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Design and Simulation of 900w Model Microgrid Wind Turbine to Improve Domestic Energy Supply

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ABSTRACT
In Nigeria, access to electricity is a critical issue. The present study has analysed the condition under which micro grid turbine MGT electrification would become technically, socially and economically viable. This research topic on power improvement system (micro grid wind turbine) is modeled to investigate into providing a free standing tower design accommodating up and down wind as a design solution to inadequate energy supply through renewable energy source like wind in Nigeria. It is a device that converts kinetic energy from the wind into mechanical energy when wind strikes the blade; the mechanical energy is then converted into electrical energy to produce electricity. The design houses interconnected electronics system that enhances the availability of power and power quality with storage management. This model is the conventional horizontal axis turbine having three basic components namely; the blade for intercepting wind energy to low speed rotational energy, the generator component which is the D.C generator, structural support which is the tower, battery with charger to stabilize battery level and back-up in absence of wind. An inverter is used for A.C stable voltage conversion. The parameter of blade model was simulated with the measured site wind speed of Oyedepo (2012) using the spread sheet of 3 key software power plants. The result shows that at 10.7mls (24mph) speed, 1062W at 15m tower height was realized. This confirms the design for this project to improve domestic energy supply. This will offer employment and financial benefit to producers and its users.

KEYWORDS: wind, turbine, rotor, wind speed, energy

1. INTRODUCTION
The word “energy” incidentally equates with the Greek word for “challenge”. There is much to learn in thinking of our Nigerian National energy problem (inadequacy and poor management in brief) in that light. Further, it is important for us to think of energy in terms of a gift of life. Climate change as presently discussed internationally presents one of humanity’s greatest challenges. To counteract global warming and guarantee economic growth and prosperity, energy must be generated and utilized in an environmental and climate friendly way.
Compared to fossil fuel, renewable energies have the advantages that they are practically inexhaustible and abundant in nature. They are also very inexpensive after the initial construction since exploring and harnessing of wind, the fuel is free.
In Nigeria as in many developing countries, it has been enormous task providing energy to rural and urban areas. It is equally enormous task formulating policies towards increasing the efficiency of the power sector. Some state and federal government have found it difficult focusing on grid expansion and distribution of petroleum products used for power generation. Installation of new independent power plants all which still do not meet the energy requirements of the Nigerian growing population. With ever increasing demand for electrical power, however, the pressure on the infrastructure for the constant supply of conventional energy resources used for power generation will continue to increase. Again, conventional energy is deflectable with extinction risk as we have witnessed with countries that run nuclear energy plants with its indentified numerous risks and problems to the environment. Bad still for countries with inadequate infrastructures to make life more meaningful.
In order to enhance the energy security of the country and establish a sustainable energy supply system, it is necessary to promote the policy of diversifying the energy supply so as to include alternatives or renewable resource and technologies into the nation’s energy supply mix. Nigeria is endowed with abundant renewable energy source like solar, wind, biomass, hydro etc. Harnessing these will not only lead to a decentralized use and implementation and quality management. It will make sustainable socio-economic development possible through self-reliance. Also the use of local natural resources a cost effective way to diversify our energy portfolio and avoid the price shocks common with coal, oil fossil fuel, natural gas and most disadvantageously pay PHCN for energy not consumed with its constant power interruptions. Micro wind turbine is good for those concerned with reducing their green house gas foot prints and mitigates climate disruption or for home owners concerned with rapidly rising utility bills or it’s inadequacy. A home wind power installation can immediately lower monthly electricity costs as an improvement.
To be clear, small wind power turbine (MGT) are electric generators that use wind to produce 300-1000w clean emission free power for domestic energy use for homes and businesses as to improve quality of life, Kevin (2010). It is time we readdress energy policies in Nigeria.

1.0 OBJECTIVES OF THE RESEARCH PROJECT

This dissertation was carried out to achieve an independent micro size wind and battery hybrid energy supply system considering our socio, economic and environmental condition

1.1 NACELL

Nacell is the enclosure here (aluminum foil) carrying the hub, the shafts and the permanent magnet generator PMG. The effective volume is in such that it accommodates these listed above (hub, shaft and generator) and water-proofed to prevent rain damage. It is connected to the vane effectively spaced to turn the nacell and blade which in turn is set on the base of the tower hoisted by a bearing to help prevent damage to blade at turbulent wind. Also, to the nacell is connected a seeker/vane. The seeker is sized in such a way to effectively turn the nacell and the blades upwind.
The measured combined weight of the nacell, its components, the blades and the hub for the 900W micro wind turbine are as;

