

Strategic Approach of Hybrid Solar-Wind Power for Remote Telecommunication Sites in INDIA

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ABSTRACT-Lack of rural cell phone subscriber in India facing tough challenges in getting stable back up power for cell sites. Grid power availability is very poor and use of Diesel generator is very expensive due to its fuel and transportation cost as well as maintenance. This paper gives the design idea of optimized pv- solar and wind hybrid energy for a GSM/CDMA type mobile base station over non-renewable diesel generator for a particular site in India (odisha). For this hybrid system, the meteorological data of solar insolation, hourly wind speed are taken for odisha in India and the output power for hybrid energy system is finding out by using MAT LAB software. This system is more cost effective and environmental friendly compared to conventional diesel generator as well as it should reduced emission of CO₂ and other harmful gases. Practical implementation and result are presented in this paper by using mat lab.

KEYWORDS: Hybrid energy system, mobile telephony base station, wind turbine, solar PV system, battery, inverter, mat lab

1 INTRODUCTION

In recent times India is the world's second largest subscriber base of 700 million and it may be come to 800 million in next 2 years. However lack of stable grid power in rural India face a big challenge to this phenomenal growth. Some areas may get agricultural power for 4-5 hours during morning and evening; during remaining period diesel generator provides power. Cell sites running on DG is very expensive due to its fuel, transportation of fuel and maintenance cost. So a sustainable alternative to power remote base station sites is to use renewable sources. In order to meet load demands of mobile base station during varying natural conditions, different energy sources (solar-wind), battery bank and converters need to be integrated with each other for extended usage of alternative energy. Based on the energy consumption of mobile base station and the availability of renewable energy sources, it was decided to implement an innovative stand alone Hybrid Energy System combining small wind turbine-generator, solar photo-voltaic panels, battery storage, advance power electronic equipment and existing diesel generators. The system architecture employed in the hybrid system is AC Coupled where the renewable energy sources and conventional diesel generator all feed in to the AC sides of the network shown in below figure.

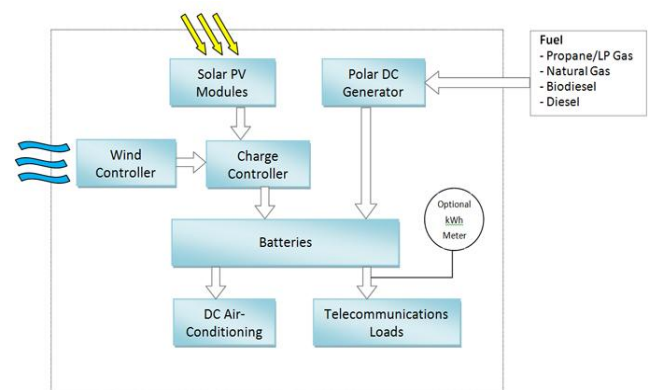


Figure 1. Arrangement of hybrid system for telephony system

2 RENEWABLE ENERGY RESOURCES FOR HYBRID SYSTEM

2.1 SOLAR ENERGY RESOURCE IN ODISHA:

The average annual solar radiation in Orissa is between 5 to 6 kW-h/m²/day. Orissa, because of its sub-tropical geographical location between the latitudes of 17 to 23°N, receives an abundance of solar radiation throughout year except for some interruption during the monsoon and winter season. According to Odisha Renewable Energy Development Agency (OREDA) estimate, the potential of solar photovoltaic power of Odisha is 14000 MW. The latitude and longitude of Odisha is 22°00' N and 94°20' E respectively.

Average monthly solar radiation in kWh/m²/day is shown below

TABLE 1.SOLAR RADIATION

Month	Solar Radiation
January	3.47
February	3.88
March	4.34
April	4.66
May	4.77
June	4.78
July	4.76
August	4.68
September	4.43
October	4.00
November	3.55
December	3.33

Month	Wind velocity
January	3.350
February	3.890
March	3.395
April	3.885
May	4.956
June	5.176
July	4.796
August	4.376
September	3.666
October	3.600
November	3.500
December	3.420

