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Investigation on Wind Energy Potential with Omni-Direction-Guide-Vane (ODGV) in Meiktila, the Republic of the Union of Myanmar

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ABSTRACT

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INVESTIGATION ON WIND ENERGY POTENTIAL WITH OMNI-DIRECTION-GUIDE-VANE (ODGV) IN MEIKTILA, THE REPUBLIC OF UNION OF MYANMAR

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Abstract

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1. Introduction

Energy has a key role to form modern economy. In developing countries, such as Myanmar, energy consumption has increased to improve their living while natural resource accessibility decreases. So meeting of growing energy demand in a safe and environmentally responsible manner is a key challenge. Therefore, the use of renewable technology has been developed to produce required energy demands for the past few years. Myanmar's population is approximately 60 million, with two-thirds of population living in rural areas[1, 2]. In 2010, 26 percent of its population was living remote rural areas without electrical grid access and quite poor. Myanmar's per capita electricity consumption is only 100 kWh per year, the lowest among ASEAN's countries. Greater use of renewable energy technologies is one of the promising ways to reduce poverty in remote rural area. The technology is developing fast, and small-scale renewable energy to provide power to electrical grids is now the cheapest option for the poor [3]. In recent years,

Myanmar has begun to exploit a wide scale of renewable energy sources, particularly solar, wind, hydro, geothermal and biomass. Myanmar has vast potential of renewable resources and now it is increasingly considering wind energy. This article concentrates on the potential of wind power to provide Myanmar with a viable renewable energy source.

2. Literature Review

Wind energy development is at the experimental and research phase in Myanmar. The evaluation of wind energy resources using modern systems has been conducted since 1998, led by the Myanmar Scientific and Technological Research Department. New Energy and Industrial Technology Development Organization (NEDO) of Japan studied in 1997 on renewable energy potentially available in Myanmar and occurred wind energy of 365.1 TWh per year in generally windy areas. Some potential areas were identified by JICA/ NGO joint survey in 2001. Judging from existing data, hilly regions of Chin and Shan states, coastal regions in the

south and western part of the country, and central part of the country appear to have the best potential for harnessing wind power[3]. But particular survey is needed to size and design the system before implementation. Appropriate site selection for wind efficiency is important and necessary. Only a very few small capacity of 300-600 W wind generators are used in lower part of the country[4]. The aim of this study is to determine the wind energy potential for electricity generation in remote area of Meiktila, central part of Myanmar, by using the Omni-Direction-Guide-Vane (ODGV). The ODGV is an augmentation device which can increase power generation of conventional wind turbine from available wind site by achieving high performance directional flow of the on-coming wind speed, guiding the wind stream to a better flow direction of the VAWT. It was designed for low wind speed regions for improving energy generation of conventional wind turbine[5]. This work is the first time analysis of wind energy potential for this region in Myanmar.

3. Materials and Methodology

The wind speed data of Meiktila over a period of ten years have been assessed and statistically analyzed. The wind speed data were recorded at a height of 10m by a cup generator anemometer by Myanmar Meteorological Service. The wind regimes are characterized by two Weibull parameter functions: the probability density function (PDF) and the cumulative distribution function (CDF). They are given by the following equations Eq.1-5[6, 7].

$$f(v) = \frac{k}{c} \cdot \left(\frac{v}{c}\right)^{k-1} \cdot e^{-\left(\frac{v}{c}\right)^k} \quad (1)$$

$$k = \left(\frac{\sigma}{\bar{v}}\right)^{-1.086} \quad (2)$$

$$c = \left(\frac{1}{n} \sum_{i=1}^n v_i^k\right)^{\frac{1}{k}} \quad (3)$$

$$\sigma = \left[\frac{1}{n} \sum_{i=1}^n (v_i - \bar{v})^2\right]^{\frac{1}{2}} \quad (4)$$

$$F(v) = 1 - \exp\left[-\left(\frac{v}{c}\right)^k\right] \quad (5)$$

Where $f(v)$ is the probability of observing wind speed v , k is the dimensionless Weibull shape parameter and c is the Weibull scale parameter (m/s). $F(v)$ is the cumulative distribution function, $\bar{v}$ is the mean wind speed (m/s) and σ is the standard deviation of the known wind speed data (m/s).

The most common expression for the variation of wind speed with hub height is the power law having the following form [8, 9]:

$$\frac{v_2}{v_1} = \left\{ \frac{h_2}{h_1} \right\}^m \quad (6)$$

Where v_2 and v_1 are the mean wind speeds (m/s) at heights h_2 and h_1 , respectively. The exponent m depends on surface roughness and atmospheric stability.

The long-term average wind power density can be expressed by Eq. 7 [10] based on the Weibull probability density function. $P_w(v) =$

$$\frac{1}{2} \rho A v^3 r \left(1 + \frac{3}{k}\right) \quad (7)$$

Where ρ is the air density (1.225 kg/m³), A is the swept area of the rotor blades (m²) and v is the wind speed (m/s) and $r(x)$ is the gamma function of (x) .

The power output of the wind turbine can be expressed by Eq.8[10].

$$P_{w,avg} = \int_0^{v_{\infty}} P_w(v) f(v) dv \quad (8)$$

The average energy output E_{out} for a period of time and the cost per kWh of wind-generated electricity can be calculated as Eq.9 and Eq.10[10].

$$E_{out} = P_{w,avg} \Delta t \quad (9)$$

Where Δt is the time period.

$$\text{Cost /kWh} = \frac{\text{Annual Cost/Annual Energy Output}}{\quad} \quad (10)$$

4. Discussion and Conclusion

The aim of this study is to assess the potential of wind powers in Meiktila, the Republic of Union of Myanmar. Long term wind speed data of Meiktila during the period of 2004-2013 have been statistically analyzed. Mean wind speed measured at 10m is determined as 1.46m/s for the studied period. Wind power density and wind power output of the turbine based on the Weibull parameters for 60m height were calculated. The propose region has low wind resource potential with wind speed of 2.78m/s while annual k and c values were 1.58 and 3.04m/s, and the power of 88.24w/m² or 773kWh/year at the height of 60m. Based on the result of yearly Weibull CDF, the operating possibilities is 75% of yearly wind speed at 60m height if 2m/s are used as the cut- in wind speed for wind turbines. Hence small scale wind turbines can be used to provide electricity in this area. The ODGV can increase the actual wind speed of the selected site to a large higher wind speed. At 60m height, the actual highest wind speed of the location was occurred at 6.99m/s in July and it increases to 12.83 m/s with the effect of ODGV while the actual lowest wind speed was reached to 2.69m/s from the original wind speed of 1.58m/s. Hence the ODGV can give the effective impact on the wind electric generation system and wind turbine size of 2kW with ODGV is the best scenario and can produce 7113kWh of annual energy output at 60m hub height. The result of this study can support information to wind research in Myanmar even though wind characteristics analysis indicates low potential of wind energy in the proposed area.

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