Mass of disc - 0.38kg
Mass of blade - 0.7 kg
Mass of generator - 0.6kg
Therefore total mass moved by the secker/vane
= 0.38 + 0.7 (kg) = 1.38 kg ie
Acceleration due to gravity G = 9.81m/s^2
Weight moved by disc (seeker) = 1.38kg x 9.81m/s^2 = 13.5N
Effective area of seeker vane = 0.6m^2

The effective power extracted by seeker with a given surface area from wind at a particular velocity is determined using Phiren (2010) expression as;

$$P = 0.5 \times A \times \rho \times V^3 \quad (1.0)$$

Where power P = the rate at which energy passes through an area per unit of time by the seeker vane.
A = area intercepting the wind
ρ = air density (1.225)
V = wind speed (1.0m/s)

The disc will move the rotor blade of a velocity of

$$\frac{\text{power extracted by seeker}}{\text{weight moved by disc}} \quad \frac{13.9}{13.5} = 1.0\text{m/s} \quad = (1.1)$$

This is a reasonable speed of rotation for focusing blade upwind. At above this on the seeker/vane will focuses the blade down ward. With an effective area of 0.6m^2
Hence from; P = 0.5 x A x P x V^3
= 0.5 x 0.6 x 1225 x 3.36^3 = 13.9w

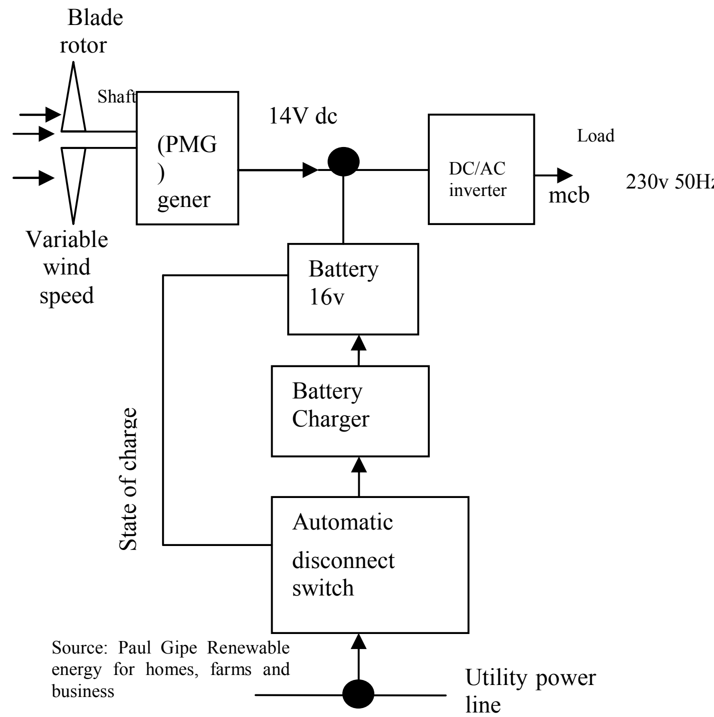


Fig 1 : Block diagram of micro grid wind turbine

1.2 LOAD ANALYSIS

2 fluorescent lights	30W
4 power saver bulbs	240W
1 laptop (computer system)	65W
1 Electric fan (240 vac)	80W
Sets of home electronics	85W
1 micro wave	15W
Total	**580W**

A power source of 900w is considered in this case accommodating future needs.

1.3 ENERGY CONSUMPTION BY LOADS PER DAY

2 Fluoresent lights 2 x 15w for 8 hours /day	= 240wh
4 Power saver bulbs 4 x 25w for 8 hours/day	= 800wh/day
1 Laptop (computer system) 65w for 4 hour/day	= 260wh/day
1 Electric fan 80w for 5 hours /day	= 400wh/day
1 Micro wave oven 15w for 1 hour/day	= 15wh/day
Set of Home electronics 150w for 4 hour/day	= 600 wh/day
Total load = 2315wh	= 2.315kh/day

Allowing inverter efficiency of 90% $\frac{2.315}{0.90}$ =2.57kwh/day

A wind blade that can intercept 2.57kwh/day energy is required.

