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Solar and Wind Power - A Hybrid Design

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Abstract - All the natural sources of energies are used for production of Electricity. Thus, the Electrical Power or Electricity is available with a minimum cost and pollution free to anywhere in the world at all times. This paper will reveal a novel step in generation of electricity with the use of available natural resources without disturbing the ecological balance. This paper describes a novel and developing Electrical Power Generation mechanism by integrating photovoltaic Solar Energy, solar Energy with Nano-antenna, Wind Energy and non-conventional energy sources. Thus we can have an uninterrupted power supply irrespective of the weather condition without any sort of environmental pollution. Furthermore this process makes possible the electricity generation at least production cost. Utilizing lightning energy for electricity generation reveals a advanced step. The equipment consists of combination of PV solar-cell array & Nano-antenna array, a mast mounted wind generator, storage batteries(lead-acid) , an inverter used 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 ,power factors ,currents and harmonic contamination data throughout the system. This hybrid solar-wind power generating system is suitable for Industries and also domestic areas.

Keywords - Photo-voltaic, Solar Cell, Nano-antenna, Wind Energy, Conventional Energy, Renewable Energy

I. INTRODUCTION

The thermal power stations are causing pollution which severely affects mankind and nature. These power stations result in causing many diseases . Also natural resources like coal, oil, radio-active materials etc will get 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 discharged during the rainy season or in the sun's shortcomings, as it is completely dependent on appearance of the sun in the sky. Moreover, it has very much limited capacity and we cannot take all available solar energy as its efficiency is much less.

The aim of this work is to design and implement a Hybrid power generation system using wind energy-solar energy-solar energy with nano-antenna. A Nano-antenna electromagnetic collector (NEC) has been designed, prototyped, and validated. The NEC devices target mid- infrared wavelengths, where conventional photovoltaic (PV) solar cells are inefficient and where there is an abundance of solar energy .

II. ENERGY RESOURCES AND TYPES

Energy resources are classified into non-renewable and renewable resources.

A. Non-renewable Energy Resources

Non-renewable energy resources are the ones which are limited and become extinct with the time , such as oil, coal and coal derivatives, natural gas, wood and radioactive material (uranium,plutonium) and also produces a lot of harmful waste.

B. Renewable Energy Resources

Renewable energy resources are the ones that are continuously available and renewing itself with the time. Industrialization and ever increasing world population need the use of renewable energy resources. Solar energy, wind energy, biomass, tidal energy, wave energy, geothermal power are popular.

1) Wind Power

The wind energy is a renewable source of energy. Wind turbines are used to convert the wind power into electric power. Electric generator inside the turbine converts the mechanical power into the electric power. Wind turbine systems are available ranging from 50W to 3-4 MW. The energy production by wind turbines depends on the wind velocity acting on the turbine. Wind power is able to feed both energy production and demand in the rural areas.

It is used to run a windmill which in turn drives a wind generator or wind turbine to produce electricity. Practically it is observed that the flexible three blades propeller about 40m in diameter, in a 62 Km/hr wind pressure with a rotation speed of 48 rpm produce maximum power 14 MW. For small wind power generation system, multiple blade type (3 - 5 number of blades) or Darrius type (Curved Blade 3 - 5 numbers) is suitable. The main drawback of this system is that as the wind speed or velocity is not constant with respect to time i.e. fluctuating, hence the electric power thus obtained is also does not have a fixed value i.e. varying nature. Thus, it is better to feed the wind electricity to the battery or any power storage device which supply the load consecutively, rather than directly supply to the load as shown in Figure.

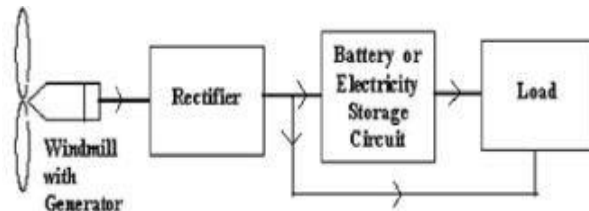


Fig.1. Block Diagram of basic Windmill Power System

In wind power system, the power generation increases in proportion to the cube of the wind speed. Thus it is highly affected in rainy and stormy season when the wind speed is too less to produce electricity. This power generation system is pollution free and ecologically balanced.

