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Enhancement of Power of a Hybrid System using Super Capacitor

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Abstract: ***In today's technology-driven world, electricity is one of the most important things in our daily lives. Because we all don't know that renewable energy sources run out immediately. So it is time for us to shift our focus from conventional energy sources to unconventional energy production. The hybrid system can be used both in industry and at home. In this paper we will generate electricity from unconventional and conventional sources. All renewable energy sources, such as solar energy, wind energy, are used to produce electricity in industry. This paper deals with the use of a solar-electric-wind system in the design of a hybrid energy system. Use of super capacitor can reduce the need to maintain electrical cables and we can manage the load demand at very high times. The paper shows that the renewable hybrid energy system using Supercapacitor. It creates a pollution-free environment.***

Keywords: Solar energy, wind energy , Hybrid power system , Super capacitor , power saving etc.

I. INTRODUCTION

Renewable energy sources provide clean energy that is sufficient on earth. These renewable sources are obtained from land, water, sun, plants, etc. These sources are widely used in the production of electricity. Solar and wind power generation are attractive sources because they are environmentally friendly. A hybrid system is a mixture of different renewable energy sources such as solar energy, biomass electricity, wind energy, etc. In hybrid energy production, the produced power is first stored in the battery and then used to meet the energy demand. Today, the wind and solar energy system is growing rapidly, and the traditional energy source is depleting every day and disappearing in the coming years. So we must look for a new source of energy that is non-polluting and easily accessible. On sunny days you get energy from the sun and on cloudy days from the wind system.

A growing global problem related to rapid economic development and a relative lack of energy, because we all do not know that renewable energy sources are quickly running out. So it is time for us to use both conventional and non-conventional sources of energy to generate electricity. Today,

Supercapacitors are widely used. These high pressure and efficient energy storage devices are also known as ultracapacitors or electrochemical double layer capacitors (EDLC). Their favorable properties make them ideal for use in energy storage systems, including the ability to charge and discharge quickly without losing efficiency in the long term. The supercapacitor package can be used in a HESS (battery-supercapacitor system), which integrates various energy storage technologies with a specific control strategy that maximizes the benefits of each energy source used for overall efficiency.

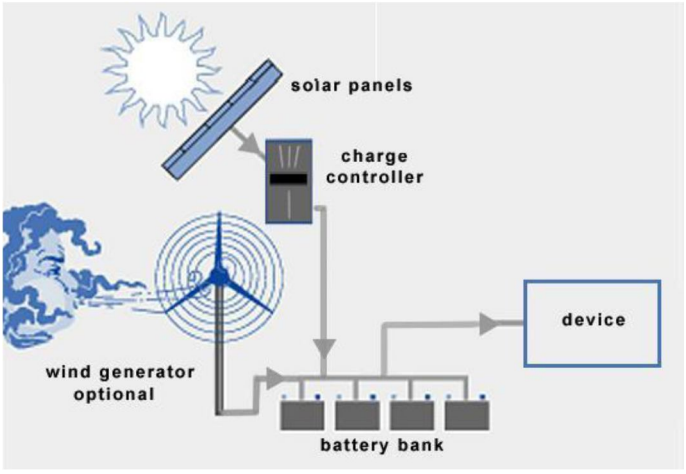


Fig. 1 Schematic of a conventional photovoltaic Hybrid System.

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II. PROBLEM STATEMENT

The use of renewable energy as a source of energy is expanding as the price of petroleum fluctuates. Therefore, it is crucial that engineering and technological students have a grasp of and awareness of technology related to renewable energy at the educational level. Solar energy is one of the most popular renewable energy sources. There is a lot of research being done to develop alternatives to improve the efficiency of photovoltaic systems (solar panels). One such method is to employ a solar panel tracking system.

A. Key Statement

1) Install sources such as horizontal axis wind turbines to increase power outages.
2) Also add a solar system to generate electricity.
3) Create a similar model that will be able to reflect system features and functionality as needed..