1.4 METHOD OF USING WIND TO GENERATE ELECTRICITY

A wind turbine is a device that converts kinetic energy from the wind into mechanical energy. When wind strikes the blade, the

mechanical energy is then converted into electrical energy to produce electricity.
In simple term, the mode of operation of wind turbine is opposite to that of an electric fan. Instead of using electricity to produce wind, wind turbine uses wind to generate electricity. The wind strikes the blade and turns it which in turn spins a shaft connected to a generator thereby generating electricity. The wind turbine type employed is a horizontal axis design (HAWT) which has the main rotor shaft and the electrical generator mounted at the top of a tower. The design is such that it can point into the wind and at increased wind turbulence ie high velocity made to swing away from the wind. Its effects are analysed in subsequent chapter.
The rotor blade maximizes the wind velocity as a result of impact at the tip and roots of the blade producing drag and lift forces that rotates the blade. This inturn rotates to drive an electric generator producing 14 volts dc that is converted to an ac by a 230v inverter. A battery is connected as a back-up should wind which is a function of time fail to rotate the blade at any particular time. Also battery charger is employed to maintain the battery level and protect it from over charge.

1.5 DESCRIPTION OF CIRCUIT

This is a battery based system which keeps the batteries properly fed and safe for a long term. The controller governs the charge produced by the wind turbine. It blocks reverse current and prevent battery over charge. This is because overcharged batteries will need more maintenance and wear out quickly. It diverts excess electricity due to high wind by provision of charge regulation and array output optimization, automatic battery equalization in the design.
This circuit can primarily be used for charging 16V battery pack. It has an in built automatic current regulator that regulates charging current to some what 4 amperes. When the charging current reaches 4A, the voltage across resistor R1 becomes 0.7V and switches the transistor Q_1 On. The transistor Q_2 which is now in ON state will short the base of Q3 to ground and inhibits the biasing of Q_4 through which the charging is done. That is how the current regulation is achieved. When charging low voltage battery packs, the excess voltage will be dropped across Q_4. Heat sink is used with transistor Q_4 and is assembled on a vero board.
T_1 is a 230V primary, 16 volt secondary, 4A step down transformer. Bridge D1 is made using IN5400 diodes and F1 is a 500mA fuse with switch.

1.6 BATTERY BACK UP

16v- volts battery is used to store energy and as it serves the energy (mix) back up when it is not windy. Battery connection that is capable of supplying the total power usage without being discharged more than 70% was choosen. Ability back-up size of around 3 to 4 day's capacity. This allows for days with low sunlight / wind and reduces the daily depth of discharge resulting in longer battery life.
With 3 days storage capacity, the battery sizing would be as follows:

Ah (amp/hours) required for three days

$$= (900\text{wh} \times {}^{3}/_{24}\ \text{V}) / 0.7 \times 1.1 = 146.1\ \text{Ah}$$

Ah required per day = 146.1/3 = 48.7Ah
Ah for 8 hours backup would be 48.7 x $({}^{8}/_{24})$ = 16.2
= 16.2 Ah

Note; the 1.1 used in the above analysis (calculation) is because generally batteries are only about 90% efficient.

1.7 INVERTER (240 AC)

The inverter converts the direct current DC to alternating current Ac which is used by domestic appliance or basic appliance. For the system to be sized correctly the power rating of each appliance that would possibly draw power from it was noted, the load estimate was for a 2 – bedroom apartment (facilities) or basic office needs, bearing in mind the scope of this design and objectives, the average residential or small office consumption of energy in Nigeria. From economic point of view is 3,500 Kwh, with assumption. "That energy efficiency is not the number of facilities (load) that are simultaneously used at a time.

2.0 LITERATURE REVIEW

Wind is simply air in motion caused by uneven heating of the earth's surface by the sun (Gipe 2004). The earth absorbs and releases the heat at different rates because it is made of different types of materials. This produces cold and warm air. The rising cool air that moves as wind is caused by differences in pressure where these differences develop, air is accelerated from higher to lower pressure. Wind has been converted into useful forms of energy for many years.
In 17^{th} century BC, Babylonia emperor Hammurabi recorded plans to use wind power for ambitious irrigation projects (Baker 1985). Over time, wind began to be converted into mechanical energy through wind mills. First, windmills were made out of wooden frames mounted on vertical shaft taking the shape of what is now called vertical axis wind turbine (Gipe 2004).
Professor James Blyth of Anderson's College now University of Strathelyde in glassgow Scotland in 1887 built the world's first wind turbine that harnessed the power of wind to actually generate electricity (Gipe 2004). During the same period, American invertors and engineer Charles F. Brush built a similar massive turbine (Gipe 2004). By 1908 Danish Scientist, Poul Law cour also built a wind turbine (David 1987). This technology has really caught on in Denmark as a global leader in the field. At least there is about 72 wind turbine electricity producing energy system ranging in output from 5kw to 25 kw mounted on 23.7m tower (Samedley, 2010).
While from 1920-1940's saw a golden age of wind turbine in America. Designers included Jacob's wind Wincharger, Miller Airite aeroelectric wind turbine, Paris Dunn wind turbine and Abadom et al using hand cut modern blade used car alternator. The first utility grid connected wind turbine to operate in the UK was built by John Brown in 1951 in Okeny Island.
A complete wind system include more than the wind turbine. It includes a tower as well as the conductors or cables to carry the electricity from the wind turbine to the home (Kevin, 2012).
The design by Abadom et al at Federal University of Technology Owerri (FUTO) could produce a low power out put of 200W with a problem of instability that caused the damage on the blade as a result of wind turbulence. The design is a 5 blade turbine using hard metal pan as blade. The material used for blade design could not match properly the momentum balance of the blade used. Also the thickness of the metal pan could not allow proper twisting (pitching) that will enable formulation of the root and tip angles for the lift and drag forces. Also, the height of tower was inadequate to harvest more power as regards power law (Gipe 2010). It is known that wind speed and hence power varies with height above the ground. It is known that wind moving across the earth's surface encounters friction or obstruction on its flow over

