

## Optimum Design of Wind and Solar Hybrid System Power Generation for Stand Alone and Remote Areas

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### ABSTRACT-

*Standalone wind with Solar Photovoltaic is known as the best hybrid combination of all renewable energy systems and suitable for most of the applications taking care of seasonal changes. They also complement each other during lean periods, example additional energy production by wind during monsoon months compensate less output generated by solar. Similarly, post winter months when wind is dull, SPV takes over. The hybrid system provides more consistent year-round renewable energy production. These systems are modular and can be expanded easily. A hybrid renewable energy system utilizes two or more energy production methods, usually solar and wind power. Hybrid wind & solar systems provide more consistent year-round performance and reduce the need for back-up generation. 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 as there is less reliance on one method of power production. Often, when there is no sun, there is plenty of wind. The packaged systems are ideally suited to remote homes, schools, clinics and other off-grid applications. They can also be retrofitted to existing diesel - generator systems to save on high fuel costs, minimize noise and provide up to 24-hour power. The standard hybrid systems available to meet power needs. We can also tailor a system to suit should you have a smaller or larger power requirement.*

**Keywords:** Solar Photovoltaic cell, wind blade, Battery, Hybrid Power Conditioning Unit.

### I INTRODUCTION

Present day energy scenario; for meeting the ever-increasing energy demand, efforts has come into focus with a view to develop new generation technologies. The major goals of these approaches are to have reduced environmental damages, conservation of energy, exhaustible sources and increased safety. In this context during the past few years renewable energy sources have received greater attention and considerable inputs have been given to develop efficient energy conversion and utilization techniques. Majority of the population in our country is located in the village and a large number of the villages are still not served by National Grid due to cost involved for laying of the Transmission line, in relation to their power consumption, is prohibition in some cases because of the distance involved, quantity of life, availability of cold storage for Medicine, TV coverage and other aspects are adversely affected in such cases.

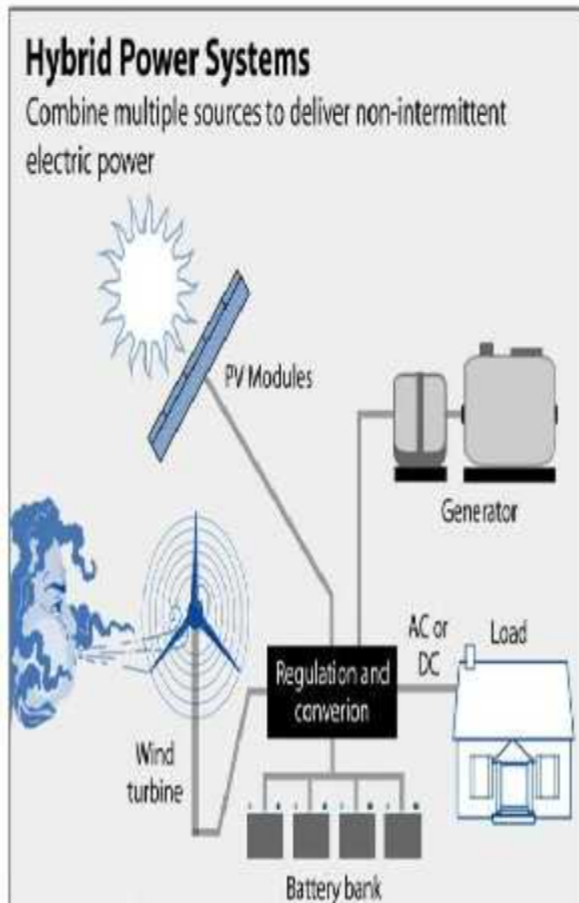
Conventional sources of energy have a long generation period, draw heavily on exhaustible deposits and adversely affect ecological balance. New and Renewable sources of energy are not only economically viable but do not suffer from any of the above disadvantages.