III. OBJECTIVE

The following is the main purpose of a supercapacitor solar-wind hybrid power generation system.

1) Design a solar-wind hybrid power generation system.
2) Modeling of hybrid sources with supercapacitor based storage.
3) Improving energy efficiency with a hybrid source
4) Testing output results after deployment of a prototype model.
5) Minimize installation and operating costs and improve reliability.
6) Combine this system with hybrid power generation to help maximize energy for any industry or community.

IV. PROJECT DESCRIPTION

A. Block Diagram

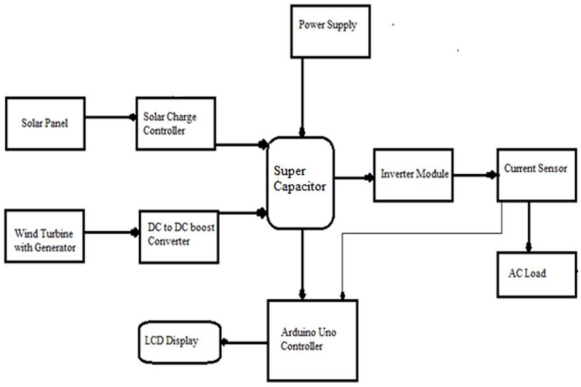


Fig. 2. Block Diagram of system

V. WORKING

1) The paper provides a clear picture of a solar-wind hybrid energy system with supercapacitor base charging. And it's easier to replace the battery with a continuous supply hybrid electric system when it's repaired.
2) This work was done considering the hybrid electric system that will be completed soon. The performance of the proposed centralized energy management strategy with interleaved conversion steps is investigated and validated under different real-time scenarios.
3) These scenarios consist of different weather profiles covering a 2-hour horizon and different intermittent power load conditions. The entire system is modeled and the corresponding test is performed.
4) Arduino 328p controller is used to control the entire charging function. The LCD display shows the real-time power monitoring system.
5) Solar and wind generator and DC boost converter are also used to store energy in a supercapacitor.
6) Finally, the inerter module is used to convert DC to AC for direct AC loading.

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7) Different real-time PV profiles covering sunny, partly sunny and cloudy conditions are considered to investigate the performance of the proposed strategy. All scenarios are recorded, analyzed and concluded that the energy balance between the sources and the AC load is maintained.
8) In addition, the system maintains a uniform regulated voltage on the DC bus thanks to the proposed power management and control architecture.

VI. COMPONENTS

1) Wind Generator
2) Solar Panel
3) Solar Charge Controller
4) DC Boost Converter
5) Super-capacitor
6) Arduino Uno Controller
7) LCD Display
8) Development Board
9) Inverter Module
10) Current Sensor
11) AC Load
12) Charging Socket
13) Adapter
14) LED Indicator
15) Others

VII. COMPONENTS SPECIFICATION

A. *Solar Panel (12v25w)*

Solar energy is that energy which we get from the sun in form of radiation. It does not cause any kind of pollution, it is inexhaustible. It is available free of cost. A solar cell is used to convert solar energy into electric energy, it is also known as photovoltaic cell.



B. *DC Generator (12v)*

A DC generator is an electrical machine whose main function is to convert mechanical energy into electricity.



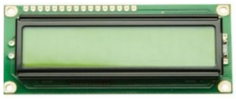
C. *Arduino Uno (12v)*

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.



D. LCD Display (5v)

A liquid crystal display (LCD) is a thin, flat panel used for electronically displaying information such as text, images, and moving pictures. LCD stands for **L**iquid **C**rystal **D**isplay. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs)



E. DC to DC boost Converter (Regulated 12v)

A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element: a capacitor, inductor, or the two in combination.



F. Current Sensor (5v)

A current sensor is a device that detects and converts current to an easily measurable output voltage, which is proportional to the current through the measured path. There are a wide variety of sensors, and each sensor is suitable for a specific current range and environmental condition.