and around mountains, hills, trees and buildings. These effects decrease with increasing height above the earth's surface. At height above this obstructions, turbulence decreases and wind increases (Gipe 2010). The benefits of using a tall tower are often greater to generate more power. From start up to rated wind speed, blade rpm increases with increasing wind speed (Gipe 2010). Similarly, voltage and frequency increases as wind speed increases. In strong winds, power is liberally available. The best indicator of how much energy a wind turbine will capture is the area swept by the rotar blade or its diameter (Gipe 2010). To improve on the power harvested by Abadom and et al design, area swept by rotor blade, and tower height were considered based on wind climate of Nigeria, and objective of this design. Conventional horizontal wind turbines are not omini directional. As the wind direction changes, horizontal wind machine must change direction with it. This is because they have means of orienting the blade with respect to the wind direction ie (provision of a bearing at the base of the nancell). Modern Danish 3 bladed horizontal axis turbine has vain tail, which keeps the turbine pointed to the wind regardless of changes in wind direction. This will not be suitable to wind climate of Nigeria because of differences in root and tip angles of the turbine. Also the design of Jacob Wind charger (1981) which is for a multi-mega watt which is massive in size. Since this research objectives in essence is to design a renewable energy system that will be comparable to 900KVA generators used by Nigerians as a strategic plan regarding independent rural electrification.

This present study has employed 10 blades and PVC materials as blade to formulate close root and tip angles that will produce a stable (smooth) rotation of blade at Nigerian wind climate as confirmed in Oyedepo (2012). Paris Dunn wind turbines are broad and massive in nature and produce higher power, but could not fit into the rural independent housing arrangement in Nigeria. Following the innovation the present study could utilize the mast provided by the local GSM operators as towers to generate reasonable electricity. This can equally serve as a stand alone energy plant for individuals.

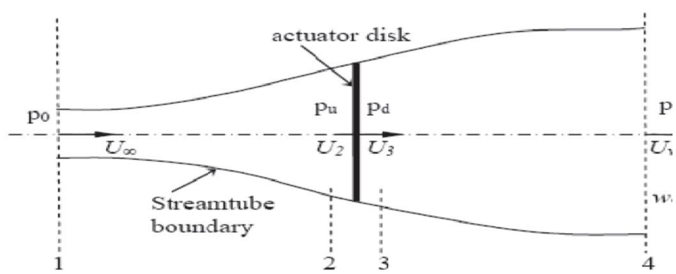
3.0 Methodology

Wind turbine power production depends on the interaction between rotor and the wind. Power output and loads are determined by aerodynamic forces generated by the wind

For this HAWTS wind turbine design, aerodynamic model is employed in this study

Aerodynamic Modelling of an Ideal Wind Turbine

- Looking at the aerodynamic behavior of wind turbine starting without any specific turbine design just by considering the energy extraction process.
- The turbine is replaced by a circular disc through which the airstream flows with a velocity U_∞ and across which there is a pressure drop from P_u to P_d as shown in fig 3.1.



