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Hybrid Power Generation Using Single Axis Solar Tracking System and Wind Energy System

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ABSTRACT: This project presents the design of Hybrid Solar Wind turbine system for the power generation system by utilizing both solar and wind renewable energy. Even today, most of the electricity that we use is produced through conventional methods. Not only are these methods expensive, but also cause grave damage to the environment. The use of fuels for the generation of electricity results in increased costs and emissions of hazardous pollutants. The only alternative is a new method that is not only cheap and efficient, but also eco-friendly. The Single Axis Solar Tracking system and Vertical Axis Wind System is capable of satisfying both these requirements. In addition to being eco-friendly, it is also relatively cheaper when compared to the conventional methods of electricity generation. This system uses both Solar and Wind Energies to generate electricity. So, we have two efficient and inexhaustible sources for uninterrupted generation of electricity. The system has two basic components – one for generation of electricity through Solar Energy and another one for generation from Wind Energy. Even in the case of absence of either of the two sources, the other remaining source could be used to supplement the absence of the former. Due to all these features, the Solar-Vertical Axis Wind system could be considered suitable for replacing the existing old means of electricity generation. Because, not only are they cheaper, but also economic and highly efficient.

KEYWORDS: Solar Energy, Wind Energy, Hybrid power, Uniaxial.

I. INTRODUCTION

Imagining a day without electricity in today's world is equivalent to a nightmare. Since its inception in early 19th century, Electricity's relevance has changed from a mere spark for illumination to a massive driving force behind gigantic tasks. Today, Electricity has become an inseparable part of every household. It has gained as much significance as that of food and water for people. From sowing to harvesting and cooking, everything has electricity embedded within it. There are two ways to produce electricity first by using non-renewable sources of energy and second by renewable sources of energy. With increase in population and advancement of technology, consumption of electricity is also increasing exponentially. Simultaneously, we have to increase the production of electricity also in order to meet the demands of growing population. The biggest disadvantage with the usage of conventional resources is that their usage causes pollution due to the production of various pollutants like ash in case of a coal power plant, smoke in case of diesel power plant, radioactive material in case of nuclear power plant. Maintaining these pollutants is not an easy task and it also requires a lot of money. So we have to find some other methods to produce electricity. The best possible way is by using non-conventional sources of energy. Out of all the possible options available in non-conventional sources of energy, solar and wind are the best methods. As tidal energy can be used only on the sea shores, ocean thermal energy can used in the middle of the sea and its setup is also very difficult . While solar and windare available in all the areas of the world and setting up their power plant is also not a complex task. The availability of solar energy is a major concern, as it is available for around 8 hours in a day, on the other hand wind is available almost for 24 hours. But we can do one thing to make up for that problem by integrating these two together. During foul weather conditions one of them can be used while during normal weather both can be operated together. So in this paper we will be describing a solar-wind hybrid power system.

II. HYBRID SYSTEM

Now we have become even more interested in usage of renewable energy sources as an alternative method of producing electricity. Hybrid systems are basically an integration of solar panels and wind turbine, the output of this combination is used to charge batteries, this stored energy can then be transmitted to local power stations. In this

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system wind turbine can be used to produce electricity when wind is available and solar energy panels are used whensolar radiations are available. Power can be generated by both the sections at the same time also. The usage of batteries is to provide uninterrupted power supply.