G. Inverter (12v DC to 220v AC)

As we know that most of the electrical appliances require AC voltage, so first the DC output of the batteries will be converted into AC voltage with the help of an inverter and then it will be transferred to the loads. The inverter must be having over voltage protection, reverse polarity and short circuit protection.



H. Supercapacitor (12V)

A supercapacitor (SC), also called an ultracapacitor, is a high-capacity capacitor, with a capacitance value much higher than other capacitors but with lower voltage limits. It bridges the gap between electrolytic capacitors and rechargeable batteries.



I. Inverter

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits.



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J. PCB's Board



A printed circuit board (PCB) mechanically supports and electrically connects electrical or electronic components using conductive tracks, pads and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate.

VIII. PROPOSED CALCULATIONS

Total energy generated by the system is the total energy generated by the solar PV panel and the power generated by the wind turbine. According to statistics, it can be represented by,

PT = NW * Pw + Ns * PS
There,
Total energy generated = PT
Power generated by wind turbines = PW
Energy produced by solar panels = PS
Wind turbine number = NW
Number of solar panels used = NS

A. Calculations for Wind Energy

The energy produced by wind power is provided by,
Energy = (air density * swept area * cubed velocity) / 2
PW = ½. ρ (AW) (V) 3
There,
P is the power in watts (W)
ρ air pressure per kilogram per cubic meter (kg / m³) AW area of air per square meter (m²) V wind speed per meter (m / s).

B. Calculations for Solar Energy

To determine the size of the PV modules, the required power consumption should be measured. Therefore, power is calculated as
PS = Ins (t) * AS * Eff (pv)

There,
Ins (t) = separation at t (kw / m2)
AS = one PV panel area (m2)
Effpv = full efficiency of PV panels and dc / dc converters.
The overall efficiency is provided by,
Eff (pv) = H * PR
There,
H = Annual rate of solar radiation on oblique panels.
PR = Performance rate, loss coefficient.

C. Cost

The total cost of a solar-wind energy system depends on the total number of wind turbines used and the total number of solar panels used. The total cost is therefore provided as follows

Total Cost = (Wind Turbine Number * Cost of One Wind Turbine) + (Solar Panel Number * Cost of One Solar Panel) + (Number of Batteries Used in Battery Bank * Cost of One Battery)

CT = (NW * CWT) + (NS * CSP) + (NB * CB)

There,

CT is the total cost per Rs

CWT is the cost of a single wind turbine

CSP costs one day panel per Rs

CB One Battery Cost Rs

NW is the amount of wind turbine used

NS is the number of solar panels used

NB is the number of batteries used in the Battery Bank.

IX. ADVANTAGES WITH HYBRID SYSTEM

1) During the rainy season and winter the amount of sunlight is insufficient as this season energy is complemented by the wind energy system.

2) Due to climate change when there is a lack of wind power beyond the power provided by solar panels.

3) Low operating costs and maintenance costs make you a savings.

4) Used in any place whether it is remote or crowded.

5) Efficient power generation

6) Solar and wind sites benefit the environment as they will reduce carbon and other harmful pollutants by about 90% in the area.

