone of civilization, with an increasing need in today's modern world. The rapidly increasing energy demand and the inevitable negative effects on the environment caused by energy production, have made renewable energy technologies increasingly important and preferred among the widely used energy sources in the last decades. Wind energy is one of the leading renewable energy technologies. Wind energy comes to mind when it comes to renewable energy, as it is a carbon free, environmentally friendly, competitive technology. A step forward in production of wind energy is offshore and onshore wind turbines, with their numerous advantages. The increasing energy needs in the world and new searches related to this make onshore and offshore wind turbine applications an increasingly widespread renewable energy source. However, with this spread, challenges arise during the construction, maintenance and, operation phases, often being associated with the strength of the wind turbines. Potential failures must be known in advance so that they can be dealt with strongly and effectively. Damages and failures have a negative effect on the continuation of the operation and cause material and moral impacts. As a result of the gradual depletion of fossil and nuclear resources, the increase in oil prices, global warming and climate change, the need for alternative and clean energy sources has increased rapidly, especially in the last 40 years (Global Wind Report, 2021).

The fact that wind energy is an economically, socially and ecologically sustainable energy source proves that it is the ideal solution for this need, with its rapidly increasing installed capacity for the last 20 years. Year of 2020 for the global wind industry was the best year in history with 53% annual growth. More than 93 GW of wind installations have proven the wind industry's incredible resilience in a challenging year that disrupted both the global supply chain and project processes. The 93 GW new installation increased the global cumulative wind power capacity to 743 GW. This means 1.1 billion tons of CO_2 reduction per year. New capacity installed in onshore wind increased by 59% (86.9 GW) compared to 2019. China and the United States remained the world's largest markets for new onshore wind farm capacity expansion, with the world's two largest economies together increasing their market share by 15% to 76%. Global wind power has roughly quadrupled over the past 10 years, making it one of the most cost competitive and durable energy sources worldwide. (Global Wind Report, 2021)

Literature Review

Wind energy is linked to the development of air flow from areas of high atmospheric pressure to adjacent areas of low pressure, with velocities proportional to the pressure gradient. During daytime, the air flow over the oceans, seas, and lakes remain cool compared to neighboring flow located over land-areas. Wind power is dependable and acceptable technology that can produce electricity at a cost that is competitive with coal and alternative energy such as nuclear, which has been in place for more than ten (10) years ago since (2005). Vilela *et al*. (2004) simulated an irrigation system for PV pumping in vineyards; these sys-tems have contributed to the water provision for rural communities in remote areas. The production of fruits, with water supplied by PV systems, could become an effective alter-native in terms of local economic activities. The viability of this proposal depends largely on the market value of the crop. Wind and solar energy can be used to power the greenhouse to produce fresh water

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without the support of energy sources from fossil fuels. Nowadays, most of the water desalination uses fossil fuels, and therefore, it contributes to rising levels of greenhouse gases (GHGs). Ouammi *et al*. (2010) investigated the monthly and seasonal variations of wind characteristics in terms of wind power potential using wind speed data collected between (2002) and (2008) for four weather stations in the region of Liguria in northwestern Italy: Capo Vado, Casoni, Fontana Fresca, and Settepani Monte. The results show that Capo Vado is the best site with a monthly average wind speed between (2.80) and (9.98) m/s at a height of (10) meters and a monthly wind power density between (90.71) and (1177.97) W/m2, with a maxi-mum energy production being achieved in December with a value of (3800) megawatt hour (MWh). The current challenges to increased penetration of wind power are grid integration, forecasting of wind availability, public attitudes, and reaction to the visual impact of wind turbines. Offshore wind energy tends to be more expensive, and a major challenge for expanding this technology lies in cutting its costs. The variable nature of wind makes it hard for electricity generated from wind energy to fully displace other electricity sources.

Methodology

The experiment took place at the Kwara State Polytechnic, farm in Ilorin, Nigeria. where maize and cassava were planted. The experimental set up and the system unit was located right in the middle of the farm for better assessment. The turbine was located far away from this set up so that there will be no wind break that may give us false reading. The set up include the computer system that will monitor wind readings. The experiment lasted for six (6) months.

