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IOT BASED HYBRID POWER GENERATIONSYSTEM USING WIND & SOLAR ENERGY

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Abstract

The rapid growth of technology and infrastructure has made our lives easier. In recent years we arc facing the power cut problems due to increasing demand of electricity, due lo the development of industrial automation that requires huge power. This project is used to generate the power by using different methods that can be stored in the battery. The battery is then discharged to power DC loads. In this project, we have focused on controlling of hybrid energy system using !OT. The microcontroller ensures the optimum utilization of resources and it also increases the efficiency of the combined system as compared to the individual mode of generation. It helps decreases in the dependence on one single source and makes the system more reliable. The hybrid system can be used for both industrial and domestic application.

Keywords *- Hybrid system, generated and monitoring, IOT.*

I. INTRODUCTION

The main objective of this paper is to design and to implement the hybrid power generation. This hybrid generation will provide electrical energy in areas where electrical grid is not reached yet and hence can light up many homes with affordable price. The renewable energy source generates electrical energy efficiently without any impact on the environment. Energy can neither created nor be destroyed but it can be transformed from one another form. There arc two types of energy sources available, which can be used to generate the electricity. They are renewable and non-renewable energy resources. Nonrenewable energy resources are coal, nuclear, oil, and natural gases which arc limitedly available, and the renewable energy resources are sunlight, wind, rain, tidal, waves and geothermal heat and this sources are naturally replenished on human timescale. Multinational company (MNCs) is also need certain megawatt (MW) interruption free power supply. This means that we may experience power cut much more than 60% in lhe short future. To compensate this power demand, power production through hybrid energy harvesting from piezoelectric material, solar panel vertical axis wind turbine and water turbine methods are used. Energy is more due to lhe rapid increase in world population, technologies and other political and economic condition. Now a day's electrical energy is generated by the conventional energy resources like coal, diesel and nuclear etc. And this arc depicting day by day. So there is an urgent need to switch on to nonconventional energy resources at this point loT plays an important role in controlling system the data is transmitted from power generation module wirclcssly trough website to ESP32 module which monitors the source of energy. The transmitted data is monitored remotely using loT in android cellphone and the result can also be displayed on LCD using microcontroller. In this project where user can monitor the how much voltage produced by each melhod of

power generation by using Wi-Fi module. Solar and wind are easily available in all condition can be good alternative sources with the rise in the demand of renewable energy resources the need of better utilization of this system as aroused. This intern as given rise to the hybrid energy system.

With the growing concern over climate change and the depletion of fossil fuels, there has been an increasing emphasis on transitioning towards renewable energy sources. Among these, wind and solar energy are abundant and readily available resources that offer significant potential for sustainable power generation. However, the intermittent nature of these sources poses challenges to their integration into the power grid, particularly concerning reliability and stability.

Hybrid power generation systems that combine multiple renewable energy sources have emerged as a promising solution to address these challenges. By integrating wind and solar energy, a hybrid system can leverage the complementary nature of these sources to enhance energy reliability and stability. Moreover, advancements in IoT technologies enable efficient monitoring, control, and optimization of hybrid power generation processes, further improving system performance and sustainability.

2. Methodology for IoT-Based Hybrid Power Generation System:

2.1. System Architecture: The IoT-based hybrid power generation system consists of several key components, including:Wind Turbine Array: Converts wind energy into electrical energy through the rotation of blades connected to a generator.

- **Solar Photovoltaic Panels:** Convert solar energy into electrical energy using semiconductor materials.
  Energy Storage System: Stores excess energy generated by wind and solar sources for later use, ensuring continuous power supply.
- **Power Electronics and Inverter:** Convert DC power generated by wind turbines and solar panels into AC power suitable for grid integration.
  IoT Sensors and Communication Modules: Monitor environmental conditions, energy production, and system parameters in real-time. These sensors communicate data to a central control unit for analysis and decision-making.
- **Central Control Unit:** Processes sensor data, implements control algorithms, and optimizes system operation based on predefined objectives, such as maximizing energy efficiency or minimizing environmental impact.
  2.2. Operational Modes: The hybrid power generation system operates in various modes to adapt to changing environmental conditions and energy demand:
- **Standalone Mode:** The system operates independently of the grid, utilizing energy generated by wind and solar sources to meet local demand.
- **Grid-Tied Mode:** Excess energy generated by the system is fed into the grid, contributing to overall energy supply and potentially earning revenue through feed-in tariffs.
- **Battery Charging Mode:** During periods of low energy demand or high renewable energy generation, surplus energy is stored in batteries for later use.

