Proposed Wind Power System in Pyay District in Myanmar

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ABSTRACT
There are many aims for this paper such as to apply renewable energy for everyone in Myanmar, to supply electricity to rural areas not only offgrid but also ongrid and to construct wind turbines widely in coastal region starting from this research. The proposed wind power system is 450W in Pyay. This proposed system may be costed around US $1700. As Bago Mountainous Region is also situated in Pyay District, wind power can produce electricity. Moreover, 49 villages is no electricity among 567 villages. In this paper, five main components is expressed such as wind turbine, permagnet generator, rectifier, battery and inverter.

Keywords: offgrid, ongrid, costal region, permagnet generator, inverter

INTRODUCTION
Though the world’s first wind turbine used to generate electricity was built by a Dane, Poul la Cour, in 1891, Myanmar Renewable Energy Association (MREA) said it is planning to build wind power plants in 27 locations in Yangon and Ayeyarwady regions and Rakhine and Chin states in 2014. The electrification rate in Myanmar is one of the lowest in Asia, at 57% in 2016. The government aims to produce 2 percent of its electricity through renewable power in by 2020 and 9pc by 2030. The two parties signed a memorandum of agreement (MoA) for a wind turbine project in the Chaungtha area of Ayeyarwady Region, which will generate 30 megawatts of electricity, according to MOEP. In this paper, the proposed wind power system in Pyay is discussed. Though maximum supplied load of Pyay is now 72.06MW in 2018-19, it can be increased to 109.56MW in 2021-22. There are five main components that are wind turbine, permagnet generator, rectifier, battery and inverter in Figure 1.

A. Wind Turbine
There are two types of wind turbine that are horizontal axis and vertical axis wind turbine. In this research, horizontal axis, 5 blades wind turbine is proposed. Pyay is located in 18.8°N, 95.2°E Latitude and Longitude so annual wind speed of Pyay is 2.6 m/s. It is measured at 10 m from NASA Source. Maximum power for this research can be calculated as following Equation (1).

\[ P = \frac{1}{2} \times \rho \times A \times v^3 \]  

where

- \( P \) = the power in the wind (watts)
- \( \rho \) = the air density (kg/m³) (at 15°C and 1 atm, \( \rho = 1.225 \, \text{kg/m}^3 \))
- \( A \) = the cross-sectional area through which the wind passes (m²)
- \( v \) = windspeed normal to A (m/s), 1 m/s = 2.237 mph

The cut in wind speed is 3 m/s and maximum power 450W can be produced at wind speed 9m/s. The wind power curve can be seen in Figure 2. LE-450 Wind Turbine, ALEKO WG 450A, Surface Power Technologies HAWT SP 460W are some of this rating available in the market. In Pyay, there are many places where is very near costal region to construct wind turbine.

![Figure 1. Proposed Wind Power System](http://www.ijtsrd.com/papers/ijtsrd22782.pdf)
The required tower height can get from Equation (2).

\[ \frac{v}{v_0} = \left( \frac{H}{H_0} \right)^\alpha \]  

\( v \) = the windspeed at height \( H \),
\( v_0 \) = the windspeed at height \( H_0 \) (reference height of 10 m),
\( \alpha \) = the friction coefficient

This wind turbine can produce the maximum power at the height of tower 650 m.

B. Generator Consideration of Wind Power System

In comparison to induction generator, the use of synchronous generator is advantageous since they are self-excited machines and the pole pitch of the machine can be smaller. It is generally favored in newer smaller scale turbine designs, since it allows for higher efficiency and smaller wind turbine blade diameter. The primary advantage of permanent magnet synchronous generator (PMSG) is that they do not require any external excitation current. To calculate the speed of generator and gear ratio, Equations 3 and 4 are expressed.

\[ \text{rpm} = \frac{\text{TSR} \times 60 \times v}{\pi \times D} \]  

\( \text{rpm} \) = the rotor speed, revolutions per minute
\( D \) = the rotor diameter (m)
\( v \) = the wind speed (m/s) upwind of the turbine

\[ \text{Gear ratio} = \frac{\text{Generator rpm}}{\text{Rotor rpm}} \]  

The speed of generator is 600 rpm because of tip speed ratio is 3.4 and the result of gear ratio is 1.25.

C. LM 317 Voltage Regulator

The output of generator is the input of voltage regulator and the output of voltage regulator goes to battery. There is an input, an output, and an adjustment terminal in LM 317. The external fixed resistor \( R_1 \) and the external variable resistor \( R_2 \) provide the output voltage adjustment. \( V_{out} \) can be varied from 1.2 V to 37 V depending on the resistor values. The LM317 can provide over 1.5 A of output current to a load. The LM 317 voltage regulator is shown in Figure 3. The output voltage can be get by solving Equation (5).

\[ V_{out} = 1.25 \left( \frac{R_2}{R_1} \right) + I_{ADJ} R_2 \]  

The output voltage of LM 317 is 12 V by substituting \( R_1 = 1k\Omega \) and \( R_2 = 10\, k\Omega \).

