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Hybrid Power Generation System

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Abstract: *As Due to limit of use of conventional energy sources, these days emphasis is given on to the use of non-conventional sources of energy. Among them is the very popular wind energy source, in which wind energy is converted into mechanical form of energy first and then with the help of a generator thismechanical energy available is converted into electrical energy thereafter this form of energy become readyto be used by the users. Though this form of energy is abundantly available the problem is today's machinery. In its simple construction a vertical axis wind mill is constructed instead of it being rest on a thrust bearing it is levitated in air using magnetic property of same pole repelling each other. One magnet isfitted into the wind mill while the other is fitted in to the hoist. Generator is coupled with is wind mill therebygenerating the electricity efficiently and at a larger capacity. The electricity generated from this type of windmill is also very large compared to the conventional wind mills. Wind energy turbines are not that kind of efficient to produce continues & sufficient power so that, to overcome the problem associated with conventional turbines we are introduces to make hybrid electricity generation system along with Solar panelas a new breed being developed. This has motivated for combining two or more renewable energy resources*
i.e., hybrid power generation. The project deals with the study and design of hybrid system of solar and wind energy for rural area's applications.

Keywords: Solar, Wind, Hybrid Power, Higher Electrical Output, etc.

I. INTRODUCTION

The concept of solar and wind energies dates back to nearly 7,000 years ago. However, in the late 1800s the Danes developed the first wind turbines to produce commercial electricity. In the early 1900s small- scale wind turbines became more widely used around Europe especially in the rural areas for producing electricity using old car generators and carved rotors. The wind power brought electricity to the rural areas and the electrical power was used to charge batteries to run radios and to draw water from deep wells. Except in Denmark where wind power production and research continued, wind power did not play any majorrole in the generation of electricity until the late 1900s. The rapid growth of solar and wind powers is due inpart to favorable global political climate towards these energies, efforts to reduce carbon dioxide (CO2) and greenhouse gases (GHG) and other power plant pollutants, global awareness of climate changes, and the urgency to develop renewable energy sources.

Other factors such as lucrative tax incentives and legislation man-dating national renewable energy standards have accelerated the march towards solar and wind energies. For example, in the US, some states have enacted "renewable portfolio standard (RPS)" law that requires utilities to sell a certain percentage of the energy from sustainable energy sources within reasonable stipulated times. Even though Europe and North America have the largest in-stalled capacity of wind turbine capacity, China, India, and developing world have the biggest potential for wind power.

Solar and wind hybrid generation is most popular power generation method as these are available readily everywhere. This paper focuses on design aspects and fabrication of hybrid power generation model. Hybridenergy generation is turning out to be a more popular method of distributing electricity in rural areas and inurban areas as well where the land constraint plays a major role. Hybrid model proposed here combines solarpanels and vertical axis wind turbine and provides continuous supply with increased reliability. This Hybridrenewable Generation system can become the best solution for feeding the mini-grids and isolated loads inremote areas. The system can also provide an answer for the individual energy concern. Higher total energyefficiency, improved operational performance, dispatch and operational control can be obtained through theproper technology selection and generation unit sizing.

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Researchers and engineers are developing differentconfigurations to utilize the system component effectively. The figures below show such two kinds of arrangements used for the hybrid generation system. Horizontal axis wind turbine system, which is most ofthe time used in wind farm, produces energy generally in MW; but its installation and maintenance cost arehigh whereas the vertical axis machines are cost and size effective, hence useful for small scale applications. Many countries are also providing fund and assistance for building it in order to satisfy the needof electricity. In India, central as well as state governments are spreading awareness and guiding people for its expansion. Maharashtra State Energy Development Agency (MEDA) is one of government institution, whopromotes renewable energy systems.