2) Photovoltaic Solar Power

Solar panels are the medium to convert solar energy into the electrical energy. Solar panels can convert the energy directly or heat the water with the induced energy. PV (Photo-voltaic) cells are made up from semiconductor structures as in the computer technologies. Sun rays are absorbed with this material and electrons are emitted from the atoms. This release activates a current. Photovoltaic is known as the process between radiation absorbed and the electricity induced. Solar power is converted into the electric power by a common principle called photo electric effect.

The solar cell array or panel consists of an appropriate number of solar cell modules connected in series or parallel based on the required current and voltage.

Storage batteries as shown in Fig.2 provide the backup power during cloudy weather to store the excess power or some portion of power from the solar arrays. This solar power generating system is used for domestic power consumption, meteorological stations and entertainment places like theatre, hotel, restaurant etc.

Traditional p-n junction solar cells are the most convenient of the solar energy harvesting technologies. The basic physics of energy absorption and carrier generation are a function of the materials characteristics and corresponding electrical properties (i.e. band gap). A photon only need greater energy than $2eV$ that of the band gap in order to excite an electron from the valence band into the conduction band. However, the solar frequency spectrum approximates a black body spectrum at $\sim 6000\text{ K}$, and as such, much of the solar radiation reaching the Earth is composed of photons with energies greater than the band gap of silicon

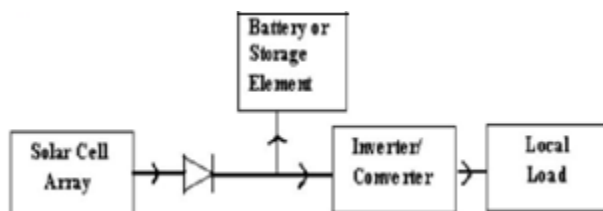


Fig.2. Basic Solar (Photovoltaic) System

These higher energy photons will be absorbed by the PV cell, but the difference in energy between these photons and the silicon band gap is converted into heat rather than into usable electrical energy. For a single-junction cell this sets an upper efficiency of $\sim 20\%$. The current research path of implementing complex, multi-junction PV designs to overcome efficiency limitations does not appear to be a cost-effective solution. Even the optimized and developed PV materials are only operational during daylight hours and require direct (perpendicular to the surface) sunlight for good efficiency.

III. ALTERNATIVE SOLUTION TO PV BASED SOLAR CELL

We have an alternative energy harvesting approach based on Nano-antennas that absorb the incident solar radiation. The Nano-antennas target mid-infrared rays, which the Earth continuously radiates as heat after absorbing energy from the sun during the day. In contrast, traditional solar cells can only use visible light, rendering them idle after dark. Infrared radiation is an especially rich energy source because it is also generated by industrial processes such as thermal plants.

We have designed Nano-antenna elements that capture electromagnetic energy from solar radiation and geo thermal radiation. The size of the antenna is relative to the wavelength of light we intend to harvest. The basic theory of operation is as follows: The incident electromagnetic radiation produces a standing-wave electrical current in the finite antenna array structure. Absorption of the incoming Electro Magnetic radiation energy occurs at the designed resonant frequency of the antenna .

Since objects give off heat as infrared rays, the nano antennas could collect those rays and re-emit the energy at harmless wavelengths. Such a system could cool down buildings and computers without the external power source required by air-conditioners and fans. It also provides designers another mechanism to increase the efficiency of antenna arrays through the expansion of the radial field. Antennas by themselves do not provide a means of converting the collected energy. This will need to be accomplished by associated circuitry such as rectifiers.

The Nano-antennas are tiny gold squares set in a specially treated form of polyethylene, a material used in plastic bags. A Nano-antenna array capable of collecting power from infrared energy that could be harvested in any weather . The cell production process is even supposed to be ridiculously cheap compared to making standard silicon photovoltaic cells, but, as always, there's a rub. The grid collects its oscillating IR energy at ten thousand billion times per second, which is proving to be a challenge to the nerds behind the tech, who are working on a way to convert that to the 50-60Hz power that the world uses.

Nano-antennas, on the other hand, can be tweaked to pick up specific wavelengths depending on their shape and size. This flexibility would make it possible to create double-sided nano antenna sheets that harvest energy from different parts of the sun's spectrum.

A. Structure of PV cell with Nano- antenna

The structure of proposed design consist array of Nano antennas at the middle part of structure and boundary covered by Photovoltaic cells shown in figure in 3. It also consist controlling circuit at the back side of panels.

