CURRENT STATUS OF HYBRID SOLAR – WIND POWER GENERATION SYSTEM

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***ABSTRACT*:**

The oil shocks of 1970s led to spiraling crude oil prices in the world market which prompted planners to view energy security as an issue of national strategic importance. Energy security has an important bearing on achieving national economic development goals and improving the quality of life of the people. World's dependence on crude oil will continue for most part of the 21st century but the continued dependence on crude oil is loaded against it with inherent price volatility linked to finite global reserves. In addition, global warming, caused largely by greenhouse gas emissions from fossil fuel energy generating systems, is also a major concern. So, there is a need to develop alternate fuels like non-conventional sources, considering the aforesaid two concerns. This paper describes about the hybrid (solar + wind energy) systems, one of the non-conventional sources and different ways of using it to convert to electric energy. This gives energy continuously around the clock. Hybrid systems are use full for all atmospheric conditions for producing energy at moderate cost.

Index Terms: — *model, solar, wind, hybrid, energy, rural electrification.*

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I. Introduction:

Energy is vital for the progress of a nation and it has to be conserved in a most efficient manner. Not only the technologies should be developed to produce energy in a most environment-friendly manner from all varieties of fuels but also enough importance should be given to conserve the energy resources in the most efficient way. Energy is the ultimate factor responsible for both industrial and agricultural development. The use of renewable energy technology to meet the energy demands has been steadily increasing for the past few years, however, the important drawbacks associated with renewable energy systems are their inability to guarantee reliability and their lean nature. Import of petroleum products constitutes a major drain on our foreign exchange reserve. Renewable energy sources are considered to be the better option to meet these challenges.

As the power demand is going on increasing day-by-day, it is responsible for our engineers to make it available as per the demand. Many of the power generating plant are using non-renewable sources as their primary source. But these may become extinct at any time and before facing the situation we have to choose an alternative to avoid the power crisis. One of the best alternatives is choosing Non-conventional sources like solar energy, Wind Energy, Tidal energy, Bio-mass energy etc as the primary sources for power generation in power stations. The power from these sources is several times greater than the one, which we are using at the present. Out of these energy sources, the best one which suits for our country is the Solar & wind energy.

The power from the sun intercepted by the earth is approximately $1.8*10^{11}$ MW, which are many thousands of times larger than the present consumption rate on the earth of all commercial energy sources. Thus if we convert this to other forms of energy, it may be one of the most promising of the non-conventional energy resources. Our country can have power supply and is available at very reasonable cost.

Solar & wind energies are also the most available renewable energy sources on earth, and many remote areas have plenty supply of both. The sun is the sources all the energies on the earth.

Generally wind speed is low in the summer when sun shines brightest and longest. The wind is strong in the winter when less sunlight is avalibul. Wind seed is also low during the day when sunlight is strong, but increases dark when the earth surface is cooler. Thus wind & a

solar energy can complement each other & hence provide reliability & long –time alternative energy sources to state electricity supply.

a) UN renewable Energy Resources

UN renewable energy resources are the ones that decay Partially or vanish with the time or needs decades for reuse, such as oil, coal and coal derivatives, natural gas, wood and Radioactive atoms (uranium).

b) Renewable Energy Resources:

Renewable energy resources are the ones that are persistently. Available and renewing itself with the time. Industrialization and increasing world population has remarked the use of renewable energy resources. Solar power, wind power, biomass, tide power, wave power, geothermal power is known ones.

II. SOLAR ENERGY

Solar energy is energy from the Sun. It is renewable, inexhaustible and environmental pollution free. Nigeria, like most other countries is blessed with large amount of sunshine all the year with an average sun power of 490W/m2/day. Solar charged battery systems provide power supply for complete 24hours a day irrespective of bad weather. More so, power failures or power fluctuations due to service part of repair as the case may be is non-existed.

SOLAR SYSTEMS:

There are two types of solar systems; those that convert solar energy to D.C power, and those that convert solar energy to heat.

a) Photovoltaic Cells:

Photovoltaics are solar cells that convert sunlight to D.C electricity. These solar cells in PV module are made from semiconductor materials. The solar cell operate on the principal of photo electricity i.e., electrons are liberated from the surface of a body when light is incident on it.

Backed by semi-conductor technology, it is now possible to utilize the phenomenon of photo-electricity.