2.1 Block Diagram

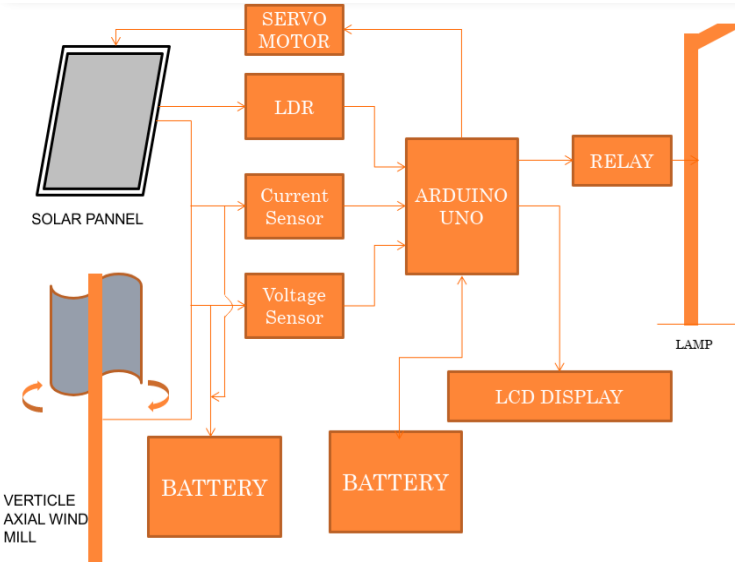

Fig 2.1 Block Diagram.

This block diagram consist of solar panel ,vertical axis wind turbine, ARDIUNO ,current sensor, voltage sensor ,light sensor ,servomotor ,relay ,LCD display ,battery and lamp. In this single axis solar tracking method we have two light sensors and one servomotor which are used to track the sunlight from east to west.

Here we use solar energy and wind energy hybrid to make use of natural sources to produce renewable energy. The system comprise of different component which is described already in block diagram.

2.2Working Description

In solar energy system , we used a solar panel having 9W output .it has 36 PV cells, each cells produce 1-1.5v. The panel here used is not fixed in single position, the position the panel can be changed accordingly to sun's direction. For rotating the panel servomotor is used. Firstly the light is sensed by the light sensor where the light radiation is high. The light sensor is connected to Arduino.The Arduino installed with software will generate pulse to start the servomotor is connected to 9W battery. Using this power the servo motor will rotate the panel to the direction of the sun to get more energy that we needed.

In wind energy system we used a vertical axis wind turbine which has more advantages for domestic usage. The windmill rotates in direction of wind to produce current. The current produced here is AC current which will converted to DC firstly by using DC motor.

Now both Solar and wind system produce its own energy which will saved in a battery to perform the work of domestic current usage. The LCD display used here is connected with the whole system to display the current and voltage produced in system at different times. In this model the LED bulb is connected to the output storage battery using controlling Relay to on & off the light.

III. PREVALENCE OF SOLAR POWER IN INDIA

Solar power in India is a fast-growing phenomenon. As of 6 April 2017, the country's solar grid had a cumulative capacity of 12.28 gig watts (GW) compared to 6.76 GW at the end of March 2016. In January 2015, the India expanded its solar plans, targeting US$100 billion of investment and 100 GW of solar capacity, including 40 GWfrom rooftop solar, by 2022. India's initiative of 100 GW of solar energy by 2022 is an ambitious target given the world's installed solar power capacity in 2014 was 181 GW.

India quadrupled its solar power generation capacity from 2,650 MW on 26 May 2014 to 12,288.83 MW on 10 March 2017. The country added 3.01 GW of solar power capacity in 2015-2016, and 5.525 GW in 2016-2017, the

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highest of any year. In addition to the large-scale grid connected solar PV initiative, India is continuing to develop the use of off-grid solar power for localized energy needs.

India has a poor electrification rate in rural areas. In 2015, only 55% of all rural households had access to electricity, and 85% of rural households depended on solid fuel for cooking. Solar products have increasingly helped to meet rural needs, and by the end of 2015, a cumulative total of just fewer than 1 million solar lanterns had been sold in the country, reducing the need for expensive kerosene. During 2015 alone, 118,700 solar home lighting systems were installed, and 46,655 solar street lighting installations were provided under a national program. The same year saw just over 1.4 million solar cookers distributed or sold in India.

India is one of the countries with the higher solar electricity production per watt installed, with an insolation of 1700 to 1900 kilowatt hours per kilowatt peak (kWh/KWp). On 16 May 2011, India's first solar power project under clean development mechanism is in is in Sivagangai Village, Tamil Nadu. India saw a sudden rise in use of solar electricity in 2010, when 25.1 MW was added to the grid, and the trend accelerated when 468.3 MW was added in 2011. Recent growth has been over 3,000 MW per year and is set to increase yet further.