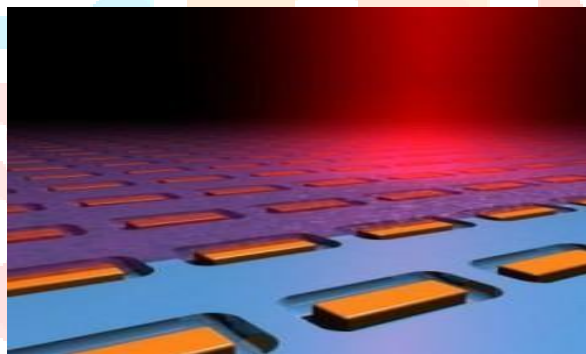


Fig.3. PV cell with nano antenna array

IV. INTEGRATED POWER GENERATION SYSTEM BASED ON WIND ENERGY- PHOTOVOLTAIC SOLAR ENERGY- SOLAR PANEL WITH NANO-ANTENNA

To eliminate the above drawbacks of individual renewable power generation system like Solar and Wind, we design a new electricity or power generating system by integrating the wind energy sources, Photovoltaic solar energy and Solar energy with Nano-antenna simultaneously, so that power supply remains continuous without any sort of interruptions or load shedding.

The aim of this work is design and implementation of a Hybrid power generation system using wind energy- photovoltaic solar energy- solar energy with Nano-antenna for continuous (24*7) power generation.

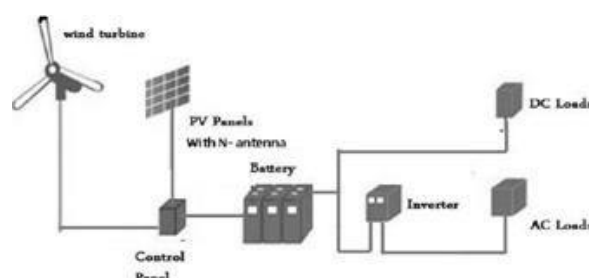


Fig.4. Integrated Electricity Generating System

The Solar-Wind with Nano-antenna Power Generation System is designed as shown in Fig. It has some special equipment to charge the battery or the power storage (accumulator) circuit. Control circuit ad-joint with electric power generating system provides necessary control functions such as adding or summing up electric power derived from more than one sources at a time i.e. solar and wind power simultaneously, solar with Nanoantenna and wind power. simultaneously, over voltage protection, amount of electric power directed to the load and the battery etc. Thus by implementing Solar with Nano-antenna Wind-Lightning Integrating Power Generation System in a compact package, we have an uninterrupted power supply at the minimum cost.to all places at all times. Moreover, we can avoid the accidental risk and causes by lightning to human and nature both. This method ensures a highly practical oriented pollution free and accident free inventory for electric power generation system. The electric power afforded by this system is completely pure and secured form without any sort of environmental pollution. Also it does not produce any greenhouse effect or acid rain or emit any kind of poisonous gases or radiation etc.

V. RESULTS

Both modeling and experimental measurements demonstrate that the individual nanoantennas can absorb close to 90 percent of the available in-band energy. Optimization techniques, such as, increasing the radial field size could potentially increase this efficiency to even higher percentages. The current and voltage values from the wind turbine, solar panels, battery group, and load are measured in the implemented system. Production and consumption of power for each module can be calculated. In order to allow separate chassis, a laptop computer which is disconnected from the power line is used to record the measurement data of the operating system.

VI. CONCLUSION AND FUTURE WORK

This Integration of renewal Energy source will be highly effective in all places, especially in commercial areas where need of electricity is more. It causes no effect on nature i.e. pollution free, at the same time not prone to any kind of accident due to lightning. It is also useful to minimize power supply load i.e. cut short power charge. By using this system, we can save electricity charge because very less maintenance charge to this equipment is required. The designing of this equipment is done in such a way that it is very compact and acts as user friendly. When it is manufactured in a large scale, cost of this integrated natural resources power generation system is affordable. Moreover there is no power failure or load shedding situation at any times. Therefore, it is the most reliable renewable power or electricity resources with less expenditure. This research is at an intermediate stage and may take years to bring to fruition and into the market. The advances made by our research team have shown that some of the early barriers of this alternative PV concept have been crossed and this concept has the potential to be a disruptive and enabling technology. We encourage the scientific community to consider this technology along with others when contemplating efforts and resources for solar energy.

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