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Renewable Hybrid Power Sources Combined With Sea Water Activated Battery

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Abstract: **This paper provides a hybrid power sources using solar, wind and sea water activated battery (SWAB). It is consider only to be placed near sea shore area because sea water activated battery provides power supply when it is dipped into the sea water. through ultra capacitor, the energy can be stored fastly in the battery storage system to provide continuous power supply when combined with the hybrid power sources(from solar, wind and sea water activated battery) for required load demand(AC or DC). This system injects an uninterruptable power supply for the load demand under all necessary conditions. This system proposes controllable power transfer capability with different operation modes. The concepts of the hybrid system was described was represented that the total performance and reliable use of hybrid system. This concept may provides an idea for generating hybrid power in different ways like by using sea water activated battery Renewable energy systems using solar and wind are of greater importance as being modular, nature-friendly and domestic.**

Keywords: **Renewable energy sources, SWAB, Battery Energy Storage, ultra capacitor.**

I. INTRODUCTION

Energy crisis increases day by day, since an enormous increase in the global demand for energy in recent years due to industrial development and population growth. In order to avoid the energy demand in upcoming decades with Eco-friendly energy solutions, renewable energy resources are used. In hybrid system, wind turbine and photovoltaic modules, offer greater reliability than using them separately, because the demand is not entirely based on one resource. For example, on a stormy day when solar energy generation is low there's likely enough wind energy available to compensate the lack in solar energy. In addition to that sea water activated battery (SWAB) can also be employed along with solar panel and wind turbines to ensure power quality, stability, reliability without degrade the environment. Some works have been discussed about hybrid systems comprising of wind energy, photovoltaic and fuel cell [1]. The performance of the system using wind and solar system with battery storage was analyzed [2]. In some systems the battery is just consider as a back-up source means to use when there is insufficient supply from renewable sources .This paper describes the effective method to integrate PV, wind and sea water activated battery, stores the energy using battery energy storage system through ultra-capacitor to get constant power. These sources are connected to a PWM voltage source inverter to provide ac supply. Here all the energy sources model are described using VB software and analysed their result proved the reliability and stability of the proposed system.

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II. OUTLINE OF THE SYSTEM

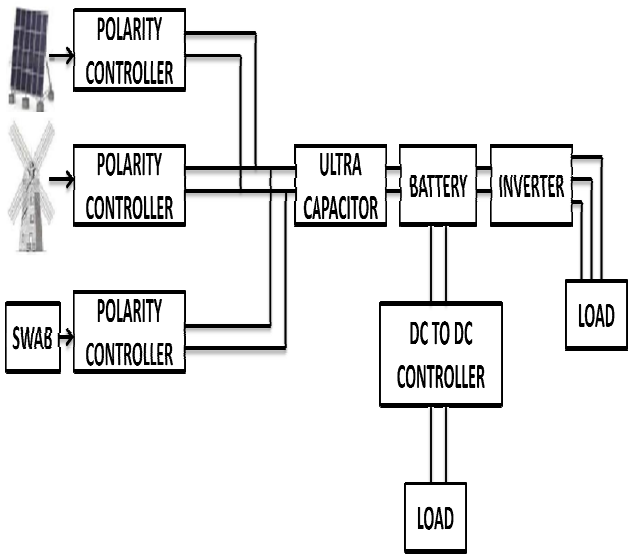

Fig1.1; Block Diagram of the Proposed System.

This project is totally depends on onshore and offshore areas. The proposed system consists of hybrid renewable energy sources like solar and wind turbines with sea water activated battery (SWAB) as shown in fig1.1. The maximum output from solar and a wind turbines track by using MPPT is integrated with SWAB. The hybrid output is controlled by polarity controller and stores in a battery energy storage system through ultra-capacitor because ultra-capacitor stores the charges in very fast manner. Through DC to DC controller, DC loads can be connected. The output from battery storage is connected to AC loads through a PWM inverter. This paper brings an efficient way to meet our today's demand.

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III. HYBRID ENERGY SYSTEMS

Hybrid energy systems generally integrating renewable energy sources with sea water activated battery to provide electric power where the electricity is either fed directly into the grid or to batteries for energy storage. A hybrid energy system consists of two or more energy systems, an energy storage system, power conditioning equipment and a controller [3]. A hybrid energy system may or may not be connected to the grid. They are generally independent of large centralized electric grids and are used in rural remote areas.

For systems employing totally clean renewable energy, high capital cost is an important barrier. However, we can produce green power by adding different renewable energy sources to sea water activated battery and battery energy storage, which is also called a hybrid system. This kind of system can compromise investment cost and also operation and maintenance costs [4-6].The hybrid energy can be stored in battery through ultra capacitor. Since ultra capacitors are used for quick charging and store the charges for long time. From that, an inverter is connected for ac loads.

