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Hybrid Wind-PV Energy System for Rural Electrification

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ABSTRACT

The main energy source in rural is fossil fuel. Buy burning the fossil fuels, the rural citizen used to fulfil their energy demand. The burning of fossil fuel will pollute the environment by liberating CO, CO_2, SO_2, NO_2 and other harmful gases and these gases are also responsible for global warming. To prevent the pollution and also to fulfil the energy need of the rural people, the preference on clean renewable energy sources are more preferred like wind energy, solar irradiance energy, others as they are available in abundant quantity and free to all. The solar energy is available on in the morning time and wind is dominant the evening and night hours. To generate the clean energy for the whole day 24x7, the combination of two energy sources, solar energy and wind energy is done called hybrid wind solar energy system. In this system when one energy source is at its minimum other energy source will be at its maximum, resulting into constant supply of electricity to meet the energy demand of the rural citizens. Solar PV cell is a semiconductor which converts the incident solar light to electricity, dc voltage. PV cells are made using the material like mono crystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride and copper indium gallium selenide or sulphide . Using advanced technology for manufacturing of solar PV panels, high efficiency panels are made available and the price of the solar PV panel is decreasing with the advancement of the technology, hence due to reduced cost it has become easily affordable by the common citizen in the rural.

Keywords- Solar PV, Wind Energy Conversion system, Batteries, Nonconventional, Conventional

I. INTRODUCTION

In India, more than 70% of India's population live in rural and out of which 30% of rural villages are not having access to grid connected power, still not electrified because it was not possible to supply electrical power due to financial feasibility issue due to tough geographical locations. Hence to have development in rural, user friendly, most efficient and feasible energy system is required to be provided. The Hybrid wind solar energy system is the only answer to this problem, as it is cost

effective and user friendly, transmission losses will be less, Return on investment is just 15 years and the most important is that it is pollution free solution.

The conventional method of electricity generation & transmission has lots of drawbacks and hence to overcome the drawback the distributed energy generation is supported. Distributed electricity generation can be done by using renewable sources like win, solar, biomass, any many others. [2]. Presently hybrid wind solar energy system is largely promoted, globally [1]. The wind and solar energy sources are seasonable and they cannot supply electricity continuously. This renewable power system cannot supply nonstop deliver of energy, cyclic in nature, hence it becomes necessary to provide the support of the storage system, to store the generated electricity and use it whenever and where ever required. The storage system approach proves to be very costly and demands for very large size storage system. To keep the cost of the storage system less we will have to reduce the size of the storage system to minimum for renewable energy system to be price efficient. The best solution with cost effective solution is to combine the wind and solar energy sources as they are both complementary to each other, which mean when solar energy is at its maximum, wind energy will be at its minimum and vice-versa.

The use of hybrid wind solar system to meet the energy demand of the rural, releases the dependency for electricity from the conventional sources The recent research in this domain proves that, the renewable approach is quite economical than the conventional system, also this approach reduces the environmental pollution. Consider the case that if a small PV system generator in the capacity of 200w-600watts can me much financially feasible compared to petrol fuel generator of 600watt[3]. The only issue is that the initial investment for Solar Pv generator is more than the petrol operated generator. The payback period of solar PV generator is 15 years the addition drawback of using petrol generator is that it pollutes the environment by emitting harmful gases In ancient days the wind energy system is used for agriculture for irrigation for lifting the water from a well and for grinding the oil seeds. From 20th century onwards the wind energy is being used for electricity generation. Tiny aero-generators are used to charge the heavy ampere rating batteries. It found that wind velocity is stronger during winter and spring months, after that the velocities of wind fall off in the month of summer season. The opposite is true for solar irradiance, it is very rich in summer but it is very much affected by unclear days in the winter and spring. The cyclic variation are wind velocity and solar irradiance can be conquer to get more stable output from alternative energy system [5]. The wind and sunlight give more balanced output from alternative energy system [5]. This document presents the design for implementation of small wind solar system to meet the energy demand of a village without any Power cut. A short evaluation of wind solar scheme is described in section II and hybrid scheme design is describe in part III. The hybrid system sizing and its economical existence reliability is described in part IV and V independently.

II. SOLAR WIND HYBRID SYSTEM

I. As per IRDEA, India, The predictable possible capacity of various Renewable Energy sources is shown in table-1.

Table.1.Renewable Energy potential in India [6, 7].

