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IOT BASED SMART HOME AUTOMATION USING RENEWABLE ENERGY

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ABSTRACT- The goal of the IoT-Based Smart Home Automation Using Renewable Energy project is to create an intelligent home system that uses renewable energy sources to generate power while enabling users to remotely monitor and manage household equipment. Rapid urbanization and the expansion of contemporary electronic gadgets have led to a major increase in the demand for electrical energy in recent years. Adoption of sustainable energy solutions has also been prompted by worries about environmental contamination and the depletion of traditional energy resources. An efficient way to achieve energy efficiency, environmental protection, and increased convenience in residential settings is to integrate smart home automation with renewable energy sources. The goal of this article is to integrate renewable energy sources with cutting-edge automation technologies to produce a dependable, effective, andeco-friendly home management system.To operate conventional household appliances that require alternating current (AC), an inverter is used in the system. The inverter converts the stored DC power from the battery into AC power suitable for operating appliances such as lights, fans, and small electrical devices. The automation and control section of the system is implemented using an ESP32 microcontroller, which acts as the central control unit. The ESP32 microcontroller is widely used in IoT applications because it has built-in Wi-Fi and Bluetooth connectivity, high processing capability, and efficient power management features.

Keywords: Internet of Things (IoT), Smart Home Automation, Renewable Energy, Solar Panel, ESP32 Microcontroller, Solar Charge Controller, Energy Management, Remote Monitoring

I. INTRODUCTION

The system operates using Internet of Things (IoT) technology, which enables different electronic devices, sensors, and controllers to communicate with each other through the internet. A microcontroller such as the ESP32 Microcontroller is used as the central control unit of the system. This microcontroller has built-in Wi-Fi capability, which allows it to connect to a wireless network and communicate with mobile devices or cloud platforms. Through a smartphone application or web-based interface, users can easily monitor and control various household appliances such as lights, fans, air conditioners, and other electrical devices from anywhere. The system can also provide real-

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time information about the operational status of appliances and the amount of energy being consumed, enabling users to manage electricity usage more effectively.

In addition to automation, this project incorporates renewable energy sources such as Solar Energy to power the smart home system. Solar panels are used to convert sunlight into electrical energy through the photovoltaic effect. The generated energy can be stored in rechargeable batteries and later used to operate household appliances or support the automation system. By using solar power, the system reduces dependence on conventional grid electricity and encourages the use of clean and sustainable energy resources. Furthermore, the system can monitor the energy produced by the solar panels and intelligently manage the distribution of power between the renewable energy source and the main electrical supply.

II. OBJECTIVES

- To Reduce Electricity Consumption in Homes
- To Improve Energy Management in Residential Buildings
- To Provide Convenient Control of Home Appliances
- To Enhance Safety in Home Electrical Systems
- To Enable Efficient Control of Multiple Appliances
- To Improve User Comfort and Lifestyle

III. SYSTEM OVERVIEW

The working of the system begins with the power supply unit, which provides the required electrical power to all electronic components in the circuit. The power supply converts the main AC supply into a regulated DC voltage suitable for the microcontroller and other electronic modules. Once the system receives power, the microcontroller acts as the central control unit. It receives input signals from sensors and manual switches and processes these signals according to the programmed instructions. Sensors may detect environmental conditions such as temperature, motion, or light level, while switches allow the user to manually control the appliances. The input signals from sensors and switches are sent to the microcontroller, where they are analyzed and processed. Based on the received input conditions, the microcontroller sends control signals to the relay board. The relay board functions as an electrical switching device that allows low voltage control signals from the microcontroller to operate high-voltage household appliances safely. Through the relay board, the system can control devices such as lights, fans, or other electrical equipment. When a relay is activated, the connected appliance turns ON, and when the relay is deactivated, the appliance turns OFF.