X. RESULTS & DISCUSSION

A. Charging And Discharging Time Of A Supercapacitor

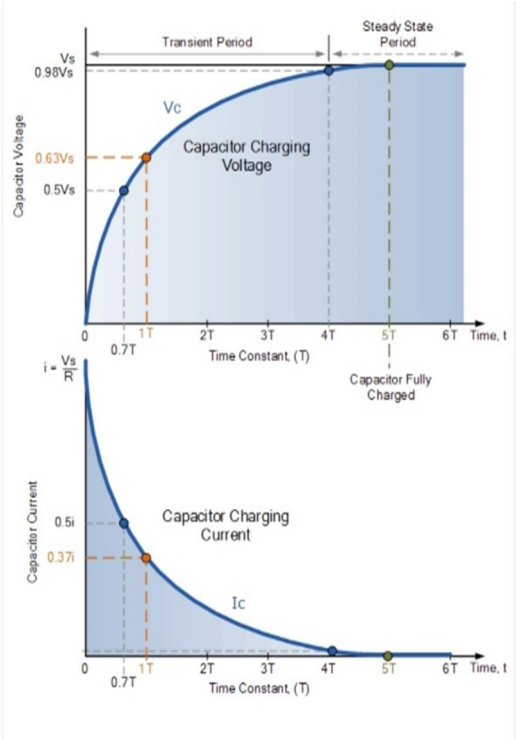


Fig. 3 Charging time of a supercapacitor

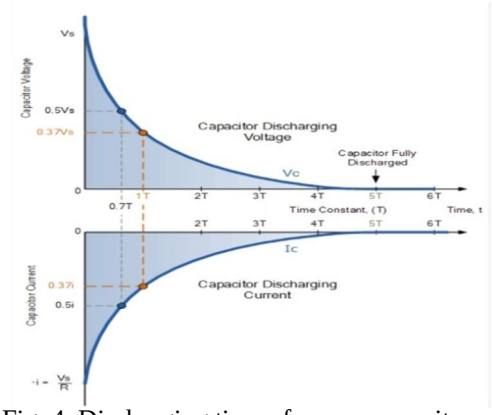


Fig. 4 ,Discharging time of a supercapacitor

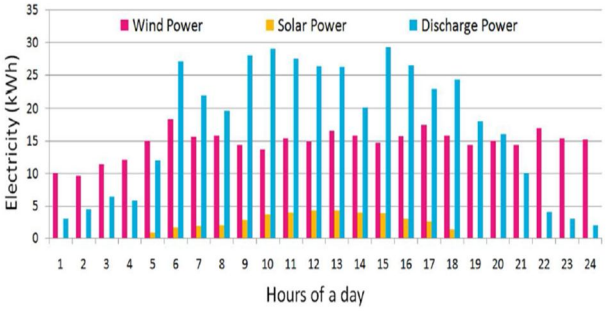


Fig. 5 Hourly generated electricity by both wind and solar from the proposed method.

The hourly required load, the total power generated by the recharging station, and the power supplied to the grid are shown in Fig. 5. In some cases such as hour 1-3.5 and 12-16.5 the station supplies few kilowatt of power to the grid.

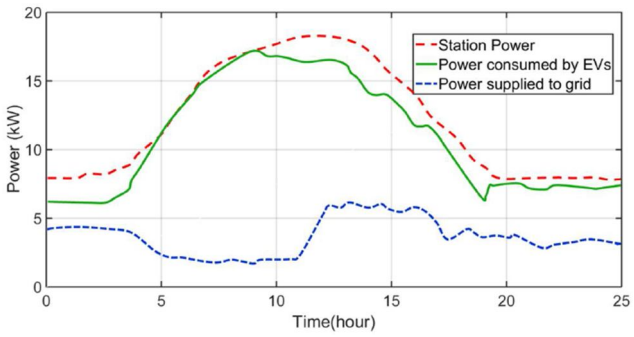


Fig. 6 Hourly power measured during a day.