Following list shows year wise achievement of wind and solar hybridsystems and its progress in the state of Maharashtra, India. Solar energy and wind energy have been deemed clean, inexhaustible, unlimited, and environmentally friendly. Such characteristics have attracted theenergy sector to use renewable energy sources on a larger scale. However, all renewable energy sources have drawbacks. Wind and solar sources are dependent on unpredictable factors such as weather and climatic conditions. Due to both sources, complementary nature, some of these problems can be overcomethe weaknesses of one with the strengths of the other. This brings us to the hybrid solar-wind power plant concept. Hybrid energy stations have proven to be advantageous for decreasing the depletion rate of fossilfuels, as well as supplying energy to remote rural areas, without harming the environment.

Hybrid Renewable Energy Systems (HRES) are becoming popular as stand-alone power systems for providing electricity in remote areas due to advances in renewable energy technologies and subsequent risein prices of petroleum products. A hybrid energy system, or hybrid power, usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply. Most of us already know how a solar/wind power generating system works, all these generating systems have some or the other drawbacks (considering standalone system), like Solar panels are too costly and the production cost of power by using them is generally higher than the conventional process, it is not available in the night or cloudy days. Similarly, Wind turbines can't operate in high or low wind speeds. Solar hybrid power systems are hybrid power systems that combine solar power from a photovoltaic system with another power generating energy source. This would create more output from thewind turbine during the winter, whereas during the summer, the solar panels would produce their peak output. Hybrid energy systems often yield greater economic and environmental returns than wind, solar, geothermal or tri-generation stand-alone systems by themselves.

The thermal power stations are causing pollution which severely affects mankind and nature. These powerstations result in causing many diseases. Also, natural resources like coal, oil, radio-active materials etc. willget extinct in near future. The other existing power generating systems like Hydro-Electricity power generating plant cannot afford much power as it is season based, although it causes less pollution. Therefore, it is of great urgency to go for non-conventional energy resources. The most popular non- conventional energy resource is solar energy which converts solar energy or solar radiation to electricity. Solar power generation system has some drawback, that is, it cannot generate power in cloudy or rainy days. Therefore, people using this solar system have to remain without electricity (power) after battery gets shortcomings, as it is completely dependent on appearance of the sun in the sky. Moreover, it has very muchlimited capacity and we cannot take all available solar energy as its efficiency is much less. The aim of thiswork is to design and implement a Hybrid power generation system using wind energy-solar, where conventional photovoltaic (PV) solar cells are inefficient and where there is an abundance of solar energy.

II. LITERATURE REVIEW

Varad Bagwe, Abhijeet Thoke, Charchit Vatsa, Dibyanshu Pandey, Sangeeta Kotecha, done the work on, Integration of Solar and Wind Energy System for Hybrid Power Generation, according to his study, With theincreased global warming concern it is becoming important to find an alternative to conventional energy sources causing less pollution and leading to sustainable use of available resources. This has encouraged renewable energy generation to become a leader in energy sector but the main obstacle in its path is its costeffectiveness. This has motivated for combining two or more renewable energy resources i.e., hybrid powergeneration. The paper deals with the study and design of hybrid system of solar and wind energy for rural area's electrification. A hybrid power generation system is better solution for power generation than conventional energy resources especially in rural areas where electricity is not stable or absent. The powergenerated can be utilized in situ thereby reducing transmission losses and cost.

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The designed hybrid systemis very compact, easy to install and ensures no power failure by solar during the day and wind during the night. As the idea is in its initial stage, so productive changes may be implemented in later stages. It is highlysafe for the environment having long life span and only need initial investment thus overall, it is good, reliableand affordable solution for electricity generation.

Dr. Recayi Pecen, Dr. MD Salim, & Dr. Marc Timmerman, done the work on, A Hybrid Solar-Wind Power Generation System as an Instructional Resource for Industrial Technology Students, according to his study,the detailed study of electrical power systems is a key element of many curricula in Industrial Technology. Anovel laboratory set-up has been designed and implemented at the University of Northern Iowa as an instructional resource for teaching electrical power system and renewable energy concepts. The set-up consists of a photo-voltaic solar-cell array, a mast mounted wind generator, lead-acid storage batteries, aninverter unit to convert DC power to AC power, electrical lighting loads and electrical heating loads, several fuse and junction boxes and associated wiring, and test instruments for measuring voltages, currents, powerfactors, and harmonic contamination data throughout the system. This hybrid solar-wind power generating system is extensively used to illustrate electrical concepts in hands-on laboratories and demonstrations inthe Industrial Technology curriculum. Obviously, a complete hybrid power system of this nature may be tooexpensive and too labor intensive for many Industrial Technology Departments.