When light energy strikes the cell, electrons are emitted. The electrical conductor attached to the positive and negative scales of the material allow the electrons to be captured in the form of a D.C current. The generated electricity can be used to power a load or can be stored in a battery. But these can't be used for higher power needs owing to their high cost. So photovoltaic cells using in satellites, which need continuous power without batteries and in small device like calculators, watch cell phones etc…

PV systems generally can be much cheaper than installing power lines and step-down transformers especially to remote areas. Solar modules produce electricity devoid of pollution, without odour, combustion, noise and vibration. Hence, unwanted nuisance is completely eliminated. Also, unlike the other power supply systems which require professional training for installation expertise, there are no moving parts or special repairs that require such expertise.

The photovoltaic cell is also referred to as photocell or solar cell. The common photocell is made of silicon, which is one of the most abundant elements on earth, being a primary constituent of sand.

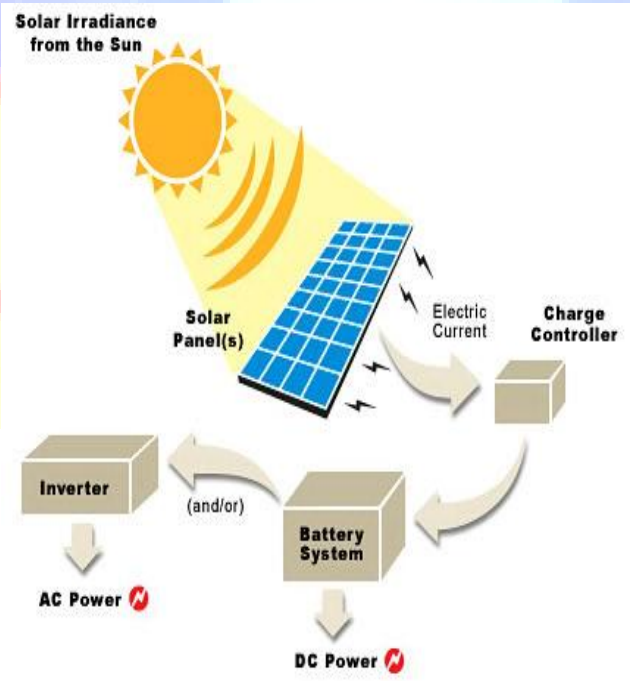


Fig: 1 direct conversion of solar energy to electrical energy using PV cell

A Solar Module is made up of several solar cells designed in weather proof unit. The solar cell is a diode that allows incident light to be absorbed and consequently converted to electricity. The assembling of several modules will give rise to arrays of solar panels whose forms are electrically and physically connected together.

To determine the size of PV modules, the required energy consumption must be estimated.

Therefore, the PV module size in Wp is calculated as

Daily energy Consumption / Isolation × efficiency

Where Isolation is in KWh/m^2/day and the energy consumption is in watts or kilowatts.

b) CONCENTRATED SOLARPOWER (CSP):

CSP system concentrated the sun beams to produce heat and the convert the heat energy into electricity by conventional ways .these are several designs for concentrating the sun beams but the method is the same in all designs there is a reflector which concentrates the beam in a heat collector also called absorber. A fluid flowing in the receiver stores the heat. The hot fluid flows to the heat energy and the energy is converted into electricity.

Parameters characterizing solar concentrators

Several terms as used specify concentrating collectors. These are

i. The aperture area is that plane area through which the incident solar flux is accepted. It is defined by the physical extremities of the concentrator
ii. The adsorbed area is the total area that receives the concentration. It is the area from which useful energy can be removed.
iii. The thermal efficiency is the ratio of the useful energy delivered to the energy incident on the aperture

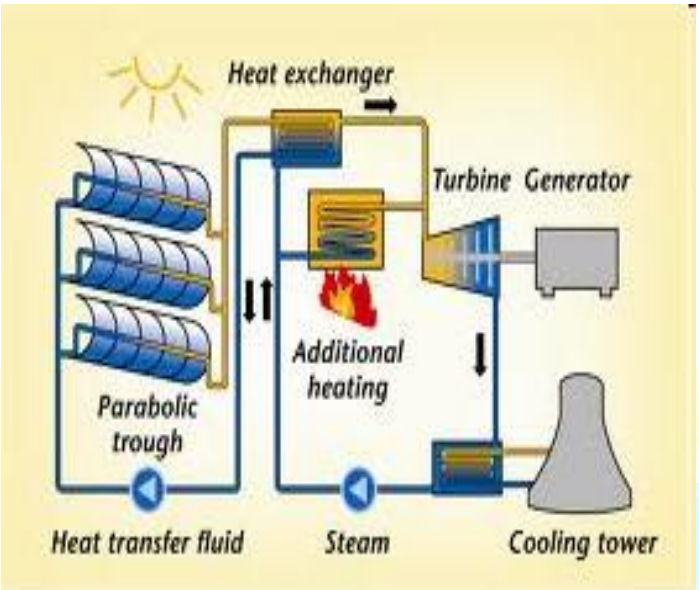


Fig: 2 conversion of solar energy to electrical energy by using CSP

- Parabolic through units with line focus.
- Parabololidal dishes with central focus.