- **Emergency Backup Mode:** In the event of grid failure or blackouts, the system switches to battery backup mode to ensure uninterrupted power supply to critical loads.

2.3 Hardware Requirements

i. **Solar panel** : Solar panel is use Low convert solar radiation to the electrical energy. The physical of PV cellis very similar to that of the classical diode with a PN junction formed by semiconductor material. When the junction absorbs light, the energy of absorbed photon is transferred to the clcctronproton system of the material, creating charge carriers that are separated at the junction. The charge carriers in the junctionregion create a potential gradient, get accelerated under the electric field, and circulate as current throughan external circuit. Solar array or panel is a group of a several modules electrically connected in series parallel combination to generate the required current and voltage. Solar panels are the medium to convert solar power into the electrical power.

Fig. Solar panel

ii. **Wind turbine:** Wind turbine is that system which extracts energy from wind by rotation of the blades of the wind turbine. Basically wind turbine has two types one is vertical and another is horizontal. As the wind speed increases power generation is also increases. The power generated from wind is not continuous its fluctuating. For obtain the non-fluctuating power we have to store in battery and then provide it to the load.

a. Fig. Wind turbine

iv. **Battery Bank:** We have to choose battery bank size per the load requirement so that it should fulfill the requirement of load for calculating the battery bank size we need to find following data I. Find totaldaily use in watt-hour (Wh). 2. Find total back up time of the battery For increase in battery bank size we need to connect cell in series so that we can get the larger battery bank size.

Fig. battery

v. **Inverter:** We have lo choose greater rating inverter than the desired rating .The pure sign wave inverter is recommended in other to prolong the lifespan of the inverter. Inverter is need to convert DCpower into AC power. As our load working on the AC supply so we need to convert DC power. The input voltage Output voltage and frequency, and overall power handling depends on the design of the specific device or the circuitry. The inverter docs not produce any power. The power is provided by theDC source.

vi. **IoT Module :** An loT board is designed to meet various application requirements with distinct advantages that help the embedded system designer too easily and quickly to enable internet connectivityto their applications. The module has an UART update feature and wcbpagc control which makes it idealfor onlinc wireless applications such as biomedical monitoring, environmental sensors, and datas from portable battery operated wireless sensor network device.

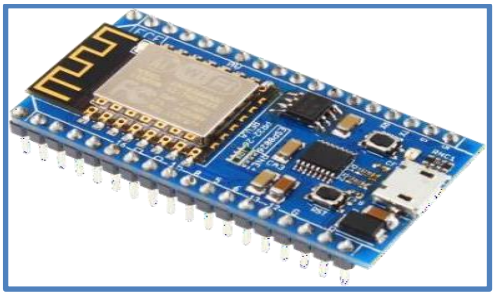

Fig. IOT Module

vii. **Charge controller**: Charge controller has basic function is that it control the source which is to be activeor inactive. It simultaneously charge battery and also gives power to the load. The controller has over- charge protection, short-circuit protection, pole confusion protection and automatic dumpload function. Italso the function is that it should vary the power as per the load demand. It add the both the power so thatthe load demand can fulfill. And when power is not generating it should extract power from battery and give it to the load.

III Simulation and Performance Evaluation:

We conducted simulations to evaluate the performance of the proposed IoT-based hybrid power generation system under various operating conditions. Key performance metrics such as energy efficiency, system reliability, and environmental impact were analyzed.

Simulation Setup:

- System Components: The simulation model incorporates multiple wind turbines, solar panels, and energy storage units interconnected through power electronics and inverters. IoT sensors are virtualized to monitor system parameters such as wind speed, solar irradiance, battery state of charge, and grid voltage.
- Control Algorithms: Control algorithms implemented in the simulation model utilize IoT data to optimize energy production and distribution. These algorithms adjust turbine pitch angles, solar panel orientations, and battery charging/discharging rates in real-time to maximize energy efficiency and system reliability.
- Environmental Conditions: The simulation considers varying environmental conditions, including changes in wind speed, solar irradiance, and grid demand patterns over time. Different scenarios representing typical weather conditions and seasonal variations are simulated to assess system performance under diverse operating conditions.

Simulation Results and Analysis:

- The simulation results are analyzed to assess key performance metrics such as energy production, system efficiency, reliability, and environmental impact. Comparative analyses are conducted to evaluate the benefits of the IoT-based hybrid power generation system compared to conventional power generation methods.