However, many of the same benefits could be gleaned from having some subset of the system, for examplea PV panel, batteries, and an inverter, or even just a PV panel and a DC motor. The enhancements to instruction, especially in making electrical power measurements more physical, intuitive, and real-world aresubstantial and the costs and labor involved in some adaptation of the ideas in this paper to a smaller scalesetup are reasonable. The use of solar and wind hybrid power generation is an especially vivid and relevantchoice for students of Industrial Technology in Iowa as these are power sources of technological, political, and economic importance in their state. In other places, other power sources could be used. For example, hybrid combinations of wind power, solar power, geothermal power, hydroelectric power, tidal power, biomass generated power, power from incineration of solid wastes, and many other technologies could be considered depending on local interests and resources. The key elements of this test bed concept presentedin this paper are two or more renewable power sources connected to a power grid with complex electrical interactions.

To avoid confusion, the family name must be written as the last part of each author name (e.g., John A.K. Smith).

Each affiliation must include, at the very least, the name of the company and the name of the country wherethe author is based (e.g., Causal Productions Pty Ltd, Australia).

III. Page Style Research Methodology

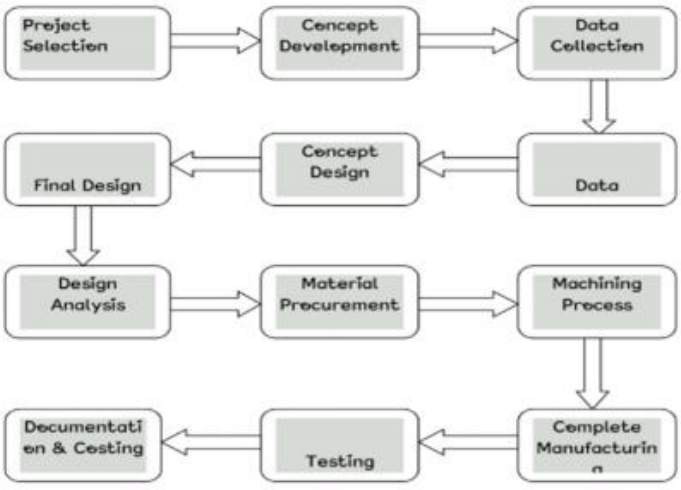

Figure 1: Flowchart of Process

3.1. Solar Panel:

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The photo- voltaic effect can be observed in nature in a variety of materials that have shown that the best performance in sunlight is the semiconductors as stated above. When photons from the sun are absorbed ina semiconductor, that create free electrons with higher energies than the created there must be an electric field to induce these higher energy electrons to flow out of the semi-conductor to do useful work. A junctionof materials, which have different electrical properties, provides the electric field in most solar cells for the photon interaction in a semiconductor. A solar cell consists of,

1. Semi –conductor in which electron hole pairs are created by the absorption of incident solar radiation.
2. Region containing a drift field for charge separation.
3. Charge collecting front and back electrodes.

Figure 2: Solar Panel

The photo-voltaic effect can be described easily for p-n junction in a semi-conductor. In an intrinsic semi- conductor such as silicon, each one of the four valence electrons of the material atom is tied in a chemical bond, and there are no free electrons at absolute zero. If a piece of such a material is doped on one side by afive-valance electron material, such as arsenic or phosphorus, there will be an excess of electrons in that side, becoming an n-type semi-conductor. The excess electrons will be practically free to move in the semi-conductor lattice. When a three-valance electron material, such as boron dopes the other side of the same piece, there will be deficiency of electrons leading to a p-type semi-conductor. This deficiency is expressedin terms of excess of holes free to move in the lattice. Such a piece of semi-conductor with one side of the p-type and the other, of the n-type is called p-n junction. In this junction after the protons are absorbed, the free electrons of the n-side will tend to flow to the p-side, and the holes of the p-side will tend to flow to then-region to compensate for their respective deficiencies.

