Abstract— Most countries are trying to produce electricity from many natural resources. Wind power system is one type of renewable energy and small-wind power system is widely used in home-use system. Therefore it can supply the nation’s energy needs from one point. Small wind power system can be constructed with materials which can easily get within local market. This paper elaborates on the construction and testing of small-scale wind power system. The production of an investigational exploration of the horizontal axis wind turbine is described in this paper. It also describes performance testing and results of wind generator model. This system is especially intended for home lighting system which directly uses DC power. And this system also intend for rural people to use easily and inexpensively. The site of this small wind turbine is selected in remote places so far from the national grids.

Keywords—blocking diode, calibrated fixed resistor, lathe machine, multimeter, permanent magnet dc motor.

I. INTRODUCTION

This paper is about construction and performance testing small wind power system aimed for rural electrification.

A wind turbine or home wind generator changes the energy in the wind called kinetic energy into mechanical energy by way of rotating the wind generator blades with the wind action flowing across the surface of the wind blades. Small wind turbines offer a promising alternative for many remote electrical uses where there is a good wind resource. In this project, PVC pipe is used as wind turbine blades. There are three blades and length of each blade is put up 3ft (Fig. 6). 24V permanent magnet dc motor (Fig. 9) is used as wind generator and its rated power has 212 watt and it is used to get started generating electricity from the wind. The blades of wind turbine are made from 8 inch PVC pipe because it is easy to find, relatively cheap, easy to work with, and performance is more than acceptable for a small basic wind turbine generator. The dc power output from DC motor is directly fed to the load. 25A blocking diode is used to flow current in one direction and to break the current from being overcharge. Lead-acid battery (12V, 70Ah) is used to store power generated from wind generator. For home lighting system, 8 watt dc lamps are used in order to save energy consumption and to be long life.

II. CONSTRUCTION OF SMALL-SCALE WIND POWER SYSTEM

This section gives details of how 212 watt household wind generator was constructed for charging 12 volt battery using propeller-type rotor. This can be seen pictorially below (Fig.13). This small wind turbine is constructed to generate 171W of the household energy by the wind resource available. Fig. 1 shows block diagram of
small wind power system.

\[
\begin{align*}
&\text{Wind} \\
&\downarrow \\
&\text{Rotor} \\
&\downarrow \\
&\text{DC generator} \\
&\downarrow \\
&\text{Electricity} \\
&\downarrow \\
&\text{Battery} \\
&\downarrow \\
&\text{Load}
\end{align*}
\]

**Fig. 1 System with Required Elements**

The average wind speed is about 5m/s and approximated rated wind speed is between 8.05m/s to 14.5m/s.

**Fig. 2 Connection Diagram of Small-Scale Wind Power System**

In this home electric system, wind turbine generator (171W, 24V), a blocking diode 25A, a number of 70Ah, 12 V deep cycle battery and eleven of 8W DC lamps are required to meet a total daily electrical of 312 Wh/day as shown in Fig. 2.

**A. Rotor Construction**

The rotor blades are made from 8 inch PVC pipe. We want to cut the PVC pipe into a 3 ft length and thickness of this pipe must let at least about 0.25 inch.

**Fig. 3 Quarter of PVC Pipe**

Then cut the pipe into quarters. Fig. 3 shows quarter of PVC pipe. After cutting the pipe into quarters, the blades are needed to shape. Fig. 4 shows the measurements to shape for each blade. The angle of each blade is 23º and Fig. 5 shows the diagram of blades after shaping in detail.

**Fig. 4 Schematic Diagram of Blade**

**Fig. 5 PVC Blades**

**B. Construction of the Hub**

The hub connects the blades to the motor. The hub must be fit on the permanent magnet dc motor shaft so that when the hub...
turns the motor will turn. The hole is put up in the centre of the shaft on the motor. In order to get good torque, the hub is made of iron sheet that is about \( \frac{1}{4} \) of an inch thick. The diameter of the hub is put up 10 inch wide. Fig. 7 shows the construction of the hub.

![Fig. 7 Hub](image)

### C. Balance of the Blades and Hub

After constructing the blades and hub, we will want to attach the blades to the hub, and then the hub to the motor shaft. Flat steel bars, approximately a foot long and 2" wide work well to attach the blades to the hub. These bars also add a lot of strength to the blades which will be needed for high winds. The distances of each blade are 120° on the hub. Fig 8 shows the diagram for balance of the blades and hub.

![Fig. 8 Balance of the Blades and Hub](image)

### D. The Generator

A dc motor (fig. 9) is used as the generator for this wind turbine. The dc motor is permanent magnet type and it has four poles. It is 13 amp motor and starts to charge at 28 rpm. If motor runs until 1500 rpm, full power will be generated. As the motor spin in back direction, blocking diode is set up in phase cable and it is used to protect reverse current’s flowing from battery to dc generator in motor action.

The specifications of permanent magnet dc motor are:

- Generator output = 312 W
- Terminal voltage = 24 V
- Full load current = 13 A
- Frequency = 50 Hz
- Speed = 1500 r.p.m
- Pole = 4

![Fig. 9 Permanent Magnet DC Motor](image)

### E. Tower Construction

In this project, the section of the tower is divided into two main parts: tower insert and tower. In order to spin easily and smoothly the motor in wind direction, tower insert is constructed. The height and thickness of the tower are 7 ft and 0.25". The base of the tower is constructed with iron sheet that is 1.5" in length and 0.5" in thickness to resist the weights of the motor, blades, hub, tower insert and tail. Fig. 10 shows installation of tower constructed in step-by-step.

![Fig. 10 Tower Installation](image)
F. Tail Construction

The tailpiece is important for maintaining balance ensuring that the blades maintain maximum efficiency.