Figure 1: Showing an anemometer

Figure 2: Showing a mounted turbine

Figure 3: lightening system

Figure 4: sprinkler chamber


Figure 5: showing a section of cassava


Figure 6: cross section of maize plant

The materials used include turbine, Computer desktops, Anemometer, Sensor, Inverter, irrigation machine, lightening system, sprinkler, battery and coding of the data for the result.

A small modern office will be built that can be used as control room for the whole operation. The study was carried out to locate where the effect of wind is paramount where the turbine will be located to obtain maximum effect of air velocity and the reading was taken from the site. The turbine was installed and wires connected to generate power and readings were made. A device installed to sense all what is going on, especially in the environment, in case any abnormality going on. Alarm signal in order to curb flying birds from getting killed by the blades of the turbine, this will protect farm animal from being killed as a result of the movement from the turbine. A portion of land was used to cultivate both maize and cassava, another area where sections animals were kept like cow, goat, and fish.

Results

The table below shows the relationship between Air Velocity (m/s), Beautfort Scale and Temperature (Celsius)

Table 1. Descriptive Statistics

	Mean	Std. Deviation	N
AIR VELOCITY (m/s)	2.8433	.98039	30
BEAUTFORT SCALE	3.2667	.82768	30
TEMPERATURE (Celsius)	29.3667	2.41266	30

From table 1, the results show that average air velocity (m/s) is 2.84 with standard deviation of 0.98; beautfort scale average is 3.27 with standard deviation and average temperature (Celsius) is 29.37 with standard deviation of 2.41.

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Table 2. Correlations

		AIR VELOCITY (m/s)	BEAUTFORT SCALE	TEMPERATURE (Celsius)
Pearson Correlation	AIR VELOCITY (m/s)	1.000	.763	.430
	BEAUTFORT SCALE	.763	1.000	.669
	TEMPERATURE (Celsius)	.430	.669	1.000
Sig. (1-tailed)	AIR VELOCITY (m/s)	.	.000	.009
	BEAUTFORT SCALE	.000	.	.000
	TEMPERATURE (Celsius)	.009	.000	.
N	AIR VELOCITY (m/s)	30	30	30
	BEAUTFORT SCALE	30	30	30
	TEMPERATURE (Celsius)	30	30	30

From Table 2, show the correlation between the variables. The results show that there is strong relationship between air velocity and beautfort scale with correlation coefficient of 0.763 which statistically significant with p-value (0.000) < 0.05 (level of significance). There exists moderate relationship between beautfort scale and temperature with correlation coefficient of 0.669 which is statistically significant (p-value (0.000) < 0.05). The relationship between air velocity and temperature is weak with correlation coefficient of 0.430 (statistically significant with p-value (0.009) < 0.05).

Conclusion

From this research it was clearly observed that the results show that there is strong relationship between air velocity and beautfort scale with correlation coefficient of 0.763 which statistically significant with p-value (0.000) < 0.05 (level of significance). This also clearly shows that the power generated from wind energy within Kwara State Polytechnic, Ilorin during this peak period of experiment shows that irrigation machine was powered and both maize and cassava plants were supplied with water within the selected farm area. This research came up with some solutions in order to save animals such as flying birds from being killed by turbine blades by introducing of lightening system and alarm buzzing in order to chase away the flying birds, even fly planes, choppers could see the lightening and such turbine position could also be avoided too.

Recommendations

Turbine installation could be done in such a way that will reduce the risk to animals and other creatures. Nigerian Government can key into renewable energy thereby power generated can be used to drive all machines that are been operated, thereby bring down the cost of production in farm produce. Masses can get affordable food as a result in low cost of ensuring finished goods, which could drive the economy of such nations; storage of excess produce could be achieved. Feeds of animal could be processed at minimal cost, thereby ensuring profit margin in that sector. Another area where this other type of renewable energy can be explored is in the solar energy, this will also help in ensuring backup energy source against down time.

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