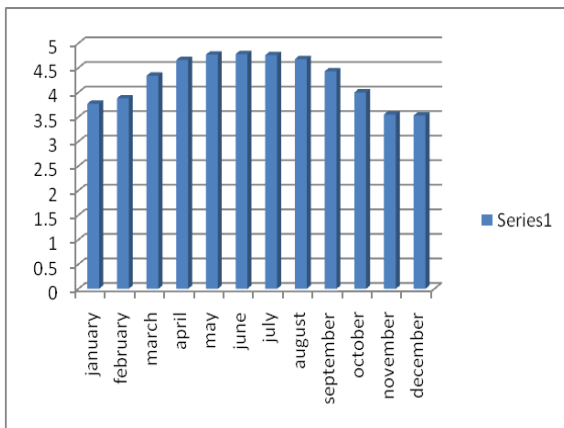


fig 2. Solar radiation

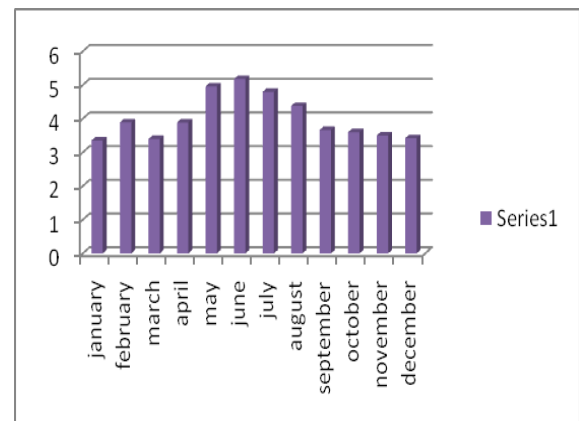


fig 3.Wind velocity in m/s

2.2 . WIND ENERGY RESOURCES IN ODISHA:

The average wind velocity in Odisha is in between 3 to 4 m/s.The average wind speed is 15km/hr in Odisha. Average monthly wind velocity in m/s is shown below

3. LOAD DETERMINATION FOR TELECOMMUNICATION SYSTEM:

The power requirement of a cell site with different BTS configuration is shown below

TABLE 2.WIND VELOCITY IN M/S

TABLE 3

NO OF BTS	NO OF TRX	AC CAPA CITY	BTS LOAD (KW)	AC LOAD (KW)	OTHER LOAD (KW)	TOTAL POWER (KW)
1	3	1.5 TR	0.76	1.80	0.48	3.04
2	6	2 TR	1.56	2.40	0.48	4.44
3	9	3 TR	2.34	3.60	0.48	6.32

One BTS can have 3 to 12 transceivers (TRXs)along with associated control and amplification circuits ,antennas etc.In rural Odisha cell sites typically have one or two BTS with 3 to 6 TRXs.Recently in rural area the GSM 2/2/2(2nd generation global system mobile telephony base station)are used. In this present study consider the power requirements for GSM telephony base station site are about 4.5 kw continuous. The load demand is approximate 114 kwh/d and 4.5 KW peak.

4. HYBRID ENERGY SYSTEM COMPONENTS:

The required components used for telephony system in rural area of Odisha are given below:

4.1 A 1000W WIND TURBINE:

The only small/mid sized wind turbine which has been type tested and certified by CWET (centre for wind energy technology, India) for "power performance" as per IEC 61400-12-1 & for "safety function test" as per IEC 61400-2 which converts wind energy into electrical energy. World wide it is more efficient turbine in its class. Power output to capacity ratio is highest. It generates more power than any other wind turbine (per KW rated capacity) at low wind speed areas. It can easily be mounted on roof tops or telecom towers. It has a rated capacity of 1KW and provides 48V DC.

The Turbine specifications are given below:

TABLE 4

Rotor diameter	9 feet/2.7 meters
Weight	65 lbs/30 kg box:87 lbs/39.46 kg
Shipping dimensions	51×20×13"/1295×508×330 mm
Mount	2.5" schedule 40/6.35 cm pipe
Start-up wind speed	7 mph/3.1 m/s
Voltage	24,36,48 VDC (HV 120/240 available)
Peak power	1132 watt at 26 mph/11.6 m/s
Rated power	1 min average power as tested under IEC61400-12-1 is 700 watts at 12.8 m/s
Turbine controller	Whisper controller (pitch, stall control)
Body	Cast aluminum
Blades	3 polypropylene/carbon glass reinforced
Over speed protection	Patented side-furling
Kilo watt hours/month	158 kwh/mo at 12 mph/5.4 m/s
Survival wind speed	120 mph/55 m/s