Source: (Emarah Kulunk,2010)

- The analysis of the actuator disc assumes a control volume in which the boundaries are the surface walls of a stream tube and two cross-sections.
- In order to analyze this control volume, four stations need be considered

1. Free-stream region.
2. Just before the blades
3. Just after the blades
4. Far wake region

- The mass flow rate remains the same throughout the flow. So, continuity equation along the stream, tube can be written using (Emarah kulunk 2010) as:

$$pA_\infty U_\infty = pA_dU_d = pA_wU_w \quad (1)$$

- Assuming the continuity of velocity through the disk gives

$$U_2 = U_3 = U_R \quad (2)$$

- For steady state flow, the mass flow rate can be obtained using;

$$\dot{m} = pAU_R \quad (3)$$

- Applying the conservation of linear momentum equation on both sides of the actuator disc given

$$T = \dot{m}\ (U_\infty - U_w) \quad (4)$$

- Since the flow is frictionless and there is no work or energy transfer is done, Bernoulli equation can be applied on both sides of the rotor. If we apply energy conservation using Bernoulli equation between section 1 and 2, then 3 and 4. Equation 5 and equation 6 can be obtained respectively.

$$P_d + \tfrac{1}{2}\ P_U^2 = P_o + \tfrac{1}{2}\ P_U^2 \quad (5)$$

$$P_o + \tfrac{1}{2}\ P_U^2 = P_u + \tfrac{1}{2}\ P_U^2{}_R \quad (6)$$

- Combining equation 5 and 6 gives the pressure decrease P^1 as:

$$P^1 = \tfrac{1}{2}P(U_\infty - U_w) \quad (7)$$

- Also the thrust on the actuator disk rotor can be expressed as sum of the forces on each side

$$T = A\ P^1 \quad (8)$$

$$\text{Where } P^1 = (P_u - P_d) \quad (9)$$

- Substituting equation 7 into equation 8 gives the thrust on the disc in more explicit form

$$T = \tfrac{1}{2}\ AP\ (U^2 - U^2) \quad (10)$$

Combining equation 3, 4 and 10, the velocity through the disk can be obtained as

$$U_R = \frac{(U_\infty - U_w)}{2} \quad (11)$$

Defining the axial induction factor a as;

$$a = \frac{(U_\infty - U_R)}{U_\infty} \quad (12)$$

Gives equation 13 and 14 ; thus

$$U_R = U_\infty (1 - a) \quad (13)$$

$$U_w = U_\infty (1 - 2a) \quad (14)$$

To find the power out put of the rotor, we use

$$P = TU_R \quad (15)$$

By substituting equation 10 into 15 gives the power output base on the momentum balance on both side of the actuator disc rotor in more explicit form

$$P = ½ P (U^2∞ - U^2) U_R \quad (16)$$

Also substituting equation 13 and 14 into equation 15 gives

$$P = 2 pAaU^3 (1- a)^2 \quad (17)$$

Finally the performance parameters of a HAWT rotor (power coefficient Cp, thrust coefficient C_T, and the tip – speed ratio ʎ) can be expressed in dimensionless form which is given in equation 18, 19 and 20 respectively

$$C_p = \frac{2P}{P_{U∞}{}^3 \pi R^2} \quad (18)$$

$$C_T = \frac{2T}{P_U{}^3 \pi R^2} \quad (19)$$

$$ʎ = \frac{R\Omega}{U ∞} \quad (20)$$

3.1 Accessing Blade Design Parameters

- To obtain these parameters the minimum wind speed and when rotation speed exceeds its minimum value for power production cut in wind speed Ucut (V) and stationary wind speed are identical
- Using the meteorological service report for the wind climate shows C_D drag coefficient of airfoil and C_L blade chord length element data at low Re is considered for chosen airfoil SG6043
- Airfoil lift and Drag
- The speed of the low speed shaft, the chord and lift coefficient of blade tip speed ratio TSR can be calculated using Phiren kumar (2010) expression as in equation 21,22 and 23

$$\text{Tip speed ratio TSR} = \frac{\text{Tip speed of blade}}{\text{Wind speed @ cut in}} = \frac{27.1}{5.42} = 5 \quad (21)$$

$$\text{RPM (rotor speed resolution)} = \frac{\text{Wind speed x TSR x 60}}{\text{Circumference}}$$

$$= 3.52 \text{ x TSR x } 60 \quad (22)$$

$$= \frac{5.42 \text{ X } 5 \text{ X } 60}{3.141 \text{ X } 2}$$

= 335 rpm (the speed of the low-speed shaft)

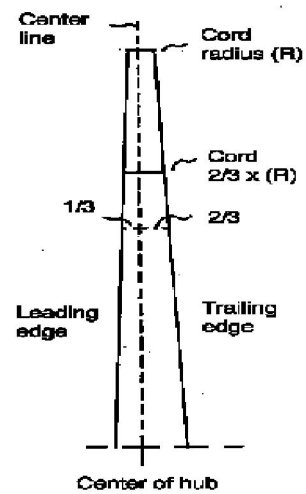
Since the gear ratio is 1:5, the high speed shaft will have a speed of 5 times the speed of the low speed shaft. This implies;
335 x 5 = 1675rpm