IV. SOLAR SYSTEM

Solar cells are made up of thin piece of silicon, the substance that makes up sand and the second most common substance on earth. The top of the wafer has a very small amount of phosphorous added to it. This gives the top of the wafer an excess of free electrons. This is called n-type silicon because it has a tendency to give up electrons, a negative tendency. The bottom of the wafer has a small amount of boron added to it, which gives it a tendency to attract electrons. It is called p-type silicon because of its positive tendency. When both of these chemicals have been added to the silicon wafer, some of the electrons from the n-type silicon flow to the p-type silicon and an electric field forms between the layers. The p-type now has a negative charge and the n-type has a positive charge.

When the PV cell is placed in the sun, the radiant energy energizes the free electrons. If a circuit is made by connecting the top and bottom of the silicon wafer with wire, electrons flow from the n-type through the wire to the p-type. The PV cell is producing electricity the flow of electrons. If a load, such as a light bulb, is placed along the wire, the electricity will do work as it flows. The conversion of sunlight into electricity takes place silently and instantly. There are no mechanical parts to wear out. Today, PV systems are mainly used to generate electricity in areas that are a long way from electric power lines.

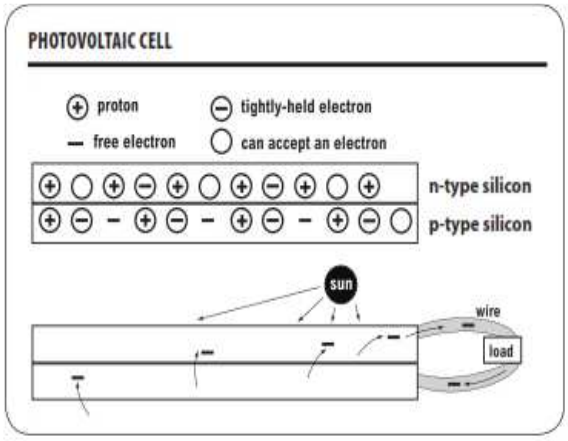

Fig4.1; Simple Circuit model of PV Cell.

In proposed system, to acquire solar energy for this application, photo-voltaic cell made up of amorphous silicon module, which is very rigid with high thermal stability and can be utilized.

The output power of photo-voltaic cell can be mathematically expressed as:

$$P=\square IS_n$$

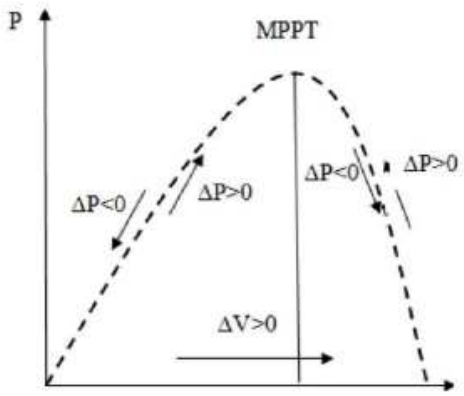

Fig4.2; Solar Outptut With Maximum Power Point Tracking.

Where □ and I are energy conversion efficiency, generating power per 1 m^2 for 1 mJ/m^2 and isolation in kW/m^2.

V. WIND TURBINE

Wind turbines are used for the conversion of wind energy into a useful form of energy. For new constructions, onshore wind is an inexpensive source of electricity, competitive with or in many places cheaper. Small onshore wind farms provide electricity to isolated locations. Wind power is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation and uses little land. The effects on the environment are generally less problematic than those from other power sources.

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Wind power is very consistent from year to year but has significant variation over shorter time scales. As the proportion of wind power in a region increases, a need to upgrade the grid and a lowered ability to supplant conventional production can occur. Power management techniques such as having excess capacity storage, geographically distributed turbines, dispatchable backing sources and some other storage.

In this proposed system**,** in order To collect wind energy, wind turbines made up of synchronous generator with mechanical model. The wind turbine is capable of rotating for small amount of wind change from the ambient. This can further be enhanced to larger value for real time implementation. The common wind turbine with a horizontal axis is simple in working principle and it will produce an electric power economically. The kinetic energy in the varying wind is converted into rotary mechanical energy by the wind turbine rotor. The rotor blades are made up of reinforced fiber, which is mounted on the steel shaft [8].The turbine may be stall - regulated or pitch - regulated. For stall - regulated machines the pitch angle is fixed at the time of installation whereas in pitch - regulated machine it varies from various wind velocities to maintain the output power constant at rated value. The equation describes the mechanical power captured from wind by a wind turbine [9] can be formulated as:

$$\mathbf{P_m = 0.5\rho A C_p v^3}$$

Where: = Air density (Kg/m^3)
A = Swept area (m^2)
C_p = Power coefficient of the wind turbine
v = Wind speed (m/s)
t = Time (sec)

The theoretical maximum value of the power coefficient *is* 0.59. It is dependent on two variables, the tip speed ratio (TSR) and the pitch angle. The pitch angle refers to the angle in which the turbine blades are aligned with respect to its longitudinal axis. *TSR* is defined as the linear speed of the rotor to the wind speed.