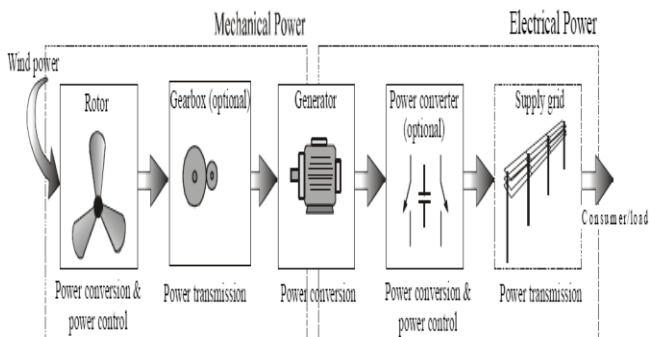


Fig 4. Converting wind power to electrical power in a wind turbine

The power curve of wind turbine is shown in below:

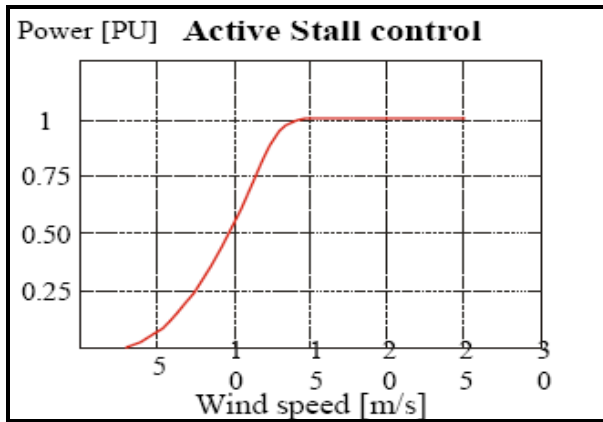
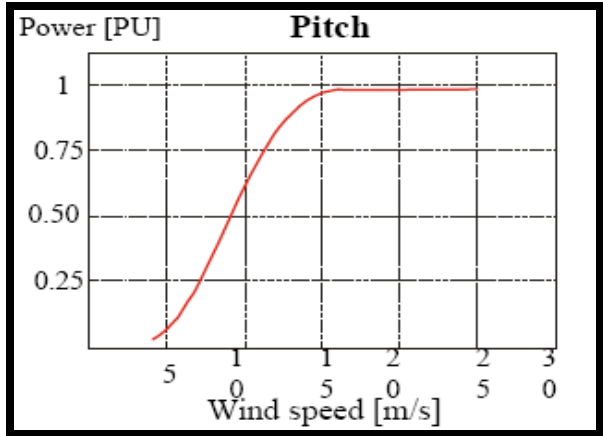


Fig 5. output curve of wind turbine by active stall and pitch control

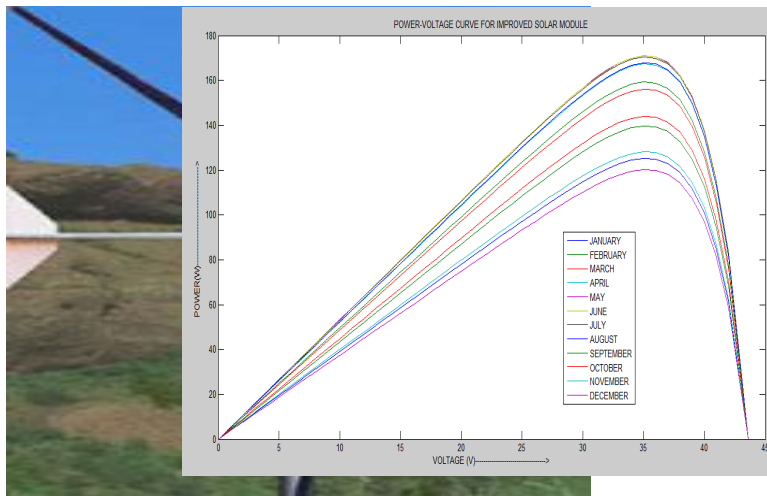


Fig 6, wind turbine

4.2 A 3.75 KW PHOTOVOLTAIC ARRAY:

25 no of Solar PV modules are connected in series parallel. When the sunrays strike the Solar PV panels, it Produces electricity. The Solar PV power at the site is higher than the wind power. 175W PV module BP4175B was chosen for modeling in MATLAB.The concerned characteristics specifications are shown in table 5.