With about 300 clear, sunny days in a year, the theoretically calculated solar energy incidence on India's land area is about 5000 trillion kilowatt-hours (kWh) per year (or 5 EWh/yr). The solar energy available in a year exceeds the possible energy output of all fossil fuel energy reserves in India. The daily average solar power plant generation capacity over India is 0.20 kWh per m2 of used land area, which is equivalent to about 1400–1800 peak (rated) capacity operating hours in a year with the available commercially-proven technologies.

So, by the given facts above, it can be seen that solar power generation is gaining ground gradually in India. But, much more work needs to be done in order to produce a substantial amount of electricity throughout the country through solar power.

3.2 Solar Power Generation Unit in Hybrid Power

The Solar component of Hybrid power generation system comprises of two basic components: The Solar Panel and Solar Tracking system. Both these parts are connected to the control unit which constantly monitors and sends commands to control the functioning of both of them. In this type of combination, the Solar Panel is not the lone source for electricity production. Even the Solar Tracking system is capable of producing electricity. So, we have two sources side-by-side to produce electricity – which means less effort and more electricity.

Solar panel

Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating.

A photovoltaic (PV) module is a packaged, connect assembly of typically 4x9 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications.

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Solar panel

Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells. The cells must be connected electrically in series, one to another Operating silently and without any moving parts or environmental emissions, PV systems have developed from being niche market applications into a mature technology used for mainstream electricity generation. A rooftop system recoups the invested energy for its manufacturing and installation within 0.7 to 2 years and produces about 95 percent of net clean renewable energy over a 30-year service lifetime.

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3.3 Description of Solar Tracking System

The continuous modification of the sun-earth relative position determines a continuously changing of incident radiation on a fixed PV panel. The point of maximum received energy is reached when the direction of solar radiation is perpendicular on the panel surface. Thus an increase of the output energy of a given PV panel can be obtained by mounting the panel on a solar tracking device that follows the sun trajectory. Unlike the classical fixed PV panels, the mobile ones driven by solar trackers are kept under optimum insolation for all positions of the Sun, boosting thus the PV conversion efficiency of the system. The output energy of PV panels equipped with solar trackers may increase with tens of percents, especially during the summer when the energy harnessed from the sun is more important. Photo-Voltaic or PV cells, known commonly as solar cells, convert the energy from sunlight into DC electricity. PVs offer added advantages over other renewable energy sources in that they give off no noise and require practically no maintenance. A tracking system must be able to follow the sun with a certain degree of accuracy, return the collector to its original position at the end of the day and also track during periods of cloud over.

Solar Tracker

Solar Tracker is basically a device onto which solar panels are fitted which tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. After finding the sunlight, the tracker will try to navigate through the path ensuring the best sunlight is detected.

Methods of Solar Tracker

a. Single axis solar trackers : Single axis solar trackers can either have a horizontal or a vertical axle. The horizontal type is used in tropical regions where the sun gets very high at noon, but the days are short. The vertical type is used in high latitudes where the sun does not get very high, but summer days can be very long. The single axis tracking system is the simplest solution and the most common one used.

b. Double axis solar trackers: Double axis solar trackers have both a horizontal and a vertical axle and so can track the Sun's apparent motion exactly anywhere in the World. This type of system is used to control astronomical telescopes, and so there is plenty of software available to automatically predict and track the motion of the sun across the sky. By tracking the sun, the efficiency of the solar panels can be increased by 30-40%.The dual axis tracking system is also used for concentrating a solar reflector toward the concentrator on heliostat systems .

Working

When the sensors track the direction of the sun and the angle, they send back the signals to the control unit. The control unit then issues a command to run the DC motor in order to align the solar panel such that it receives maximum sunshine again. The movement of servomotor during alignment results in generation of electricity due to the movement of its shaft.