### II TO DEVELOP NEW GENERATION TECHNOLOGIES & RENEWABLE ENERGY SOURCES

- (a) Ever-increasing energy demand
- (b) Reduced environmental damages and increased safety
- (c) Conversion of energy and inexhaustible sources
- (d) Received greater attention to develop efficient energy conversion and utilization Techniques.
- (e) The realization of enormous need to electrify and energies remote rural areas.
- (f) Adequately available, least impact on environment and ecology
- (g) Ideally suited for decentralized variety of applications.
- (h) The future of fossil fuels has a limited time for their availability i.e. estimated that it could be around 70 to 100 years.
- (i) Inaccessible areas and hilly terrain's, renewable energy becomes very handy.
- (j) The cost of generation goes on decreasing as time passes.
- (k) Environmental friendly projects

### III HYBRID SYSTEMS (WIND - SOLAR)

A Hybrid plant combines Wind, Solar, and hybrid power conditioning unit with a battery as shown in schematic diagram figure-1. to supply electricity to remote areas, locations that have relied on conventional fuel may now take advantage of natural energy.



Standalone wind with Solar Photovoltaic is known as the best hybrid combination of all renewable energy systems and suitable for most of the applications taking care of seasonal changes. They also complement each other during lean periods, example additional energy production by wind during monsoon months compensate less output generated by solar. Similarly, post winter months when wind is dull, SPV takes over. The ground space required for wind generator is hardly 5 x 5 Sq ft. It can be easily erected on towers of 9 mts up to 18 mts with fold over mechanism on the ground or / it can also be mounted on roof-top of tall buildings. The low inertia comes in handy to start generating wind speeds as low as 2.5 mts per second. The energy generated can be easily combined with that of Solar PV through an integrated controller which will ensure continuity of energy transfer into battery bank system. This DC stored energy can be converted by power conditioning unit to AC Single phase 230V/50Hz, Power which can be used for Lighting load.

### IV SOLAR AND SOLAR PHOTOVOLTAIC MODULES

Solar energy is a very large, inexhaustible source. The power from the Sun intercepted by the Earth is approximately  $2.9 \times 10^{15}$  MW, which is many thousands of times larger than the present consumption rate on the earth of all commercial energy source. Thus in principal, solar energy could supply all the present and future energy needs of the world as a continuous basis. This makes it one of the most promising of the unconventional energy sources.



The solar modules generate DC electricity whenever sunlight shines on the solar cells. The solar modules should be tilted at the optimum angle for that particular location, face due south and should not be shaded at any time of the day

### V ADVANTAGES / DISADVANTAGES OF PHOTOVOLTAIC SYSTEM

(a) **Advantages:**

- (i) Direct room temperature conversion of light to electricity through simple solid state devices.
- (ii) Absence of moving parts
- (iii) Maintenance cost is low, as they are easy to operate.
- (iv) They do not create pollution.
- (v) They are highly reliable
- (vi) They consume no fuel to operate, as the Sun's energy is free.
- (vii) Wider power handling capabilities.
- (viii) Easy to fabricate
- (ix) Amenable to onsite installation
- (x) It is an environmentally clean source of energy.
- (xi) Free and available in adequate quantities in almost all parts of the world where people live.
- (xii) Non-availability of conventional source of energy.

(b) **Disadvantages:**

- (i) The solar radian flux availability is a low value 1 kW / m<sup>2</sup> for technological utilization.
- (ii) Large collecting area required. and Cost is more.
- (iii) Availability varies with time.
- (iv) In many applications, energy storage is required because of insolation at night.
- (v) The relatively poor conversion efficiency.