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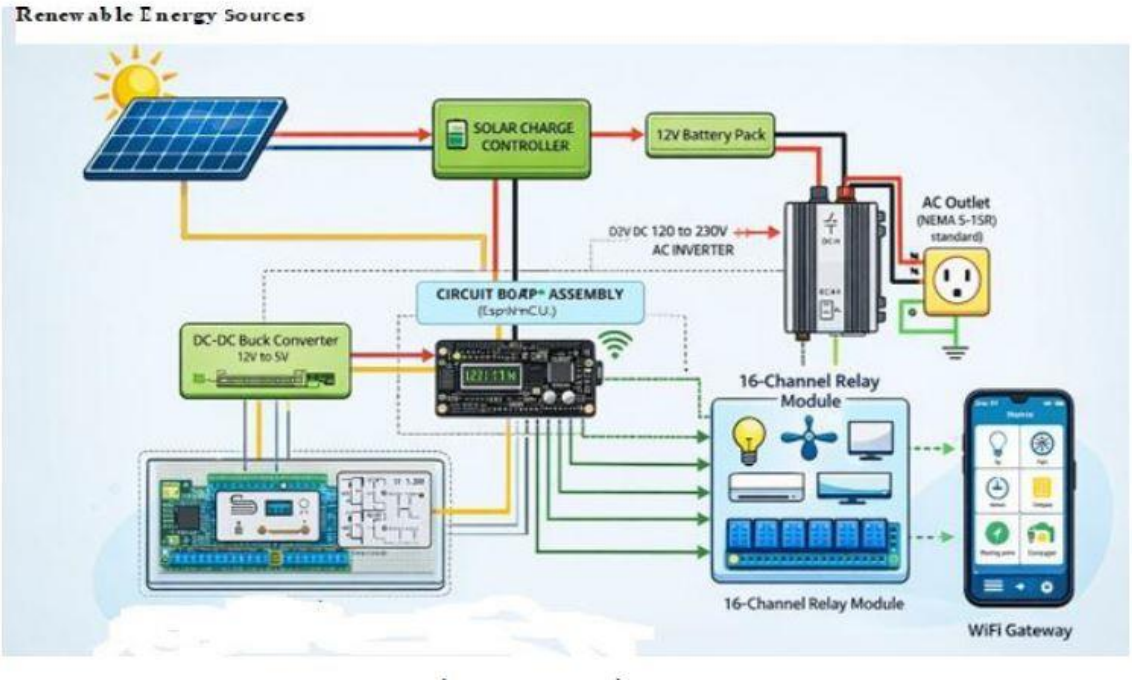

Fig.1 System Design

The solar charge controller is responsible for regulating the voltage and current coming from the solar panel. It ensures that the battery is charged safely and prevents overcharging or deep discharging. This device maintains the proper charging condition of the battery, improving battery life and system reliability. After regulation, the electrical energy is directed to the 12V battery pack, which acts as the energy storage unit of the system.

The 12V battery pack stores the electrical energy generated by the solar panel. This stored energy is used to power the entire smart home system when sunlight is unavailable, such as during nighttime or cloudy weather. The battery ensures a continuous and stable power supply to the control circuit and household appliances. Since most home appliances operate on alternating current (AC), the stored DC energy must be converted into AC.

IV. HARDWARE COMPONENTS

- **Solar Panel**

In the project "IoT-Based Smart Home Automation Using Renewable Energy", the solar panel plays an important role as the primary source of electrical energy. A solar panel works on the principle of the photovoltaic effect, where sunlight is directly converted into electrical energy. The solar panel consists of multiple photovoltaic (PV) cells made from semiconductor materials such as silicon. When sunlight falls on these cells, photons from the sunlight transfer their energy to electrons in the semiconductor material. This energy causes the electrons to move freely, creating an electric current. This process generates direct current (DC) electricity.