IV. WIND POWER

Wind Energy, like solar is a free energy resource. But is much intermittent than solar. Wind speeds may vary within minutes and affect the power generation and in cases of high speeds - may result in overloading of generator.

Energy from the wind can be tapped using turbines. Setting up of these turbines needs little research before being established. Be it a small wind turbine on a house, a commercial wind farm or any offshore installation, all of them, at first, need the Wind Resource to be determined in the area of proposed site. The Wind Resource data is an estimation of average and peak wind speeds at a location based on various meteorological. The next step is todetermine access to the transmission lines or nearest control centre where the power generated from the turbines can be conditioned, refined, stored or transmitted. It is also necessary to survey the impact of putting up wind turbines on the community and wildlife in the locality. If sufficient wind resources are found, the developer will secure land leases from property owners, obtain the necessary permits and financing; purchase and install wind turbines. The completed facility is often sold to an independent operator called an independent power producer (IPP) who generates electricity to sell to the local utility, although some utilities own and operate wind farms directly.

Prevalence of Wind Power in India:

Wind power generation capacity in India has significantly increased in the last few years and as of 31 January 2017 the installed capacity of wind power was 28,871.59 MW, mainly spread across the South, West and North regions. By year end 2015 India had the fourth largest installed wind power capacity in the world. The development of

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wind power in India began in 1986 with the first wind farms being set up in coastal areas of Maharashtra, Gujarat and Tamil Nadu with 55 kW Vestas wind turbines. These demonstration projects were supported by the Ministry of New and Renewable Energy (MNRE).

HARDWARE

Fig 5.1 Hardware View.

The Hardware Components are listed below :
1-Ardino UNO
2-Light Sensor
3-Voltage Sensor
4-Curent Sensor
5-Servo Motor
6-LCD Display
7-Battery
8-Lamp
9-Solar Panel
10-Vertical Axis Wind Turbie

V. EXPERIMENTAL RESULT

In the model, the output get from the duel power source (solar and wind) is displaced in the LED. According to this, the output got in our model are given below

From solar panel

- Power=9W
- Voltage=12V
- Current=1A

From vertical axis wind turbine

- Current =0.5 A
- Voltage=3V

Since the wind mill rotate as per wind speed, the power we got is according to size of the wind turbine and wind speed in different areas.

For storing the energy source , the battery used here is 12V.Lamp with battery backup of 10 min this battery is connected to glow a7W LED bulb in this model.

The above model is in an idea of hybrid the solar and wind energy at same place. The efficiency of solar panel, wind turbine, battery backup can be calculated according to the power. We needed in order to create a prototype, this capacity of prototype may change from place to place as per or need.

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VI. CONCLUSION

Solar-wind hybrid energy system is the most feasible economic solutions in lowering electricity bills; it also avoids the high costs encountered during extending grid power lines to remote areas and provides a clean renew- able non-polluting source of electricity. Developing hybrid systems is one of the most convenient and effective solution for producing electricity as compared to non-renewable energy resources. It is not only less costly but also it does not cause any harm to the environment. Anotherthing is that it can be used to generate electricity in hilly areas, where it is quite difficult to transmit electricity by conventional methods. Depending on the requirement its setup can be decided. All the people in this world should be motivated to use non-conventional resources to produce electricity in order to make them self-reliable to some extent. Long life span, less maintainence are some of its plus point. It just requires some high initial investment.

Future Aspects

In this paper we study the various data about the wind, solar for generating the hybrid at small level that help to the decision makers to study the various factors in construct a Hybrid generation plant with a various minimum cost with highest generating capacity. The result shows by the experimental and theoretical data that has been able to predict the energy generation through hybrid system. For future scope different time period has been use for calculating the power and efficiency. This method motivates the engineers to install small scale solar wind hybrid system . The government of India takes a major decision towards the hybrid energy sources. The Jawaharlal Nehru solar mission (JNNSM) target to produce 20 gig-a watts up to 2022 and should 100 % Renewable up to 2050.

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