Sl.No.	Energy source	Potential
1	Solar	20MW/sq.km
2	Wind	20,000 MW
3	Small Hydro	10,000MW
4	Ocean Thermal	50,000MW
5	Tidal	10,000MW
6	Biogas	12 Million plants
7	Biogas based cogeneration	3500MW
8	MSW	1000MW

The biggest market for solar energy is considered to be India. It is estimated to have solar PV based Power generation is about 20MW/Sq.Km India [5]. Each square meter of earth on which sunlight falls has the capacity to generate 1700Kwh of Power every year [1].The part of the solar radiation reaching earth is sufficient enough to generate the electrical power which is 10,000 times more than the global energy consumption. The solar energy can be utilisied to provide rid quality reliable power to meet the energy demand of the rural citizens, in the regions where there is a low voltage or heavy power cut are observed. The government of India has estimated to electrify 18000 villages by the year 2012 with the help of solar PV system [1]. This offer huge development for Indian PV industry. This resulted a wonderful commerce chance for solar module and additional related apparatus and associate system.

The blow of air is called as wind , the velocity of wind contain the kinetic energy along with the movement of the air. In ancient days, before the 20^{th} centurary, this wind energy is used by our ancestors for sailing the ship in sea, grinding the food grains, lifting of water from an open well for irrigation application. After 20^{th} centurary, wind energy is used for the generation of electricity [4].based electricity generation in the location where there is a continuous blow of air with sufficient velocity. The drawback of wind energy is that affects the visual impact consideration. When the blow of wind is very slow or calm, wind turbine generates very less or limited power. cyclic variation of sun and wind are shown in fig.1. cyclic variant in wind and sun means there are period wherever system perhaps inadequate within how really electrical power it can generate. So there is necessary to discover a solution to counterbalance the nil days of summer and the rainy days of winter

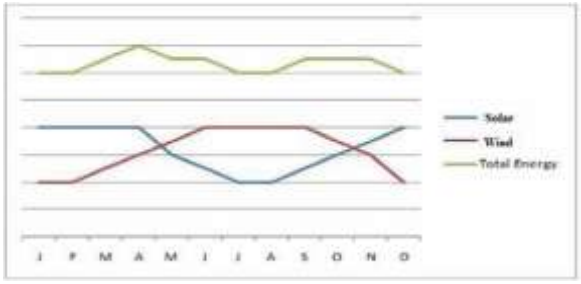

Fig.1. Seasonal Variation of sun and wind fortunately

To have the balance approach for generation of electricity, one has to plan to exploit the merits and demerits of wind and solar energy sources. The characteristics of wind and solar are opposite to each other, which means when wind energy is maximum, at that moment solar energy will be at its minimum and vice versa. This type of arrangement can be relevant for some rural area where there is a mountainous areas from which location the wind and solar energy are available in gigantic volumes. Therefore the plant integrate the profit of Solar PV and

wind energy. This concept may not be workable in city areas as the overall price of the project will be more than the mains power supply installation. Hence the planned method proves more cost-effective in rural locations.

III. SYSTEM CONFIGURATION

Hybrid power plant possesses of the PV solar panels and wind mills. The electrical energy produced by two energy sources is combined together. This combined electrical energy is connected to mixture charge regulator. The combined energy from the charge controller is than stored in an high efficiency, low self discharge, C_{10} rating, gel tubular battery with properly estimated AH rating to support the peak load for the desired back hour of time. .The output of the battery is then connected to high efficiency, pure sine wave inverter of suitable VA rating to drive the load. The DC energy from the battery is connected as an input to inverter, which converts the DC voltage to AC voltage, which in turn drives the load as per the necessity. The practical building block diagram of hybrid solar-wind power shown in fig.2.

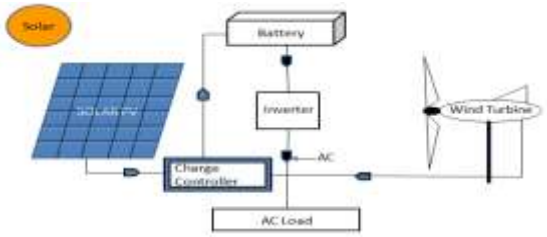

Fig.2. Block diagram of Solar-Wind Hybrid Power System

IV. SYSTEM SIZING

The proper sizing of the unit is done to optimize the system competence. Algorithm developed for sizing of the hybrid power plant is presented in fig.3.