TABLE 5

PARAMETER	VARIABLE	VALUES
Maximum power	P_m	175W
Voltage at p_{max}	V_m	35.4V
Current at p_{max}	I_m	4.94A
Short circuit current	I_{sc}	5.45A
Open circuit voltage	V_{oc}	43.6V
Temperature coefficient of I_{sc}	A	$(0.065 \pm 0.015)\% / ^\circ C$

The lifetime of the PV arrays are taken as 20 years and no tracking system is included in the PV. . The obtained characteristics graph for different months is shown below

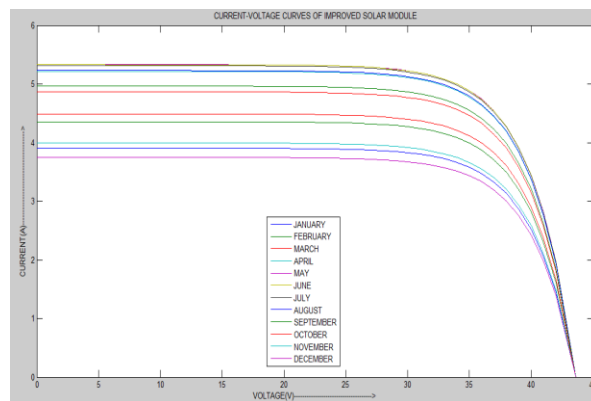


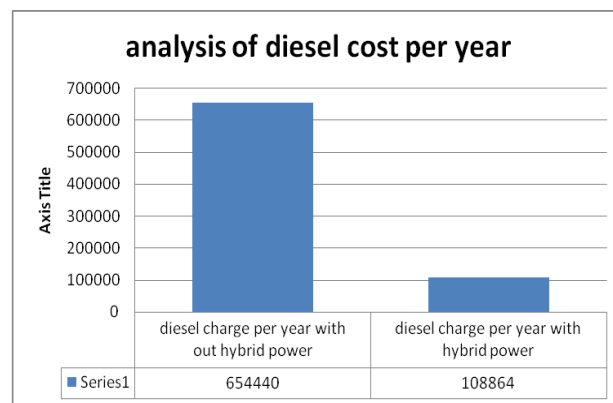
Fig 8. Current voltage graph

4.3 BATTERY BANK:

A battery bank is used as a backup system and it also maintains constant voltage across the load. The Lithium Ion batteries have the following advantages over lead acid (flooded, AGM / Starved Electrolyte, Gel, etc.) in cycling applications:

- 3 times more discharge cycles for service longer life. Deeper discharge capacity (i.e 70% vs 20%) than lead acid.
- The deeper discharge put the cost of the Lithium Ion competitive with the Lead acid.
- Can tolerate higher and lower ambient temperatures than sealed lead batteries. Eliminates air-conditioning.
- The Lithium Ion battery can be charged at higher power levels and has a significantly higher charging efficiency; this reduces generator runtime and fuel consumption.
- The Battery Management System incorporated into a Lithium Ion pack monitors each cell and can provide remote monitoring of the battery bank's state of health.
- The Lithium Ion chemistry produces a higher

Fig 7. Power-voltage graph



voltage per cell than lead acid; only 8 cells series are required to make up a 48 Volt battery as opposed to 24 for lead acid. Fewer cells in series increase reliability.

4.4 CONVERTER:

A power electronic converter is needed to maintain flow of energy between the ac and dc components. Lifetime of a unit is considered to be 15 years with an efficiency of 90%. Consider for this hybrid system 5kW converter.