In this smart home automation system, the electricity produced by the solar panel is first supplied to the solar charge controller. The charge controller regulates the voltage and current coming from the solar panel and ensures that the connected battery is charged safely. It prevents overcharging, deep

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discharging, and protects the battery from damage. The regulated power is then stored in a 12V battery, which acts as an energy storage unit. The stored energy is later used to power the home automation system and connected electrical appliances.

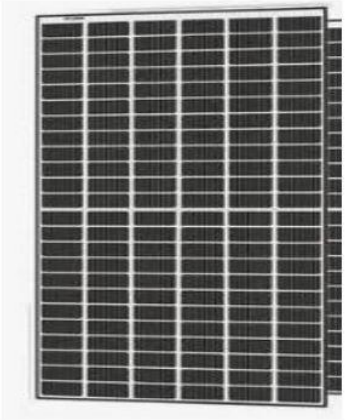

Fig. 2 Solar Panel

The application of the solar panel in this project is to provide clean, renewable, and sustainable energy for operating the smart home system. It reduces dependency on conventional electricity, lowers energy costs, and supports environmentally friendly energy utilization while enabling intelligent control of home devices through IoT technology.

- **Solar Charge Controller**

In the project "IoT-Based Smart Home Automation Using Renewable Energy", the solar charge controller plays a critical role in managing the energy produced by the solar panel and safely charging the battery. It acts as an interface between the solar panel, battery, and load, ensuring that the battery receives the correct voltage and current. The main working principle of the solar charge controller is to regulate the charging process and protect the battery from damage due to overcharging or deep discharging. In this system, the controller typically operates with a 12 V DC solar panel and charges a 12 V battery that supplies power to IoT modules such as the microcontroller, sensors, and communication devices. The controller contains internal components such as voltage regulators, MOSFET switching circuits, and protection diodes to ensure efficient power management

Fig.2 Solar Charge Controller

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- **12 Volt Battery Pack**

In the IoT-Based Smart Home Automation Using Renewable Energy project, the 12-Volt battery pack acts as the main energy storage unit that stores electrical energy generated by the solar panel and supplies stable power to the IoT devices when solar energy is unavailable. The solar panel produces electricity during daylight hours, which is regulated by the solar charge controller and then stored in the 12 V battery pack. This stored energy is later used to operate smart home components such as the microcontroller, sensors, Wi-Fi module, relays, and other control circuits. The battery ensures continuous power supply during night time, cloudy weather, or low solar radiation conditions, thereby maintaining uninterrupted operation of the automation system. The battery pack also helps in stabilizing voltage fluctuations and provides backup power for the IoT communication modules

Fig. 3 12 Volt Battery Pack

- **AC Inverter**

- In the IoT-Based Smart Home Automation Using Renewable Energy project, the AC inverter is an important power conversion device that converts the stored DC (Direct Current) energy from the battery into AC (Alternating Current) power required for operating household electrical appliances. Since the solar panel and battery produce DC power, but most home appliances operate on AC supply, the inverter is used to perform efficient DC-to-AC conversion. The inverter ensures that renewable energy generated by the solar panel can be utilized to run devices such as fans, light and other AC loads in the smart home system. The working of the AC inverter is based on high-frequency switching and pulse width modulation (PWM) techniques. The DC voltage from the 12 V battery pack is first supplied to a switching circuit consisting of MOSFETs or IGBTs controlled by a driver circuit. These switching devices rapidly turn ON and OFF in a specific pattern to create an alternating waveform

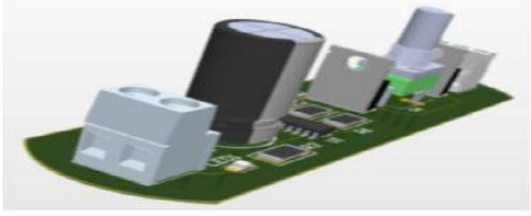

Fig. 4 AC Inverter

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- **ESP 32 Microcontroller**