This diffusion will create an electric field from the n-region to the p-region. This field will increase until it reaches equilibrium for voltage, the sum of the diffusion potentials for holes and electrons. If electrical contacts the connected through an external electrical conductor, the free electrons will flow from the n-typematerial through the conductor to the p-type material as shown in the figure. Here the free electrons will enter the holes and become bound electrons thus both free electrons and holes will be removed.

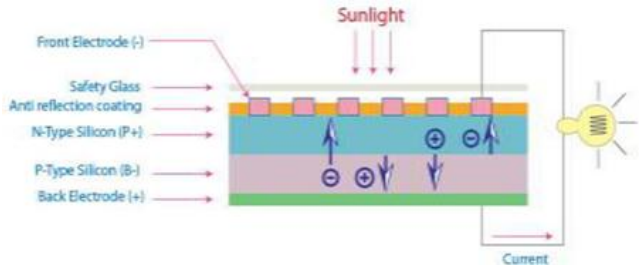

Figure 3: Photovoltaic Effect

The flow ofelectrons through the external conductor constitutes an electric current, which will continue as long as movefree electrons and holes are being formed by the solar radiation. This is the basis of photo-voltaic conversion that is the conversion of solar energy into electrical energy.

The combination of n-type and p-typesemiconductors thus constitutes a photo-voltaic cell or solar cell. All such cells some

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rate direct current thatcan be converted into alternating current if desired. The photo-voltaic effect can be observed in almost anyjunction of material that have different electrical characteristics, but the best performance to date has beenfrom cells using semiconductor material especially all of the solar cells used for both space and terrestrial applications have been made of the semiconductor silicon. Future cells may use such materials as the semiconductors like Gallium arsenate, copper sulphate cad sulphate etc. The device used to utilize the photovoltaic effect is solar cell.

3.2 Solar Charger:

The power charge regulator is also known as charge controller, voltage regulator, charge-discharge controller or charge-discharge and load controller. The regulator sits between the array of panels, the batteries, and the equipment or loads. By monitoring the voltage of battery, the regulator prevents overcharging or over discharging. Regulators used in solar applications should be connected in series: theydisconnect the array of panels from the battery to avoid overcharging, and they disconnect the battery fromthe load to avoid over discharging. The connection and disconnection are done by means of switches which can be of two types: electromechanical (relays) or solid state (bipolar transistor). Solar chargers should never be connected in parallel. In order to protect the battery from gasification, the switch opens the charging circuit when the voltage in the battery reaches its high voltage disconnects (HVD) or cut-off set point. The low voltage disconnects (LVD) prevents the battery from over discharging by disconnecting the load. The most modern regulators are also able to automatically disconnect the panels during the night to avoid discharging of the battery. They can also periodically overcharge the battery to improve their life, andthey may use a mechanism known as pulse width modulation (PWM). Solar charger has three lightindicators. The first light blinks when the batteries are charging by using solar energy. The second light glows when the charging in the batteries is very low. The third light glows when the batteries are fully charged and an extra load (charging) is applied on the batteries.

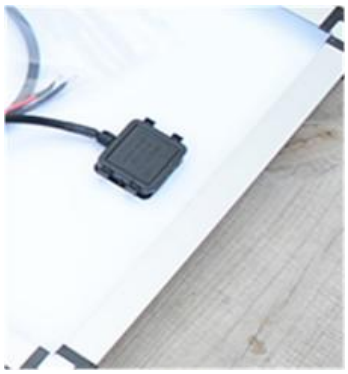

Figure 4: Solar Charger Circuit

3.3 Battery:

The batteries are used as a storage device for solar energy which can be further converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water suppliesfor storage, for small units with output less than one kilowatt. Batteries seem to be the only technically andeconomically available storage means. Since both the photo- voltaic system and batteries are high in capitalcosts, it is necessary that the overall system be optimized with respect to available energy and local demandpattern. To be economically attractive the storage of solar electricity requires a battery with following particular combination of properties:

Specification of Battery:

Battery Type: Lead Acid Battery
Charging Time: 1 to 1.5 Hours

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Figure 5: Battery

3.4) DC Motors:

A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore so is its current. The current in the rotor is switched by the commentator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque. DC motors have a rotating armature winding (winding in which a voltage is induced) but non-rotating armature magnetic fieldand a static field winding (winding that produce the main magnetic flux) or permanent magnet. Different connections of the field and armature winding provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armatureor by changing the field current. The introduction of variable resistance in the armature circuit or field circuitallowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.

Figure 6: DC Motors

Specification:

DC supply: 12V
RPM: 60 at 12V
Shaft diameter: 6mm

3.5) Ball Bearings:

This type of bearing consists of i) a cast iron pedestal, ii) gun metal, or brass bush split into two halves called “brasses”, and iii) a cast iron cap and two mild steel bolts. The detailed drawing of a pedestal bearing is shown in image below. The rotation of the bush inside the bearing housing is arrested by a snug at the bottom of the lower brass. The cap is tightened on the pedestal block by means of bolts and nuts. The detailed part drawings of another Plummer block with slightly different dimensions are also shown in image below.

Figure 7: Pedestal Bearing

IJARSCT
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3.6) Shaft:

Shaft is a common and important machine element. It is a rotating member, in general, has a circular cross- section and is used to transmit power. The shaft may be hollow or solid. The shaft is supported on bearings and it rotates a set of gears or pulleys for the purpose of power transmission.

Material for Shafts:

The ferrous, non-ferrous materials and nonmetals are used as shaft material depending on the application.

Figure 8: Shaft

3.7) Washer:

A washer is a thin plate (typically disk-shaped) with a hole (typically in the middle) that is normally used to distribute the load of a threaded fastener such as a screw or nut. Other uses are as a spacer, spring (wave washer), wear pad, preload indicating device, locking device, and to reduce vibration (rubber washer). Washers usually have an outer diameter (OD) about twice the width of their inner diameter (ID). Washers are usually metal or plastic. High quality bolted joints require hardened steel washers to prevent the loss of pre-load due to Brinelling after the torque is applied. Rubber or fiber gaskets used in taps (or faucets, or valves) to stop the flow of water are sometimes referred to colloquially as washers; but, while they may look similar, washers and gaskets are usually designed for different functions and made differently. Washers are also important for preventing galvanic corrosion, particularly by insulating steel screws from aluminum surfaces.

Figure 9: Washer

3.8) Nut and Bolt:

As nuts and bolts are not perfectly rigid, but stretch slightly under load, the distribution of stress on the threads is not uniform. In fact, on a theoretically infinitely long bolt, the first thread takes a third of the load, the first three threads take three-quarters of the load, and the first six threads take essentially the whole load. Beyond the first six threads, the remaining threads are under essentially no load at all. Therefore, a nut or bolt with six threads acts very much like an infinitely long nut or bolt.

Figure 10: Nut and Bolt

IJARSCT
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International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
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3.9) Spur Gear:

A gear is a rotating ((machine part having cut teeth, or in the case of a cogwheel, inserted teeth (called cogs), which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a ((power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape. Two or more meshing gears, working in a sequence, are called a gear train or a ((transmission. A gear can mesh with a linear toothed part, called a rack, producing((translation instead of rotation.

Figure 11: Spur Gear

3.10. Wild Mill Blade:

The number of blades is selected for aerodynamic efficiency, component costs, and system reliability. Noise emissions are affected by the location of the blades upwind or downwind of the tower and the speed of therotor. Given that the noise emissions from the blades' trailing edges and tips vary by the 5th power of bladespeed, a small increase in tip speed can make a large difference. Carbon fiber-reinforced is generally used material for wild mill blade.