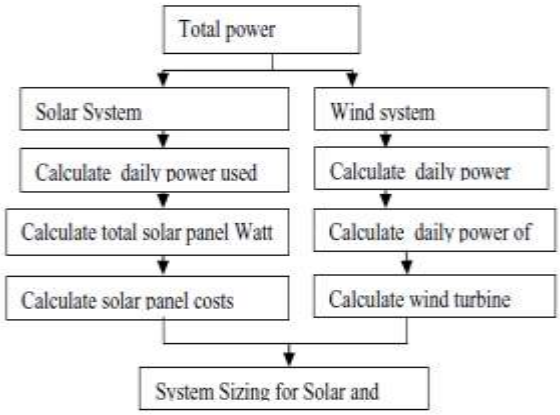

Fig.3 Flow Chart of system sizing

V. LIFE CYCLE COST

The sum total cost of preliminary money investment, the process and preservation price and the battery substitute price comprise the Life Cycle Cost of Hybrid Wind solar power plant. This is tool used to evaluate the know-how

price with Life cycle price investigation is a tool used to evaluate the final deliver price of the technology with diverse price configuration.

Example:- Consider, house having three rooms with 1 Tube, 3 CFL, 2 Fan & 1 T.V. as connected load.

Table No. 3 Total Consumption of House

Associated Load	Watts	Hour	Watt hour
1 Fluorescent lights	40	4.0	160
3 Closed Fluorescent Lamps	45	4.0	180
2 Fans	80	6.0	480
1Televion set.	150	6.0	900
overall Load	315		

Peak requirement of power= It is maximum requirement of load on the residence for the duration of a given period.

Diversity Factor= sum of individual max. Demand / Max. Requirement of house

ovel utilization= 1620wh

Estimated utilization= 1.8kwh or 1.8units/day Consumption per month= 1.8 x 30= 56units/month Monthly invoice=56 x 4=Rs.224/-

yearly invoice=224 x 12=Rs.2688/-

Estimated yearly invoice=Rs.2800/- per year

For solar panel:-

Solar panel watt capacity= 1.8kwh/7hours x 1.25=0.32142kw or 321.42watts per day

Solar section price= 321.42 x 150=Rs.48, 213/- (as per table given below)

For wind generation:-

For 800 w production of electricity considering value from table,

Wind System price=0.8 x 45,000= Rs. 36,000/-

Total cost of solar and wind system=

Rs 48213 + 36,000 + 8000 + 8000 = Rs. 1, 00,213/-

Table No. 2 price values of the financial parameters and apparatus for the base case

S. No	Parameters	Cost
1	Silicon type PV panel price	Rs.150-200 /Wp
2	Lead acid battery price	Rs.4000 /kWh
3	price of battery charge controller	Rs.2000 /kWh
4	Wind system cost	Rs.45,000 /kW
5	Economic assessment time	20-30 years

6	Lead acid battery normal life	4-5 years
7	Life period of wind turbine	10 years
8	Life period of SPV system	25 years
9	Silicon type panel effectiveness	8-14%

VI. COSTING:

The price for per KW hybrid wind solar system is in the range from Rs.2,50,000 to Rs.3,50,000 based on the proportion of wind and solar apparatus. The price of system erection along the price of construction work is estimated to be Rs 10,000 per KW.The price of service and maintenance is estimated to be RS 3000 per KW per year[1].

Reimbursement interval calculation:-

Overall price of hybrid wind solar system

=Rs. 1, 00,213/-= Rs. 1, 03,000/-

So, reimbursement interval for wind solar energy system will be,

Reimbursement interval= Total cost of solar and wind hybrid system

Overall price of utility supply reimbursement interval=1,00,213/1,03,000=0.97years=1year (approx)

So, Hybrid System is further proficient for rural area which are not yet electrified.

VII. CONCLUSION

Consider the present severe power shortage situation in the country with the rising price of natural gas, coal & fuel price used for the turbine and effect on environment due to pollution, the immediate solution is to be found out to find substitute source of energy to produce electricity. Many different methods are used to produce electricity using renewable energy sources like biogas, solar, wind, tidal, many others. Generation of electricity by using only solar or by only wind energy appears to be costlier and not feasible.

The hybrid technology for electricity generation is found quite beneficial to our country also they can diversify the electrical power supplies, reduce the pollution and improve the environment we breathe, reduce our dependency on imported fuels and rejuvenate our economy by creating new employment opportunities to educated youths in the manufacturing, installation, repair and maintenance & marketing of hybrid wind solar systems. Hybrid energy system can electrify the distant locations and urban cities in the coming future to prevent repeated unwanted power cuts.

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