**VI AERO WIND GENERATOR**

Wind energy is a clean renewable energy source cheaper to maintain, saves fuel and can give decentralized energy. This is one of the main components in this system and converts kinetic energy of wind into electrical energy in the wind into mechanical energy. An electric generator is coupled to the propeller shaft directly, this propeller in turn rotates rotor of the electric generator and in turn generates DC electricity. The output from the wind generator varies as per the wind speed. Wind electricity for decentralized system or hybrid generation of electricity using other energy sources as complementary to wind energy has now been given some attention and this could be suitable in low wind regimes for localized small grid systems or battery charging for low wind speed, wind pumps could also be a viable option. This needs creation of necessary data and manpower base, setting up some demonstration plants at appropriate locations and carrying out research and studies for indigenisation of technology. The ground space required for wind generator is hardly 4x4 sq ft, it can be easily erected on towers of 9 mts upto 18 mts with fold over mechanism on the ground or / it can also be mounted on roof-top of tall buildings. The low inertia comes in handy to start generating wind speeds as low as 2.5 mts per second. The energy generated can be easily combined with that of solar pv through an integrated controller which will ensure continuity of energy transfer into battery bank system. This dc stored energy can be converted by power conditioning unit to ac single phase 230v/,50hz, power which can be used for lighting load.



**VII FEATURES OF AERO WIND GENERATOR**

- (a) 20 years life of the equipment
- (b) Simple rooftop installation - no tower necessary
- (c) Microprocessor-based smart internal regulator with peak power tracking safety protection electronics controls voltage and rotor rpm.
- (d) Maintenance-free - only two moving parts exclusive auto-brake-feature that slows the system to a silent spin when the batteries are charged thus extending bearing life and reducing noise.
- (e) Sophisticated internal charge controller - externally adjustable for any type of battery.
- (f) Low cost, low maintenance cost, no fuel cost
- (g) No pollution , easy installation
- (h) Designed to be used in combination with photovoltaic modules to balance system energy output during times of seasonal fluctuations.

**VIII ADVANTAGES / SAILENT FEATURES OF HYBRID SYSTEMS**

- (a) Eliminates expensive mains cable installation costs;
- (b) Eliminates any associated electricity bills;
- (c) Increases public safety aids in providing a safe working environment in areas where mains power is difficult to access;
- (d) Fully automatic operation; Easy to operate and maintain.
- (e) High quality construction and components;
- (f) .Designed for easy to operate, servicing and maintenance where required;
- (g) Most eco-friendly & clean source of power;
- (h) No pollution and no recurring fuel costs;

**IX HYBRID SYSTEM MAJOR COMPONENTS**

- (a) Solar Photovoltaic modules
- (b) Wind Generator

- (c) Hybrid Power Conditioning Unit  
(Inverter and charge controller)
- (d) Battery

- (e) Street lighting.
- (f) Transmissions & communication Tower and many more applications.
- (g) High output make ideal for virtually any remote battery charging application.

## X HYBRID POWER CONDITIONING UNIT

Hybrid power conditioning unit is used to combine the Solar PV Array & wind generator. This unit prevent the overcharging and the deep discharging of the battery bank. It is the brain of the whole set up. When batteries are fully charged then it stops the further charging of the batteries and when the batteries are deep discharged then it disconnects the load and allows the battery to charge. The output from Batteries is in DC form. To supply power to the loads sch as compact fluorescent lamps (CFL's), Street Lights, Television, this DC power needs to be converted to AC. Power conditioning is an electronic device which inbuilt Inverter, converts the DC power to AC with the help of IGBTs. The advantage of using AC is that we can use energy efficient lights such as CFLs. (e.g. 11W CFL gives same lumen output as that of 60W ordinary bulb) & we can optimise the overall system size, thereby saving in the initial higher investment.

## XI BATTERY

Once the power output from solar and wind is converted to DC, it is supplied to batteries and the batteries get charged. Depending upon the load requirement and the number of hours of operation of loads the adequate battery size is calculated. Battery banks are typically sized to supply the electric load for one to three days.



## XII APPLICATIONS

- (a) Ideal for cell phone recipient stations.
- (b) Farm houses, guesthouses, Hospitals, Hotels, Laboratories and R&D centres
- (c) Remote and Rural village Electrification.
- (d) Residential colonies & Apartments General lighting.

## XIII MNRE GUIDELINES

These guidelines are to select new projects and provide the necessary policy framework for development of projects under the scheme of JAWAHARLAL NEHRU NATIONAL SOLAR MISSION (JNNSM).