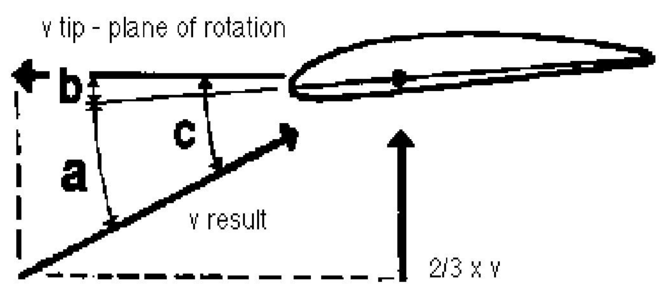
This speed is sufficient to drive the generator of 1500rpm.

$$\text{Blade chord m} = \frac{5.6 \text{ x } R^2}{\text{I x } C_L \text{ x r x TSR x TSR}} \quad (23)$$

Where R = radius at tip = 2.68m
r = radius at point of computation (measured) 0.82m
I = number of blades (10)
From equation (23)

$$\text{Lift coefficient } C_L = \frac{7.50}{90.048} = 1.2$$





$$\text{Cot C} = \frac{(1.5 \text{ X } 0.82 \text{ X } 7)}{0.82} = 10.5$$

:. Cot 10.5 = 5.6 degrees

Calculating different values of r with small intervals at the outer third of the blade.
B = c-a where a = angle of attack
Now from fig. 4.1a
Blade chord at 2/3 C_R = 2/3 x 0.82=0.55m
Blade Chord at 1/3 x r = 1/3 x 0.82 = 0.27m
Using SG6043 profile gives calculated/measured value of chord, twist and radius as

Table 1: SG6043 profile gives calculated/measured value of chord, twist and radius

Radius m	1.30	1.60	1.90	2.20	2.5	2.8
Chord mm	210	190	170	145	121	96
Twist mm	20	12	10	8	6	3.5

3.4 Algorithm Using the Spread Sheet of 3 Key Software Power Plant Simulators

The 3 key power plant simulator is used to match the overall system performance and choice of parameters for components.

Input R: TSR; I and C_L ; S

Output ; a ; r

Step 1 R (diameter) 2.68mm
TSR; 5
I (No of blades); 10
a (angle of attack) 6 degrees centigrade
C_L (lift coefficient); 1.2
S (No of stations); 5

Step 2 Compute V
V (Wind velocity m/s); 5.42; 10.84

Step 3 Compute Ur; Vo
Open voltage of generator; 14v
(User ratio) 1:5
(rpm) ; 1500
(measured ohm); 6

Run

4. RESULTS AND FINDINGS

Rotor Diameter=2.68 meters
Tip Speed Ratio =5

Station	Radius	Bld angle	Chord	Thickness	Drop	Prop Performance MPH	Watts
1	10.55	28	3.41	.51	1.89	10	77
2	21.1	13	2.22	.33	.7	12	133
3	31.65	7	1.56	.23	.34	14	211
4	42.2	4	1.2	.18	.2	16	315
5	52.76	2	.97	.15	.13	18	448
6						20	615
7						22	818
8						24	1062
9						26	1350
10						28	1686

Rotor thrust =19.38lbs
Tail Size min =1.93sq feet
Rotor Offset =4.22 inches

Recommended Gear Ratio =5.078

Generator Data

Amps	Open Volts	RPM	Ratio	Watts at Rec Ratio
5.2	17.92	693	4.36	150
8.99	20.19	781	4.09	254
14.26	23.35	903	4.05	357
21.28	27.57	1066	4.18	461
30.27	32.96	1274	4.44	565
41.55	39.73	1536	4.82	668
55.27	47.96	1854	5.28	772
71.76	57.85	2237	5.86	873
91.22	69.53	2688	6.49	976
113.92	83.15	3215	7.21	1080

4.0 DESIGN CALCULATION FOR TOWER

Using Euler's assumption in the analysis of a long column, a column with one end fixed and other free has this relation for determining the load P

$$P = \frac{\pi^2 Em}{4L^2} \quad (4.0)$$

Where E = modulus of elasticity of the column material
M = moment of inertia of the column cross-section
L = length of the column (tower height)

From the theory of strength of materials for a hallow cylinder. The moment of inertia is given as;

$$M= \left(\frac{\pi}{64}\right)(D^4 - d^4) \quad (4.1)$$

Parameters of mild steel column used are;
Length L = 120 000mm
Outer diameter D = 114mm
Inner diameter d = D – 2t
Where t = thickness of column = 9mm
d = 114 -18 = 96mm

$$\therefore M = \left(\frac{\pi}{64}\right)(114^2 - 96^4) = 41244.62mm^2 \quad (4.2)$$

For mild steel, young modulus is usually about 200GPa, so load P that can be safely borne by the column without bukling is

$$P = \frac{\pi^2}{4L^2} = \pi^2 \times 200 \times 10^6 \times 41244.62 \text{ mm}^2/4 \times 120,000 \quad (4.3)$$
$$= 33.96KN.$$

The combined weight of nacelle and seeker is 13.5N, so the tower cans comfortable carry the system.