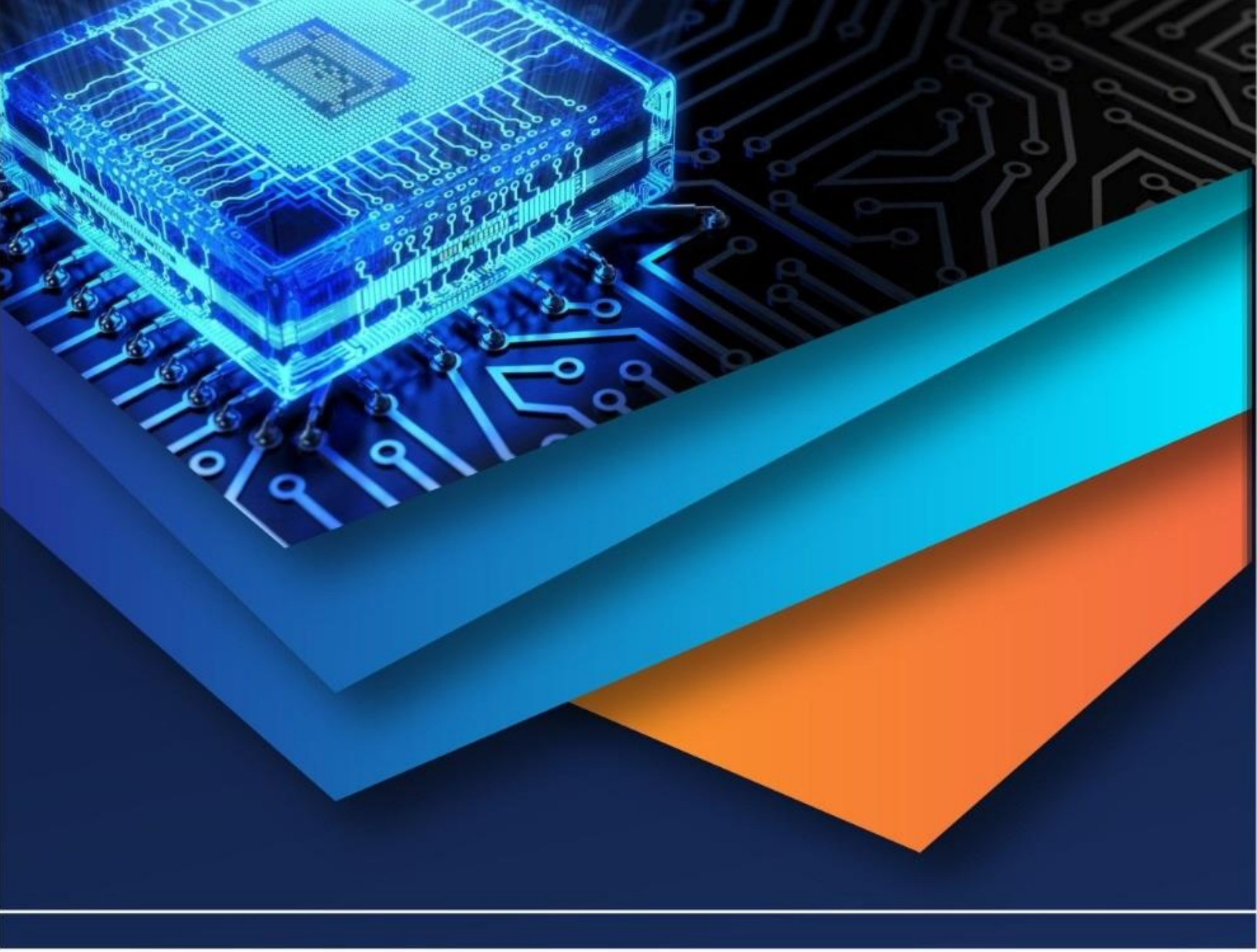
XI. CONCLUSION

Developing hybrid systems is one of the simplest and most efficient solutions for generating electricity compared to non-renewable energy resources using supercapacitor. Not only is it expensive but it also does not cause environmental damage. Also, it can be used to generate electricity in hilly areas, where it is difficult to transfer electricity in normal ways. Depending on the need the setting can be determined. All the people in the world should be encouraged to use extraordinary resources to generate electricity so that they can be relatively reliable. Longevity, minimal care is one of your best places. It just needs a higher initial investment.

As we know the mixed system has additional production costs per unit but uses the resources available effectively. This Hybrid program is also capable of recovering from any accidental or unwanted situation. And the hybrid system is able to harness power in remote and rural areas. So it is clear that the Hybrid system is the best choice.

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