Parabolic through collectors are preferred because of low cost of manufacture and simple single plane sun-tracking. Where as in paraboloidal collectors use double plane sun-tracking and are expensive.

BASIC STRUCTURE:

Large parabolic collectors are employed for collecting solar energy, which is used to heat the fluid generally water which is stored in the storage tank. This heat energy is left to the boiler with a feedback, which is converted to high-pressure steam energy.

This steam energy is sent to the turbine chamber with high speed leading to the rotation of prime-mover of the turbine. As turbine is internally coupled with the alternator, the incoming mechanical energy to the turbine is converted to electrical energy by the alternator. Steam is

condensed in the condenser and feed water returns to the boiler for re-use. The heat of the cooling water of the condenser may be utilized for some other purposes.

III. *Wind Power*

Wind Power is energy extracted from the wind, passing through a machine known as the windmill. Electrical energy can be generated from the wind energy. This is done by using the energy from wind to run a windmill, which in turn drives generator to produce electricity. The windmill in this case is usually called a wind turbine. This turbine transforms the wind energy to mechanical energy, which in a generator is converted to electrical power. An integration of wind generator, wind turbine, aero generators is known as a wind energy conversion system

The power that can be theoretically obtained from the wind is proportional to the cube of its velocity and thus high wind velocities are most important. The power developed using this law, in atmospheric conditions where the density of the air is 1.2014 kg/cu meter, is given as

Power developed = 13.14*10^-6 AV^3 KW

Where A is the swept area in sq. meter and V the wind velocity in Km/hr. the energy developed is affected by the altitude of the site, velocity duration curve.

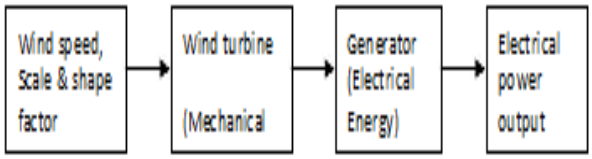
Component of a wind energy project:

Modern wind energy systems consist of the following components

- A tower on which the wind turbine is mounted
- A rotor that is turned by the wind;
- The nacelle which houses the equipment, including the generator that converts the mechanical energy in the spinning rotor into electricity.
- The tower supporting the rotor and generator must be strong. Rotor blades need to be light and strong in order to be aerodynamically efficient and to withstand prolonged used in high winds.

In addition to these, the wind speed data, air density, air temperature need to be known amongst others.

The block diagram shows the conversion process of wind energy to electrical energy.



Block diagram 1: Energy conversions from Wind to Electrical

a) WIND TURBINE

A wind turbine is a device that converts kinetic energy from the wind, also called wind energy, into mechanical energy; a process known as wind power. If the mechanical energy is used to produce electricity, the device may be called wind turbine or wind power plant. If the mechanical energy is used to drive machinery, such as for grinding grain or pumping water, the device is called a windmill or wind pump. Similarly, it may be called wind charger when it is used to charge batteries.

Several types of wind wheels nave been used but the advantage of propeller rotating about a horizontal shaft, in a plane perpendicular to the direction of the wind makes it the most likely type to realize economic generation on a large scale. A propeller consisting of two or three blades and capable of running at the high spars is likely to be the most efficient .present technology has been above build systems with 60m long blades, on towers as high as 305m.

A large tower system, to support many small rotor-generator units, can also be built.

When the pressure rotates the wind vanes or propellers attached to a shaft. The revolving shaft rotates the rotor of a generator, through a mechanism of gears coupling etc., thus, electricity is generated.

Wind energy can prove to be a potential source of energy for the energy problem it can certainly go long way to supply pollution free energy to millions of people, living in the villages all over the world.