5.0 SUMMARY/ CONCLUSION

This modelled simulated project therefore, has demonstrated micro scale wind battery hybrid system that will improve living standard and working condition as energy mix in Nigeria. It is an excellent solution for the most areas where the grid extension is difficult and uneconomical especially in times of unavailability and affordability of petroleum (fuel). The power out put of this system will increase with area of different wind climate of higher speed and less wind obstruction. It strives to give the optimum output by utilizing the available natural resources in the surroundings and it's setup in a grid will compensate each others limitation and deficiency to give steady and optimal output.

This project is a contribution to any effective and efficient rural electrification strategy.

Wind energy as a power source is attractive as an alternative to fossil fuels because it is plentiful, renewable, widely distributed, cleans and produces no greenhouse gas emission. However the initial construction of wind farms is expensive and usually not welcome due to their visual impact and other effects on the environment. Wind power is non-dispatchable, meaning that for economic operation all of the available output must be taken when it is available. Other resources, such as hydropower and standard load management techniques must be used to match supply with demand. The intermittency of wind seldom creates problem when using wind power to supply a low proportion of total demand.

Where wind is to be used for a moderate fraction of demand such as say 40%, additional costs for compensation of intermittency are considered to be modest. The challenges of intermittency is shared commonly by all power system, solar power has to deal with issues of sunshine and cloudy days, gas turbines have to deal with gas supply and price fluctuation issues, hydro plants have to content with dry or rainy seasons and water levels behind the dams.

As it is known all over the world, conventional and alternative power generation systems are not fail-proof and therefore integrated with each other to provide stable and uninterrupted power supply to consumers will be an extensive improvement. Hydro, gas power plants are interconnected with each other along the same transmission lines to provide seamless power supply to consumers. When one power source goes down a back up source is activated to cover the shortfall. No nation depends on only one or two sources of power generation no matter how abundant.

Solar power has penetrated the Nigerian energy market with many street lights being powered by solar PVC cells. It beats imagination why NEPA/PCHN has not ventured into renewable power generation with all the shortcomings experienced in their current and past concentration on gas powered system and all advantages enjoined with wind power generation. Large-scale wind farms are connected to the electric power transmission network (on grid); whereas smaller facilities are used to provide electricity to isolated locations or stand alone to improve domestic residence (off grid).

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REFERENCES

1) Abadom, I.A, Alajemba, J.N and Amadi, C.O., 2011 Research work on wind as alterative energy source Federal University Technology Owerri
2) Anamimous 2010 China data Presentation at 1st World wind energy Association, world summit
3) David, F. 1987 Wind turbine Engineering Design. New York 352pp
4) David, S. 1994 Wind Turbine Technology: Foundational 650pp ISBN 0-7918-1205-7.
5) Dhiren, K. 2012 www.ijsrp.org Blade design
6) Electronic Projects & Designs www.circuittoday.com wind energy charge controllers systems
7) Emrah, K. 2010 Aerodynamics of wind turbines New Mexico Institute of mining and Technology USA
8) Freris, L. 1990 Wind Energy Conversion systems
9) Gerald, W. 1982 Putnam's power from the wind second Edition 470pp
10) Gipe, P. 2010 A cursory introduction to wind energy and small wind turbine. Chelsea Green publishing 122 pp,148pp ISBN 1-890132 -07
11) Golding, E.N. 1976. The generation of Electricity by wind power. London. 332 pp.
12) Grigg's-Putnam 1955. Wind speed index for annual energy AEO.
13) Hackleman, M. 1975. The home-Built wind generated Electricity hand book, 253 pp ISBN 0-917352-06
14) John, W. 2002 Wind energy hand book 617 pp. ISBN: 0-471-48997.2
15) Josué, N., Libii and David M.D.2011 World Transaction on engineering and technology Education Vol. 10. No. 2, Pg. 69 2012
16) Kevin, S. and Brain, C. H. 2012, Build your own small wind power system by McGraw-Hill Company USA.
17) Kulunk, E, Yilnaz, N. 2009. HAWT Rotor Design and performance analysis ASME 3rd International Conference on Energy sustain ability, ES2009-90441 San Francisco
18) Nicholas, J. 1997. Wind Energy Technology, Chichester, United Kingdom
19) 161 pg ISBN 0-471-96044-6.
20) Olumide, O. 2009. Wind Energy in Nigeria: Time is now
21) www.the wind power.net-Wind developing in Nigeria.
22) Oyedepo, O.A. 2012 .International Journal of Energy and Environmental Engineering 2012 3:7 doi:10.1186/2251-6832-3-7
23) Pott, M. 1999 Living well with power from the sun, wind and water. Chelsea Green Publishing 408pp ISBN: 1-890132 – 14-4
24) Ruppo, C. 2011. www.Intechopen.com/books/fundmental-and-advanced-topic-in- wind-power/aerodynamics-of-windturbine
25) Ruppo, C., 2012 Fundamental and Advanced Topics in wind power
26) ISBN 978-953-307-508-2 publisher in technical.
27) Torrey, V. 1976. Wind Catchers: American Windmills of yesterday and tomorrow, Stephen Green Press 226 pg. ISBN: 0-8289-0292-5
28) Vivian, P. 2009. EcoGeneration"Growing small wind" www.ecogeneration.