In this project, the material used is iron pipe and the thickness of the iron pipe is 0.25 ft. The length of the tail stalk is put up 3 ft because a tail length of between 3 ft and 4 ft works the best from tests and length of the blade is 3 ft. Simply cut out a tail fin from the iron sheet and attach it to the back of the tail stalk assembly with hex bolts, nylon washers and SSTL washers. We can use any shape of tail fin to catch the wind enough. When wind speed is so much, blades can be damaged. To protect from damage, the ring of spring is attached to the tail stalk. Figure 11 shows the working steps of the tail.

III. WIND GENERATOR PERFORMANCE TESTING

In this system, permanent magnet dc motor is used as wind turbine generator. This motor is tested with lathe machines by changing different various speeds. The data of voltage on no-load and load test, current on load test, frequency and generated power on load test are measured by clamp meter, multimeter, calibrated fixed resistor and lead-acid battery. Fig. 12 shows performance testing of wind generator.

IV. SMALL-SCALE WIND TURBINE TESTING

I have tested small wind turbine on the roof of my university’s main building. The site location is Mandalay Division that is between latitude 22° 43' 12" N and longitude 95° 57' 24" E. The average wind speed is about 3 m/s to 8 m/s.
The voltage and current is tested with multimeter. The power generated from wind turbine is directly fed to lead-acid 12V battery. As the load test, 8W, 8V DC lamp is used for home lighting. When testing load test, calibrated fixed resistors are also used. 1x7029, 300/500V wire size is selected to resist charging of the battery. 20A diode is set up to the phase of the cable. Fig. 14 shows testing of small wind turbine.

Table 1 shows the results at no-load and Fig. 15 shows the result curve at no-load. According to these results, the changes of voltages at variable speeds are known.

<table>
<thead>
<tr>
<th>Load</th>
<th>Speed (rpm)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-load</td>
<td>28</td>
<td>0.4</td>
</tr>
<tr>
<td>No-load</td>
<td>40</td>
<td>0.6</td>
</tr>
<tr>
<td>No-load</td>
<td>45</td>
<td>0.7</td>
</tr>
<tr>
<td>No-load</td>
<td>90</td>
<td>1.3</td>
</tr>
<tr>
<td>No-load</td>
<td>112</td>
<td>1.6</td>
</tr>
<tr>
<td>No-load</td>
<td>160</td>
<td>2.3</td>
</tr>
<tr>
<td>No-load</td>
<td>180</td>
<td>2.7</td>
</tr>
<tr>
<td>No-load</td>
<td>224</td>
<td>3.2</td>
</tr>
<tr>
<td>No-load</td>
<td>250</td>
<td>3.8</td>
</tr>
<tr>
<td>No-load</td>
<td>315</td>
<td>4.5</td>
</tr>
<tr>
<td>No-load</td>
<td>355</td>
<td>5.2</td>
</tr>
<tr>
<td>No-load</td>
<td>450</td>
<td>6.5</td>
</tr>
<tr>
<td>No-load</td>
<td>500</td>
<td>7.5</td>
</tr>
<tr>
<td>No-load</td>
<td>630</td>
<td>9.1</td>
</tr>
<tr>
<td>No-load</td>
<td>710</td>
<td>10.6</td>
</tr>
</tbody>
</table>

Table 2 shows the results at on-load test. Fig. 16 and 17 show the result curve on load test at speed of 500 rpm and 1000 rpm.

<table>
<thead>
<tr>
<th>Speed (rpm)</th>
<th>Load (On-load)</th>
<th>Voltage (V)</th>
<th>Current (A)</th>
<th>Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>3 Ω</td>
<td>7.25</td>
<td>2.417</td>
<td>17.523</td>
</tr>
<tr>
<td>5</td>
<td>7.2</td>
<td>1.44</td>
<td>10.368</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>7</td>
<td>0.7</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>14.7</td>
<td>2.94</td>
<td>43.218</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>12.8</td>
<td>0.427</td>
<td>5.466</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>3 Ω</td>
<td>14.9</td>
<td>4.967</td>
<td>74.008</td>
</tr>
<tr>
<td>5</td>
<td>14.7</td>
<td>2.94</td>
<td>43.218</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>14.5</td>
<td>1.45</td>
<td>21.025</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>13.5</td>
<td>0.675</td>
<td>9.113</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>12.8</td>
<td>0.427</td>
<td>5.466</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 14 Small Wind Turbine Testing

Fig. 15 Results of DC Voltage on No-Load Test

Fig. 16 Results On-Load Test at Speed of 500 rpm
Lighting system depends on resistance load. In dc system, resistance is directly proportional to the load current. In order to test changes of the load current, calibrated resistor is used. Seeing this result, the values load voltages do not change but load currents clearly change at rated speed.

- This small wind turbine does not need many areas to construct it.
- There is no need many labours to install it.
- The equipments needed for this turbine can be easily bought within local market.
- The equipments of small turbine can be tested and made preparation conveniently.
- It has less maintenance.
- There is no environmental damages and noise by constructing this small wind turbine.

Finally, I have got many technical knowledge and general knowledge by constructing this small wind turbine.

V. CONCLUSION

The construction of home wind electric system is particularly appropriate for use not only in rural areas but also in urban areas. They are quite easy to construct, operate and maintain by users with a little technical experience. This system is mostly suitable remote areas which are far from national grids. In this area, wind resources can get sufficiently than urban areas because there is no defence. The performance of home electric system depends upon DC generator. The life of DC lamps is long and the consumption of watt power is less than fluorescents.

This small wind turbine can be installed not only on the roof of the building but also on the ground. If it gets sufficient starting wind speed, the blades of the turbine will spin continuously.

The purpose of this project is to get rural electrification and to use cheaply for the rural people. The advantages of this project are:

REFERENCES