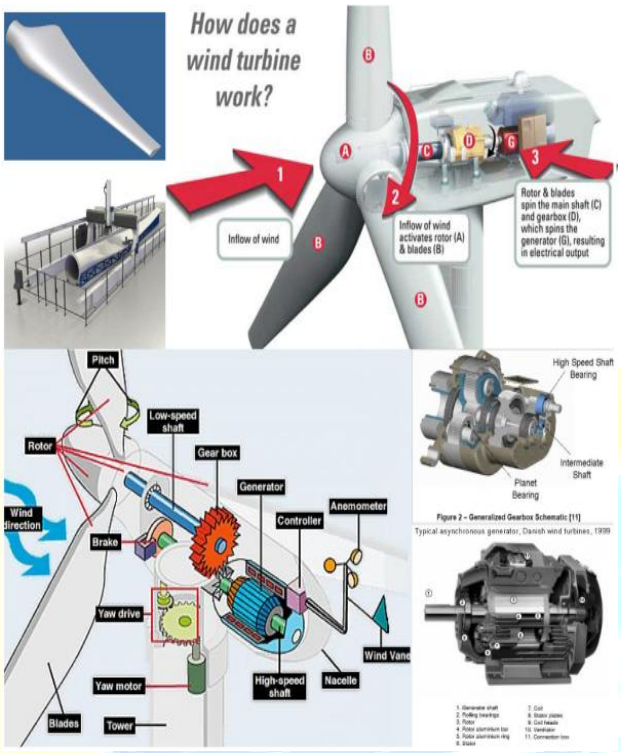


Fig.3 : working of the wind turbine

The result of over a millennium of windmill development and modern engineering, today's wind turbines are manufactured in a wide range of vertical and horizontal axis types. The smallest turbines are used for applications such as battery charging or auxiliary power on boats; while large grid connected arrays of turbines are becoming an increasingly important source of wind power produced commercial electricity.

Wind turbines can also be classified by the location in which they are used as Onshore, Offshore, and aerial wind turbines.

The variation of the velocity of wind over the period affects the power output e.g., let the velocity over the first hour be 30 Kmph and the next hour be 20kmph the energy developed is proportional to that 303 + 20 3 = 35000. On the other hand, if we assume average velocity during these two hours of 25kmps, the power developed is proportional to 2*253 = 33250. Thus the relation between the actual energy available, and that available from a steady wind of average

velocity, varies considerably and depends on the shape of the velocity- duration curve for the period of generation.

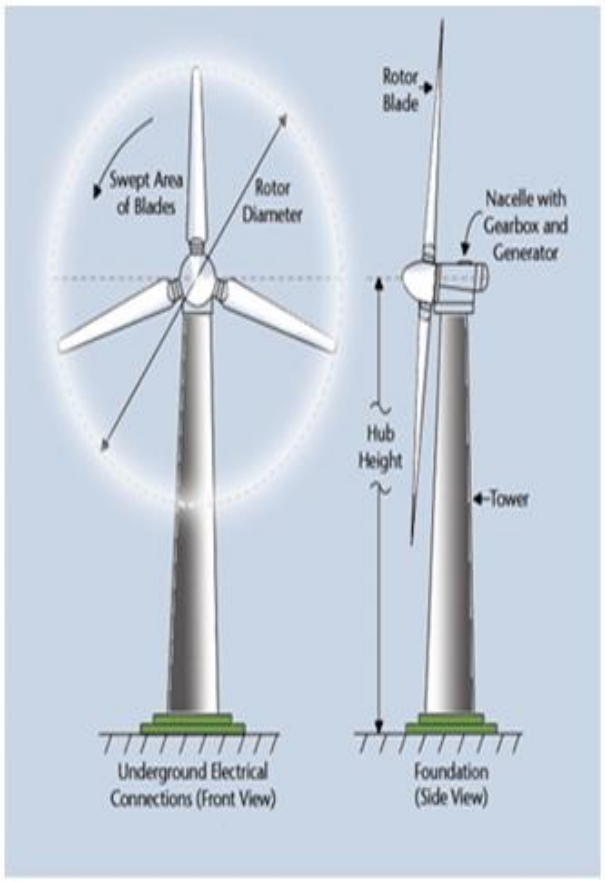


Fig.4 : diagram of wind turbine

IV. DESIGN AND IMPLEMENTATION OF SOLAR-WIND HYBRID ENERGY SYSTEM

The combination of both solar and wind energy sources are used to gain maximum amount of energy depending upon the availability of sources in nature. The wind is a form of solar energy. By combing using this two sources the system power transfer efficiency and reliability can be improved significantly.