VI. SEA WATER ACTIVATED BATTERY(SWAB)

With the increase of energy demand; Mil3, Inc has developed a superior Seawater Activated battery source. SWAB is more portable, safe, and economical for marine buoys and related applications. SWAPS utilize metal alloy magnesium, silver and so on reacting with saltwater to produce hydrogen. This hydrogen is converted to DC electrical power in proton exchange membrane (PEM) fuel cells at an efficiency of about 50%[10-11]. Considerably with an energy density of 1.4 kWh/kg and scalability for power requirements of watts to kilowatts, SWAB is lighter and less expensive than batteries, and will always produce 100% of its design output power. For this, the only chemical by-product is a metal hydroxide which naturally occurs in seawater. SWAB stores potential energy in its alloy fuel, provides power on-demand, is inherently self-regulating, and requires no moving parts or external control In contrast, batteries represent low energy density, excessive mass and volume and prohibitive costs for many applications. In deep water detection system The swab unit continuously provides 4 kW for a duration of 48 hours to charge a custom designed 2 kWh $LiFePO_4$ battery that - an produce the 40Kw[11].

Fig6.1; Simple Diagram of Sea Water Activated Battery.

SWAB is also far smaller and inexpensive than photovoltaic, wind turbine and wave energy systems and SWAB is not affected by weather or time of day. SWAB must compete with solar and wind energy for charging a battery storage unit.
In the proposed hybrid system, advanced type of SWAB is chosen like in European countries, recently swab makes with increasing life span and reliability. SWAB can produce maximum of 400V.

VII. POLARITY CONTROLLER

Polarity controller is a diode with two electrodes called the anode and the cathode. Relative to the anode when the cathode is negatively charged at a voltage greater than the minimum level of voltage called forward breakdown voltage, then the current flows through the diode. If the cathode is positive with respect to the anode, is at the same voltage as the anode, or is negative by an amount less than the forward break over voltage, then the diode does not conduct current.

VIII. BATTERY ENERGY STORAGE

"*Electrical energy cannot be stored directly, but it can be stored in other forms and then converted back to electricity when needed"*.
Storing electrical energy efficiently with dynamic Battery Energy Storage Systems which is an effective and efficient approach that enables energy produced by renewable sources and SWAB to be stored and then made available as required. The batteries are convert electrical energy into chemical energy for storage. Batteries are charged and discharged using DC power, regulates the flow of power between batteries and

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the energy systems is done by a bi-directional power electronic devices. Consider Lead-Acid batteries, offer a competitive solution for energy storage applications. In this hybrid system, during coupled operation, Changes in the wind and solar PV generation output will cause an immediate change in the battery energy storage output and it must neutralize by quick changes in output power. Rate variation control (or ramp rate control) and it is applied for smoothing real power fluctuations from an associated coupled system. Allowable ramp rates are typically specified by the utility in kilowatts per minute (kW/min), and are a common feature of wind and solar power purchase agreements between utilities and independent power producers. The information is processed by the Battery Energy System controller estimates the state of charge (SOC) of each battery cell and capacity of each battery cell, and protects all the cells operate in the designed SOC range.[10-11].. Generally, SOC is maintained between 30%-70% to get the longer life cycle for the battery.
The technical and economic advantages of energy storage systems as follows:

- It is one of the most efficient energy sources.
- Improves reliability and power quality.
- Provides backup power for critical loads.

IX. ULTRACAPACITOR

Here hybrid energy stores in the battery system through ultra capacitor for faster charging rate**.** Like an ordinary capacitor, a Super Capacitor has two plates that are separated by a dielectric. The differences are the plates are coated with activated carbon. Activated carbon is a very porous substance, having an enormous surface area enabling storage of much more electrical energy. The dielectric that separates the plates of a capacitor is an electrolyte. The electrolyte is a liquid that is electrically active. In a normal capacitor there is a dielectric separator that keeps the positive charges on one plate and negative charges on the other plate safely apart. A Super Capacitor the electrolyte is polarized by the charged plates.