D. Battery

The overall cost of the lead-acid battery is low compared to Nickel-cadmium (NiCd), Nickel-metal hydride (NiMH) and Lithium-ion (Li-ion) batteries. Because of its least cost per Wh delivered over the life, the lead-acid battery has been the workhorse of the industry. Battery capacity, voltage and current of charging and discharging state are calculated as follows.

Charging voltage = charging voltage per cell x number of cell = 2.25 x 6 = 13.5V (fully charged)

Discharging Voltage = discharging voltage per cell x number of cell = 1.75 x 6 = 10.5V (fully discharged)

Battery capacity = Whr/voltage = 400/12 = 30 Ah

Choose two parallel 12V 14Ah lead-acid battery.

Charge or discharge current, \( I = \text{Ah/hr} = 28\text{Ah}/7\text{h} = 4\text{A} \)

E. Inverter

An inverter is an electronic device or circuitry that changes direct current (DC) to alternating current (AC). The square wave inverter is one of the simplest waveforms among others such as pure sine wave inverter, modified sine wave inverter and is best suited to low-sensitivity applications such as lighting and heating. Square wave" is the term used when the electricity has a constant force, such as it has with DC but switches direction more or less instantly at the same kind of frequency as the normal grid supply (at 50 times per second). Component of the inverter circuit

1. Transistor (2N 3636 & 3055) 4nos
2. Capacitor 2nos
3. Resistor 2nos
4. Center tapped Transformer (12-12/230V) 1nos

The following Figure 4 is used to change battery 12 V DC to 230 V AC load. In this Figure, Q1 and Q2 are used for oscillation. Q3 and Q4 are used to get the positive polarity and negative polarity. \( R_1 \) and \( R_2 \) are used for basing the Q1 and Q2 and \( R_3 \) and \( R_4 \) are used for basing the Q3 and Q4.

![Figure 4. 12 V DC to 230 V AC Inverter Circuit](image-url)
Result
The proposed wind power system in Pyay is 450 W with cut in 3m/s and rated wind speed 9 m/s. For this wind turbine, the number of blade is 5 and tower height is required to be 650m. Due to wind, generator can produce electricity with maximum power 450W. The primary advantage of permanent magnet synchronous generator (PMSG) is that they do not require any external excitation current. LM 317 voltage regulator is applied to get output voltage to be stable. Two numbers of 12 V, 14 Ah battery is needed to back up supply while no wind blows. AC load can connect to 12 V – 230 V, 450W inverter.

Table 1. Main Components and Specifications

| Main Components                  | Specification          |
|----------------------------------|------------------------|
| Wind Speed                       | 3 m/s ~ 9 m/s          |
| No: of Blade                     | 5                      |
| Height of Wind Turbine           | 650 m                  |
| Generator                        | 450W, 12V              |
| Voltage Regulator Circuit        | LM 317                 |
| Battery                          | 12 V, 14 Ah (2 No:)    |
| Inverter                         | 450W, 12V-230 V        |

In Pyay, there are many mountains so wind turbine can be constructed. From NASA source, the annual wind speed is about 2.6 m/s. In this paper, 450W wind turbine is discussed and the rated wind speed is 9 m/s. As wind is not steady, the output is not constant. LM 317 voltage regulator can regulate the output voltage. The following Figure 5 is simulation result of LM 317. The output voltage is about 10.2 V when the input is 12 V. The resistors R1 and R2 are calculated.

Recommendations
Our research group needs to have connection to Government Society for practical works. The simulation results and experience results should compare and note to give conclusion. Another software as MATLAB can be checked for this proposed system. Moreover, battery charging circuit that can protect over charging and under charging can be further added in the original circuit. Hybrid with solar can be connected for this system. If so, more power beyond 450W can be drawn.

Conclusion
Though the electrification rate in Myanmar is one of the lowest in Asia, at 57% in 2016, Myanmar Government aims to produce 2 percent of its electricity through renewable power in by 2020 and 9 percent by 2030. In this paper, 450 W wind power system in Pyay is discussed. The simulation results of voltage regulator and inverter are expressed. Though maximum supplied load of Pyay is now 72.06MW in 2018-19, it can be increased to 109.56MW in 2021-22. Renewable energy using is one of simple solutions. Rules and regulations should be limited in time before all projects that do not begin. Starting only one wind turbine should continue big wind farm for tourists’ attraction in ancient town Pyay.

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