- In the IoT-Based Smart Home Automation Using Renewable Energy system, the ESP32 microcontroller acts as the central control unit that manages communication, monitoring, and automation of household devices. It receives electrical power from the renewable energy system, usually through a regulated 5 V or 3.3 V supply derived from the solar-powered battery pack. The ESP32 processes input signals from sensors and user commands from the IoT platform, and then controls connected appliances through relay modules or driver circuits. The working of the ESP32 begins when the device is powered ON and the firmware program stored in its flash memory starts executing. The microcontroller reads data from connected sensors such as temperature sensors, light sensors, or motion detectors through its GPIO, ADC, or digital communication interfaces (I2C, SPI, UART). The ESP32 has built-in Wi-Fi and Bluetooth capabilities, which allow it to connect directly to the internet or a home router. Through this connection, it communicates with cloud platforms such as mobile applications or IoT dashboards, enabling users to monitor and control home appliances remotely.

Fig. 5 ESP 32 Microcontroller

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V. WORKING PRINCIPLE

Circuit Diagram: -

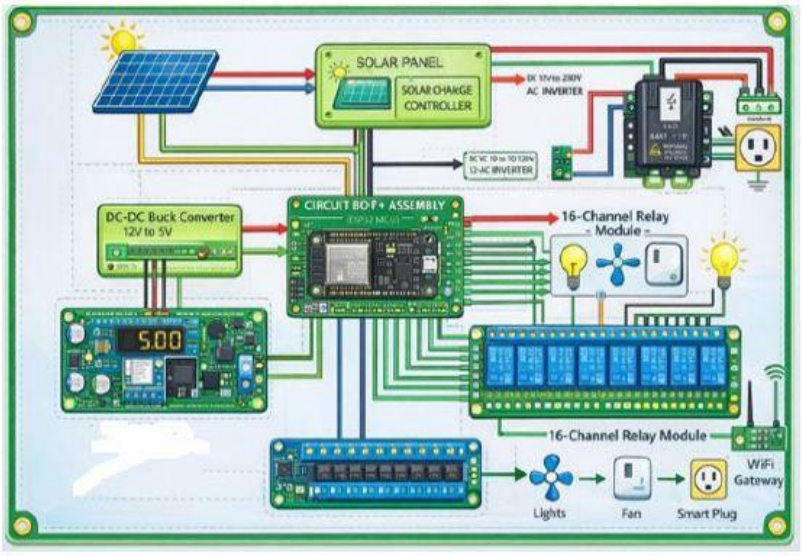

Fig.8 Proposed System

The circuit diagram illustrates an Internet of Things (IoT)-based smart home automation system that uses renewable energy, with solar power serving as the primary energy source to run household appliances via an intelligent control system. To provide an effective and automated home environment, the system combines energy storage, voltage management, renewable energy generation, and IoT-based device control. The solar panel serves as the renewable energy producing unit at the start of the circuit. It uses the photovoltaic effect to transform sunlight into direct current (DC) power. The solar charge controller receives the electrical energy generated by the solar panel. The charge controller's primary job is to control the voltage. The regulated output from the charge controller is connected to a 12V battery pack, which acts as the energy storage unit. The battery stores the electrical energy generated during the daytime and supplies it whenever solar power is not available, such as during nighttime or cloudy conditions. This ensures continuous operation of the smart home automation system.

Experimental Set up

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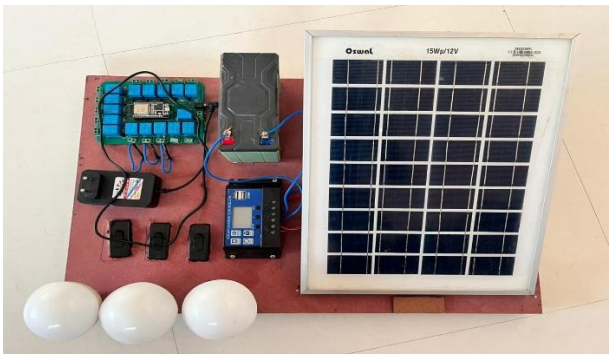

Fig. 10 Experimental Set up

VI. RESULT AND DISCUSSION

To present the results of the IoT-based Smart Home Automation System using Renewable Energy, several performance parameters were measured such as solar panel voltage, solar power generation, battery charging voltage, and overall system efficiency. The results show how the renewable energy system performs throughout the day and how efficiently it powers the smart home devices.