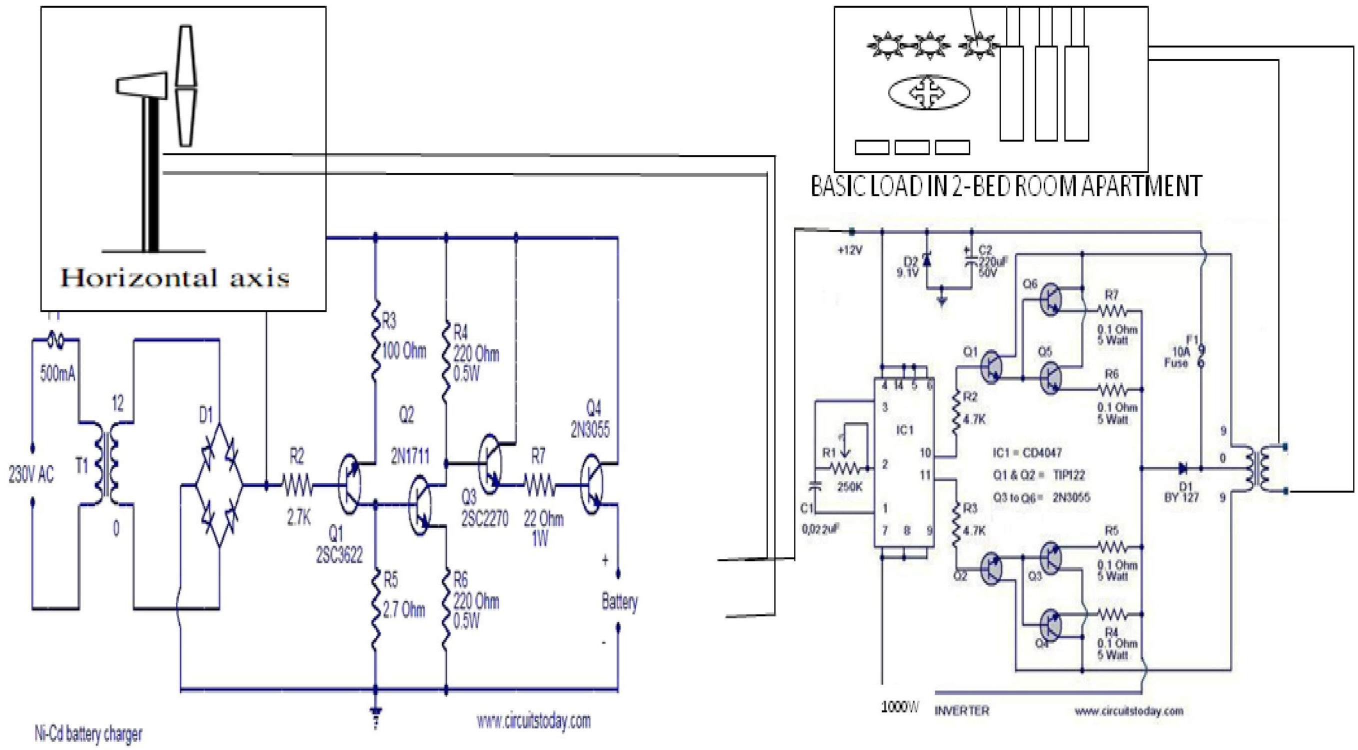

Fig.2: Complete system Diagram