4.5 DIESEL GENERATOR:

DG convert mechanical energy to electrical energy. Before use of hybrid energy in particular rural sites fuel consumption per year is approximate litter for 1KW diesel generator. Recently the cost of diesel is Rs40/-. Here we give the practical data of diesel consumed before and after Hybrid power installation are given below table

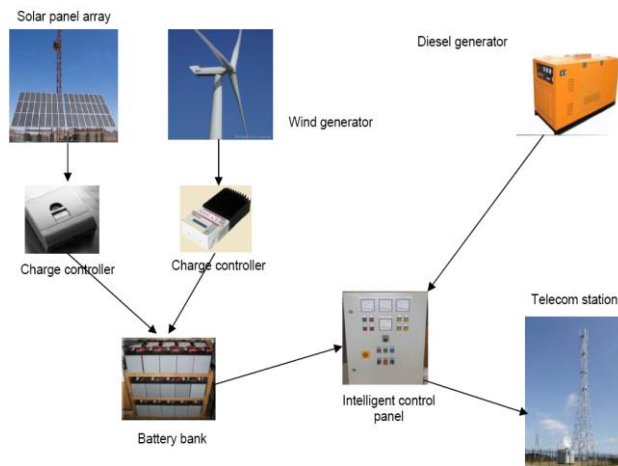


Fig 10.

TABLE 6

practical data of diesel consumption per year

MONTH	DG RUN HOUR	DIESEL CONSUMED	DIESEL CHARGE	MONTH Y CHARGE
BEFORE HYBRID INSTALLATION				
January to December	8760 hr	16,350 litter	16350×40 = 6,54,440/-	54,500/-
AFTER HYBRID INSTALLATION				
January to December	1440 hr	2721.6 litter	2721.6×40 = 1,08,864/-	9072/-

Here we see that before installation of hybrid energy diesel generator operate for 24 hour to operate the telecommunication system. It consumed 16,350 litter of diesel per year as well as pollute atmosphere and its capital cost, operating cost, maintenance cost are very high. After installation of hybrid energy system the diesel consumption at rural Odisha cell sites can be drastically reduced by over 90%..Here the DG operate for only emergencies or in cloudy days when solar power not available. With highly attractive government subsidies and incentives, it is economically viable too, plus it helps in reducing the pollution and keeping the rural Odisha green .

Fig 9. diesel cost per year

5. ARRANGEMENT OF HYBRID TELICOMMUNICATION SYSTEM :

The system above includes:

- Solar panels with charge controller, mounting (ground or pole), circuit breaker, lightning protection and battery bank
- Wind generator with tower, controller and battery bank
- The solar and wind systems go through a battery bank storing DC power (used by most telecom stations). Depending on requirements a small inverter can be installed to tap power from the batteries and provide AC power for small appliances.
- Diesel generator with automatic switching system and rectifier. This is the last resort and used only in emergencies or on cloudy days if the system is solar and generator alone.
- Control panel—this controls the power sources
- Remote monitoring system—a data logger and GSM system that transmit information to remote computer at the office.

The first source of power is electricity from the solar panels or solar panels and wind generator. The control panel treats the solar system as the primary source of power. If the power from solar panels and wind generator is all consumed, the controller triggers the generator to take over. Note that the generator is the last resort since its power is expensive to run.

6. CONCLUSION:

By integrating and optimizing the solar photovoltaic and wind systems, the reliability of the systems can be improved and the unit cost of power can be minimized as well as it give the continuous 4.75 KW power to telephony system. The DG set up as back up only operate for only emergencies or in cloudy days when solar power not

available. Before when hybrid power not installed DG consumed diesel 16,350 litter with cost 6,54,440/-per year. After installation of hybrid power DG consumed diesel 2721.6 litter with cost 1,08,864/-per year if it will run 4 hour per day. The fuel consumption is also reduced to approximate 80%.with increasing oil prices, payback times on the investment to hybrid solar-wind powered base station sites are continuously decreasing. Considering operating cost and maintenance cost, an autonomous site powered by wind solar hybrid system pay-off after 2-4 years in a good sunny and windy location. The Base stations powered by the solar wind hybrid energy system with diesel backup – are proving to be the most environmentally friendly and cost effective solutions for many challenging sites. Operating and maintenance costs are extremely low, making it economical to extend cellular coverage in far-flung regions. Solar- and wind-powered sites benefit the environment as well as the operator business case, whether they are located in highly populated or remote areas. Due to powering the base station by hybrid renewable energy system, it will reduce the carbon and other harmful gases emission is about 90% in environments. Due to powering the base station by hybrid renewable energy system, it will reduce the carbon and other harmful gases emission is about 90% in environments.

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