Hybrid systems are the ones that use more than one energy resources. Integration of systems (wind and solar) has more influence in terms of electric power production. Such systems are called as “hybrid systems”.

Hybrid solar-wind applications are implemented in the field, where all-year energy is to be consumed without any chance for an interrupt. It is possible to have any combination of energy resources to supply the energy demand in the hybrid systems, such as oil, solar and wind. This project is similar with solar power panel and wind turbine power. Differently, it is only an add-on in the system.

Photovoltaic solar panels and small wind turbines depend on climate and weather conditions. Therefore, neither solar nor wind power is sufficient alone. A number of renewable energy expert claims to have a satisfactory hybrid energy resource if both wind and solar power are integrated within a unique body. In the summer time, when sun beams are strong enough, wind velocity is relatively small. In the winter time, when sunny days are relatively shorter, wind velocity is high on the contrast.

Efficiency of these renewable systems show also differences through the year. In other words, it is needed to support these two systems with each other to sustain the continuity of the energy production in the system.

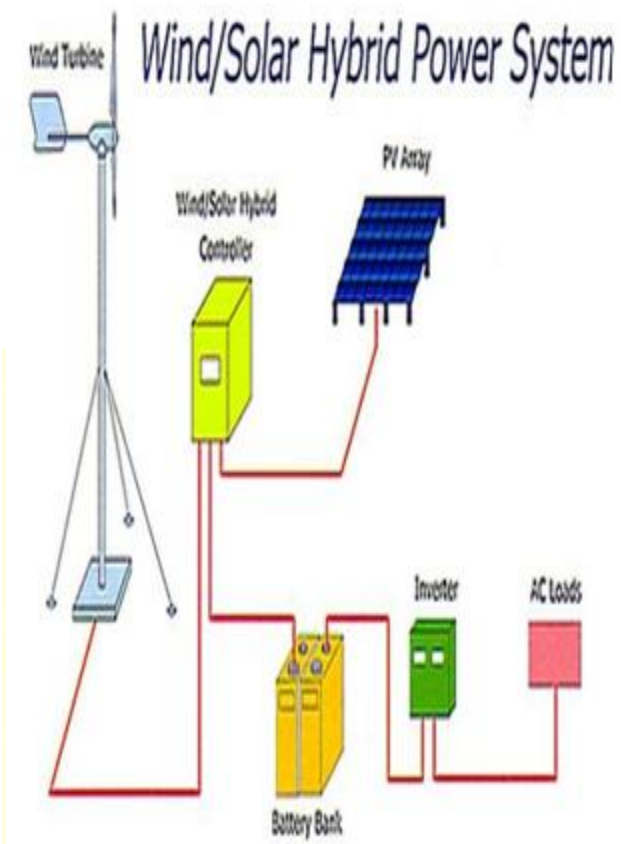


Fig.5 Hybrid solar and wind power system

In the realized system, a portion of the required energy for an ordinary home has been obtained from electricity that is obtained from the wind and solar power. Experimental setup for the domestic hybrid system consists of a low power wind turbine and two PV panel. Depending on the environmental conditions, required energy for the system can be supplied either separately from the wind or solar systems or using these two resources at the same time. Control unit decides which source to use for charging the battery with respect to condition of the incoming energy

Wind turbine first converts the kinetic energy to mechanical energy and then converts it to the electricity. The wind turbine in the system consists of tower, alternator, speed converters (gear box), and propeller. And a picture of the constructed hybrid system is show in Figure6.

Fig.6 Hybrid solar and wind power system

The kinetic energy of the wind is converted to the mechanical energy in the rotor. The rotor shaft speed, 1/18, is accelerated in the reduction gear and then transmitted to alternator. The electricity that comes from the alternator can be directly transmitted to DC receivers as well as it can be stored in the batteries.

The solar panels in the system convert the day light directly into electricity. The properties of the PV module (Solar Energy Corporation) in the system are given in the below Table 1.

PMAX (WP)	*65*
MPP Voltage (V)	*16.5*
MPP Current (A)	*3.94*
Open Circuit Voltage (V)	*20*
Short Circuit Current (I)	*4.50*

TABLE 1. *PV module properties*

Generally wind speed is low in the summer when sun shines brightest and longest. The wind is strong in the winter when less sunlight is avalibul. Wind seed is also low during the day when sunlight is strong, but increases dark when the earth surface is cooler. Thus wind & a solar energy can complement each other & hence provide reliability & long –time alternative energy sources to state electricity supply.