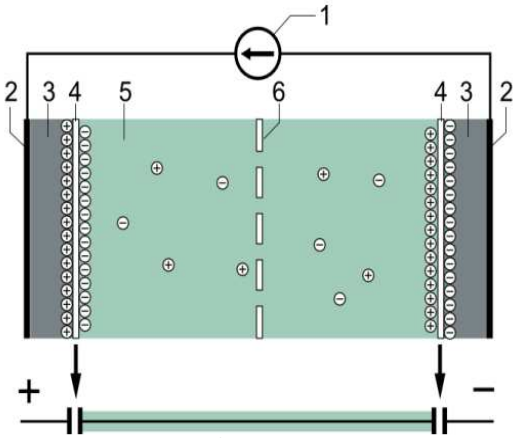

Fig9.1; Principle Construction of a Ultra-Capacitor; 1. Power source, 2. collector, 3.polarized electrode, 4. Helmholtz double layer, 5. electrolyte having positive and negative ions, 6.Separator.

The positive ions of the electrolyte are attracted by the negative charge of one plate; conversely, the negative ions by the positive charge of the other plate. This movement of the ions form a second charge, the double layer allows the Super Capacitor to store much more electrical energy providing a higher power performance.

X. POWER ELECTRONICS CONTROLLERS

A: DC TO DC CONTROLLER: Mainly DC to DC controllers means changing fixed DC to variable DC with step-up or step down voltage i.e Chopper. Here DC to DC controller is used to connect the battery system to DC loads with improved efficiency and controlled design.
B: INVERTER: Generally inverter design is used to convert DC supply into AC. In this proposed system, a single PWM voltage source inverter is used to connect the battery with AC loads.

XI. RESULT AND DISCUSSION:

This shows that solar and wind energy with maximum output through MPPT (fig11.1) is integrated with sea water activated battery to get hybrid energy which is stored in a battery through ultra capacitor. The output power of the battery is given to DC loads directly through power electronics DC to DC controllers or to AC loads through PWM voltage source inverter.

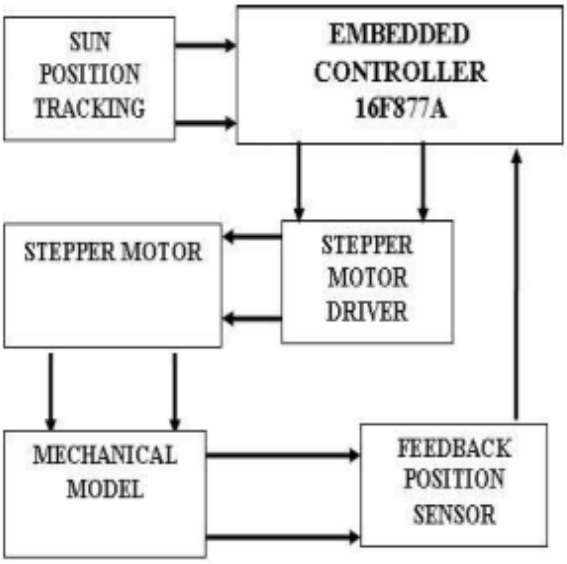

Fig11.1; Simple Block Diagram Solar Tracking with MPPT.

The simulation results of this hybrid system with output readings of solar, wind and SWAB in visual basic 6.0 software are as shown in (Fig11.2).

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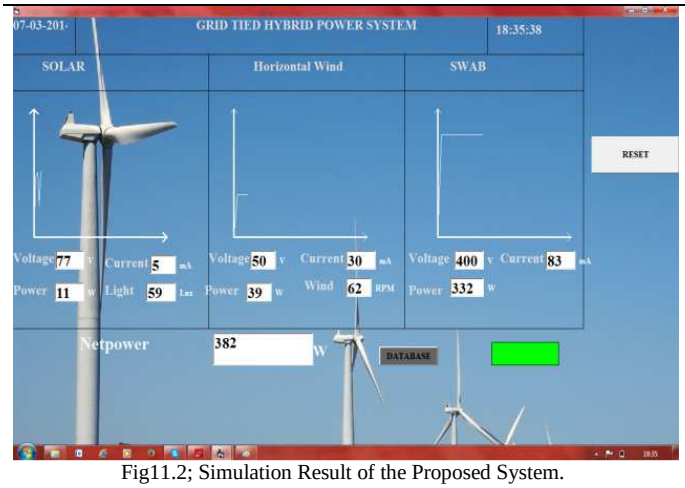

Fig11.2; Simulation Result of the Proposed System.

XII. FUTURE SCOPE:

This system proposes a new idea to generate hybrid power more effectively with sea water activated battery. This paper basically concentrated on grid connected hybrid system with different solutions to meet the energy demands in our day to day life.

XIII. CONCLUSION

Due to more energy demand, by introducing sea water activated battery source with a renewable hybrid energy sources like solar and wind energy is totally a new concept. This paper deals with eco-friendly hybrid generation system. It also brings that hybrid system can be placed in onshore and offshore applications gives more efficiency ,reliability and presents enough stability to the load demand increases. The experimental results show the very good energy quality supplied to the consumers. Since the awareness of sea water activated battery can be increased with further work in the power generation effectively by this project.

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