IV. Advantages of IoT-Based Hybrid Power Generation System Using Wind and Solar Energy:

- Optimized Energy Production: The integration of IoT technology enables real-time monitoring and control of wind turbines and solar panels, allowing for optimized energy production by adjusting parameters such as turbine pitch angle and solar panel orientation to maximize output.
- Enhanced Reliability: IoT sensors continuously monitor system components, detecting faults or performance issues promptly. This proactive approach to maintenance minimizes downtime and ensures reliable power generation.
- Improved Energy Management: IoT-based systems facilitate intelligent energy management by balancing energy production and consumption. Energy storage systems can be efficiently managed to store surplus energy during periods of high production and discharge it during peak demand, enhancing overall system efficiency.
- Remote Monitoring and Control: With IoT connectivity, operators can remotely monitor and control the hybrid power generation system from anywhere with an internet connection. This capability facilitates proactive management, troubleshooting, and optimization without the need for on-site intervention.
- Data-Driven Decision Making: IoT sensors collect a wealth of data on energy production, environmental conditions, and system performance. By analyzing this data, operators can make informed decisions to

optimize system operation, improve efficiency, and reduce operational costs.

- IoT gains more space in people's life. System is mainly used for tracking. The computers track information about various Things using lot. The amount of monitoring time is saved using ToT. System is used in various sectors like patient monitoring, home security etc. The IoT network saves time of the users as well as money.

Applications of IoT-Based Hybrid Power Generation System

- Off-Grid Applications: IoT-based hybrid power generation systems are ideal for off-grid applications in remote or rural areas where traditional grid infrastructure is unavailable or unreliable. These systems can provide a reliable and sustainable power supply for off-grid communities, schools, healthcare facilities, and agricultural operations.
- Grid Stabilization: In grid-connected applications, IoT-based hybrid power generation systems can contribute to grid stabilization by providing ancillary services such as frequency regulation, voltage support, and peak shaving. By integrating renewable energy sources with energy storage and IoT control, these systems enhance grid stability and reliability.
- Industrial and Commercial Facilities: IoT-based hybrid power generation systems find applications in industrial and commercial facilities seeking to reduce energy costs, improve energy resilience, and meet sustainability goals. These systems can be integrated into the existing infrastructure of factories, warehouses, data centers, and commercial buildings to supplement grid power and optimize energy usage.
- Microgrids: IoT-enabled hybrid power generation systems play a crucial role in the development of microgrids, which are localized energy systems that can operate independently or in conjunction with the main grid. These systems provide energy resilience, energy independence, and cost savings for communities, campuses, military bases, and remote installations.
- Disaster Recovery and Emergency Response: In disaster-prone areas, IoT-based hybrid power generation systems serve as critical infrastructure for disaster recovery and emergency response efforts. These systems can provide backup power to essential services such as hospitals, emergency shelters, communication networks, and water treatment facilities during natural disasters or grid outages.
- Some real time applications are Street lighting, Traffic Signals.Various monitoring systems., Powering up for communication system. ,Pump irrigation Systems., Also As per requirement of electrical energy the system can be either designed or updated for higher energy requirement.

  In summary, IoT-based hybrid power generation systems offer numerous advantages in terms of optimized energy production, enhanced reliability, improved energy management, remote monitoring, and data-driven decision-making. Their diverse applications span off-grid communities, grid stabilization, industrial facilities, microgrids, and disaster recovery, making them a versatile and valuable solution for sustainable energy generation.

V. CONCLUSION

This paper proposes that with the use of solar concentrators and optical tilters, energy wasted from the conversionof solar energy to electricity can be conserved and higher efficiency is achieved.The educational institutions, furnace regions, industrial arcas ,malls and other locations arc ideal for the purpose of establishing

such energy centres where the hcat bcing dissipated arc easily available for the recycling and conversion to the same system. The hardware is developed in such a way that the power is generated from two different sources that is from solarwind energy. These sources are combined to run the DC motor as well as AC motor. This module can be implemented in both private and public sectors .they can also be implemented in high renewable. energy power plant areas to generate power gain. In this project we arc crcating hybrid power from two sources that is solar celland wind turbine. Since solar panels cannot be used in the absence of sunlight, we arc using wind energy along with solar panel. By this, we are generating power using hybrid source sand monitoring it with the help of IoT.

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