Figure 12: Wild Mill Blade

IV. MECHANICAL DESIGN

In mechanical design the components are listed down and stored on the basis of their procurement in two categories,

Design Parts & Parts to be Purchased.

For designed parts detailed design is done and dimensions there obtained are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified.

The process charts are prepared and passed to manufacturing stage. The parts to be purchased directly areselected from

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various catalogues and are specified so as to have case of procurement In mechanical designed at the first stage selection of appropriate material for the part to be designed for specificapplication is done. This selection is based on standard catalogues or data books.

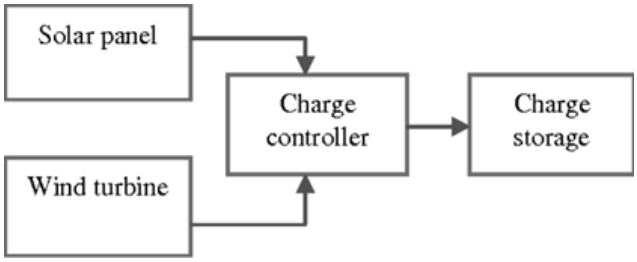

Figure 13: Setup Block Diagram of Hybrid Power Generation System

Solar energy is energy from the Sun. It is renewable, inexhaustible and environmental pollution free. 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 nonexistent.Wind is a natural phenomenon related to the movement of air masses caused primarily by the differential solar heating of the earth's surface. Seasonal variations in the energy received from the sun affect the strength and direction of the wind. The wind turbine captures the winds kinetic energy in a rotor consisting of two or more blades mechanically coupled to an electrical generator. The turbine is mounted on a tall tower to enhance the energy capture.

The hybrid power means something which is made by the combination of solar & wind power storage element. In energy system the electricity can be generated by two sources at a time like Wind & solar. Here we are developing a module to generate hybrid energy like wind-solar hybrid. Among the above hybrid energygeneration module, the wind-Solar hybrid module is more important because it is abundant in nature and it is very much environment friendly. Hybrid energy generation is more important because the wind not floe continuously and sun radiation is only present approx. 8 to 10 hours in a day. So, for continuous power it is important to hybridize the solar and wind power with the storage batteries. The hybridization in India has large prospect because over 75 % of Indian household face the problem like power cut specially in summer. In the proposed model, a charge controller is used to regulate the power generated by both solar panels and the wind turbine. It also simultaneously charges battery and gives power to the load. The controller has over-charge protection and short-circuits protection. A specifically chosen battery is used to store the generated power. A Charge controller, considered as a heart of solar generation system, is used to regulate the voltages and current coming from the solar panels and wind generator. It regulates the chargeto the batteries preventing any overcharging.

V. CONCLUSION

Renewable energy sources are currently one of the most, if not the only, suitable option to supply electricity in fragmented areas or at certain distances from the grid. Indeed, renewable are already contributing to therealization of important economic, environmental and social objectives by the enhancement of security of energy supply, the reduction of Greenhouse gases and other pollutants and by the creation of localemployment which leads to the improvement of general social welfare and living conditions. Hybrid systemshave proved to be the best option to deliver “high quality” community energy services to rural areas at the lowest economic cost, and with maximum social and environmental benefits. Indeed, by choosing renewable energy, developing countries can stabilize their CO2 emissions while increasing consumption through economic growth. As the usage of fossil fuels are increasing day by day it has an adverse effect onenvironment, it also increases the depletion of fossil fuels. We will see a world without fossil fuel in future.

Without the energy sources we cannot generate electricity. So, we have to depend extensively on renewableenergy sources and make use of them to a larger extent. So, by this system of smart poles, we can increasethe utilization of wind and solar power. After the required advancements of the system these can replace theexisting energy systems which will be produce combine 12-to-15-watt power. Reaching the non-electrifiedrural population is currently not possible through

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the extension of the grid, since the connection is neither economically feasible, nor encouraged by the main actors.

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