And it gives the constant output because of the when the solar peaks are high then the wind peaks are low and when the wind peaks are high then the solar peaks are low so therefore the constant output power is obtained while observing the wave forms in the fig 7

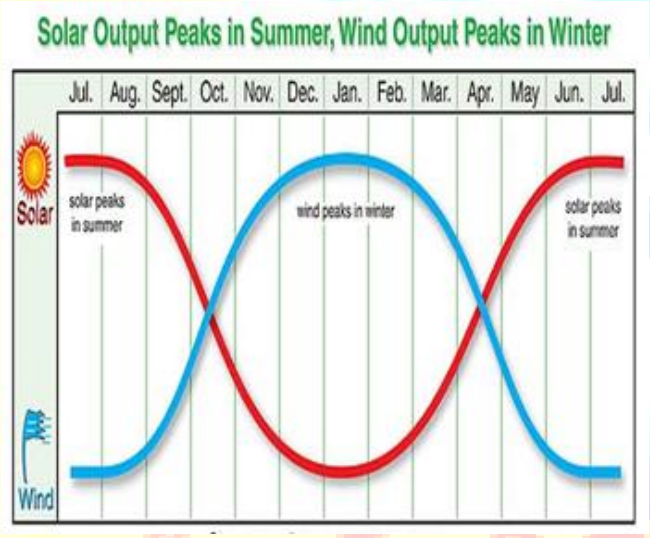


Fig.7 waveforms of solar -wind in summer & winter

Solar + wind hybrid technology assures reliable charging of maintenance free batteries .Driving latest LED based indoor lights & induction lamps outdoor luminaries light sources by battery, provides reliability & long time back up a regular basic .Efficiency of power lighting induction-clamp is the best option in solar applications & with latest technological developments ,solar + wind hybrid systems shall become the regular source of electricity making regular state electric supply to take backseat.

V. Advantages:

The major advantage of the system is that it meets the basic power requirements of non-electrified remote areas, where grid power has not yet reached. The power generated from both wind and solar components is stored in a battery bank for use whenever required. A hybrid renewable energy system utilizes two or more energy production methods, usually solar and wind power.

The major advantage of solar & wind hybrid system is that when solar and wind power production is used together, the reliability of the system is enhanced. Additionally, the size of battery storage can be reduced slightly as there is less reliance on one method of power production. Often, when there is no sun, there is plenty of wind. Wind speeds are often low in periods (summer, eventually) when the sun resources are at their best. On the other hand, the wind is often stronger in seasons (the winter, in many cases…) when there are less sun resources. Even during the same day, in many regions worldwide or in some periods of the year, there are different and opposite patterns in terms of wind and solar resources. And those different patterns can make the hybrid systems the best option in electricity production.

A hybrid wind-solar electric system demands an higher initial investment than single larger systems: large wind and solar PV systems are proportionally cheaper than smaller systems.

But the hybrid solution is the best option whenever there is a significant improvement in terms of output and performance - which happens when the sun and the wind resources have opposite cycles and intensities during the same day or in some seasons

- This system of energy conversion is noise less and cheap.
- Maintenance cost is low.
- They have long life.
- Pollution free.
- Highly reliable.
- Another advantage of wind energy is that when combine with solar electricity, this energy source is great for developed and developing countries to provide a steady, reliable supply of electricity.

VI. CONCLUSION

The feasibility study for the hybrid system is based on the findings of the wind and solar energy potentials at the particular locations. From the results, the wind energy potential of this site, Debrezeit, is not attractive enough for independent wind farm applications. However, it can be concluded that the potential in some cases could be a viable option if integrated into other energy conversion systems such as PV, diesel generator and battery. The results of this study can be considered as applicable to a significant size of the regions in the country having similar climatic conditions.

There is the need for the provision of an alternative sustainable electric power supply system to provide electricity to rural and the unreached communities. The importances of Information Communication Technology for e-service to rural communities are inevitable in order to achieve the MDGs objective. Also there is the need for rural banking and hospitals if the social and economic lives of rural citizens in Nigeria are to be improved.

The provision of hybrid solar -wind energy system to power ICT infrastructures, banking and hospitals in rural and the unreached communities that are not connected to National Grid Power supply system is very important so as to maintain a continuous electricity supply.

When considering the cost and overall efficiency, it is advisable for all the stakeholders who have concern for the rural community development to embrace solar and wind power.

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