- (a) The objectives of these guidelines are:
  - (i) To facilitate a quick start up of the JNNSM,
  - (ii) To ensure serious participation for projects to be selected under JNNSM,
  - (iii) To facilitate speedier implementation of the new projects to be selected to meet the Phase I target of JNNSM;
  - (iv) To enhance confidence in the Project Developers and
  - (v) To promote manufacturing in the solar sector, in India

## XIV MNRE SUBSIDY

As part of this mission the Government has initiated a subsidy scheme to help individuals and organizations procure these Solar Energy Systems at reduced capital costs. The scheme is being implemented by IREDA (Indian Renewable Energy Development Agency Ltd.) through NABARD (National Bank for Agriculture and Rural Development). The scheme that was last modified on 15th March 2012 provides **40% subsidy** on capital costs of Solar PV Systems for units located in both urban and rural areas in India.

Models	Photovoltaic modules/ Panels (Vp)	Battery capacity	Maximum Recommended Load And Duty Cycle	Benchmark cost (Rs)	Maximum capital subsidy eligible (Rs)
I	13	12V,7AH(SMF)	5-7 Watt Load For 3-4 Hrs(20 Watt Hrs/Day)	2700	1080
II	18-20	12V,20AH(Tubular L.M.Gel VRLA)	10 Watt Load For 4 Hrs (40 Watt Hrs/Day)	4800-5400	2100
III	37-40	12V,40AH(Tubular L.M.Gel VRLA)	20 Watt Load For 4 Hrs (80 Watt Hrs/Day)	9900-10800	4320
IV	53	12V,50AH(Tubular L.M.Gel VRLA)	30 Watt Load For 4 Hrs (120 Watt Hrs/Day)	13500	5400
V	73-80	12V,80AH(Tubular L.M.Gel VRLA)	45 Watt Load For 4 Hrs (180 Watt Hrs/Day)	18000-21600	8640
VI	130	12V,80AH(Tubular L.M.Gel VRLA)	60 Watt Load For 4 Hrs (240 Watt Hrs/Day)	27000	10800
VII	125	12V,150AH(Tubular L.M.Gel VRLA)	75 Watt Load For 4 Hrs (300 Watt Hrs/Day)	33750	13500
VIII	150-190	24V,75/80AH(Tubular L.M.Gel VRLA)	90 Watt Load For 4 Hrs (360 Watt Hrs/Day)	40500-47200	17280
IX	230-240	24V,100/120AH(Tubular L.M.Gel VRLA)	120 Watt Load For 4 Hrs (480 Watt Hrs/Day)	54000-56700	22080

### XV EXPECTED ENERGY GENERATION DETAILS

- (a) The energy generated from the wind aero generator is considered 1kwh/day.
- (b) The energy generated from the solar module by considering 7hrs/day. For 75W x 7hrs = 525WHrs and For 150W x 7hrs = 1050WHrs
- (c) Energy generation

Sl No	Hybrid System	Generation Per Day Kwh	Generation Per Month Kwh	Generation Per Annum Kwh
1	600W = 400W WIND + 200W SOLAR	2.05	61	738

### XVI SIZING OF EQUIPMENT

Sl No	Name of the Equipment	Units	475	550
a	Wind Aero Generator	W	400	400
b	Solar PV module	W	75	150
c	12 V Battery	Ah	200	400
d	Solar PV module - Charger	A	10	15
e.	Hybrid Power Conditioning -Unit (Inverter and charge controller Systems).	VA	500	500

### XVII CONCLUSION

- (a) Standalone wind with Solar Photovoltaic is known as the best hybrid combination of all renewable energy systems and suitable for most of the applications taking care of seasonal changes.
- (b) Hybrid wind & solar systems provide more consistent year-round performance and reduce the need for back-up generation.
- (c) 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 as there is less reliance on one method of power production.
- (d) The packaged systems are ideally suited to remote homes, schools, clinics and other off-grid applications.
- (e) Remote and Rural village Electrification & domestic lighting applications.

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