Parameter	Specification
Solar Panel Voltage	12V – 18.5 V
Solar Power Output	20 W – 65 W
Battery Charging Voltage	12.0 V – 13.6 V
DC-DC Converter Output	5 V / 3.3 V
Relay Switching Response Time	< 10 ms
Wi-Fi Communication Range	~30 m
System Efficiency	80% - 90%

Table: Output Parameter

The results show that solar power generation increases from morning to afternoon, reaching maximum output around midday. The battery voltage increases during charging and provides stable power to the ESP32 microcontroller and relay modules. The system maintained high efficiency (around 85–90%), ensuring reliable operation of home appliances controlled through the IoT platform.

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VII. CONCLUSION

- In order to increase energy efficiency and convenience in residential settings, the IoT-based Smart Home Automation System utilizing Renewable Energy is a creative solution that combines contemporary communication technology with sustainable energy sources. This project's primary goal is to power household appliances with sustainable solar energy while utilizing Internet of Things (IoT) technologies to enable intelligent monitoring and control. The project shows how to lessen reliance on traditional electricity sources by integrating solar power generating with automated control systems. In this system, solar panels use sunlight to produce electrical energy, which is then stored in a battery using a solar charge controller.
- modules, and the IoT platform. Through Wi-Fi connectivity, users can monitor and control appliances remotely using a smartphone or web application.In conclusion, the IoT-based smart home automation system powered by renewable energy provides a practical, energy-efficient, and environmentally friendly solution for modern homes. It offers improved convenience, remote accessibility, and better energy management. This project also highlights the potential for integrating renewable energy technologies with IoT applications to create smarter and more sustainable living environments in the future.

REFERENCES

1.Imam Hossain, Md. Shihabul Islam, Rabeya Sultana and Md. R. Rahman, “IoT Based Home Automation System Using Renewable Energy,” American Journal of Agricultural Science, Engineering and Technology, 2022.
2.Dipali Ghorpade and Amit Patki, “A Review on IoT Based Smart Home Automation Using Renewable Energy Sources,” International Journal of Science and Research (IJSR), 2016.
3.Rahmawati Fitriyan and Syafii Syafii, “Solar-Assisted IoT-Based Smart Home for Energy Efficiency and Hazard Prevention Toward Sustainable Living,” Andalasian International Journal of Applied Science, Engineering and Technology, 2024.
4.Habibu M. A., S. Sivakumar, G. R. Kanagachidambaresan and E. S. Mwanandiye, “An Effective IoT-Based Demand Response for Energy-Efficient Smart Homes,” Energy Informatics, 2025.
5.Challa Krishna Rao, Sarat Kumar Sahoo and Franco Fernando Yanine, “IoT-Based Intelligent Smart Energy Monitoring System for Solar PV Power Generation,” Energy Harvesting and Systems Journal, 2023.
6.Ying Zhen, T. Maragatham and Rajendra Prasad Mahapatra, “Design and Implementation of Smart Home Energy Management Systems Using Green Energy,” Arabian Journal of Geosciences, 2021.
7.Laura Jia, Zhe Li and Zhijian Hu, “Applications of the Internet of Things in Renewable Power Systems: A Survey,” Energies Journal, 2024.
8.R. K. Kodali and S. Yerroju, “Energy Efficient Home Automation Using IoT,” International Conference on Communication, Computing and Internet of Things (IC3IoT), 2018.