https://doi.org/10.46335/IJIES.2024.9.5.15 e-ISSN: 2456-3463
Vol. 9, No. 5, 2024, PP. 63-68

International Journal of Innovations in Engineering and Science, www.ijies.net

Sustainable Streets: Sensor-Driven Lighting Solutions During Non-Effective Hours To Reduce Energy Consumption

Dr. Minhaj Ahemad[1], Aman Sontakke[2], Anush Narnaware[3], Gaurav Hadge[4], Gourav Paithankar[5], Rugwed Kadu[6]

[1]Assistant Professor, [2, 3, 4, 5, 6]Student
Mechanical Department, St. Vincent Pallotti College of Engineering & Technology, Nagpur, Maharashtra

***Received on**: 12 May, 2024* ***Revised on**: 20 June,2024,* ***Published on**: 22 June ,2024*

***Abstract** - This study examines current advances in solar energy technology and the use of the Internet of Things (IoT) to control street lighting and charging facilities for electric vehicle (EV) stations. The combination of solar energy, IoT, with technology for smart grids has transformed the street lighting system into a contemporary, intelligent network. The research focuses on the essential characteristics, advantages, problems, and future possibilities of this emerging technology. Given the depletion of nonrenewable energy supplies, notably fossil fuels, the increasing usage of them poses a serious threat to the future. As a result, there is an increasing demand for alternate, sustainable energy sources. The Internet of Things develops as a disruptive technology that enables the linking of electrical things, resulting in a wiser society. This technology integration is transforming smart designs in operational switches. India, one of the world's fastest-growing technology marketplaces, is actively adopting this new paradigm. Automation system advancements have the ability to address many different global economic concerns, as well as improve individuals' quality of life by allowing smarter and more pleasant living.*

Keyword: - Solar Energy, Automatic streetlight, Internet of things, Electric Vehicle charging etc.

I. INTRODUCTION

Street lighting is one of the city's largest energy expenditures, playing an important role in ensuring visibility on roadways and streets at night. An automated street lighting arrangement has the potential to drastically cut municipal street lighting expenses, by 50% to 70%. The current system turns on the lights before sunset in the evening and turns them off in the morning once there is enough light outside. However, this strategy wastes some electricity since the lights are turned on according to a set timetable rather than adjusting to the real darkness [1].

The existing street light systems encounter issues, especially on bright and wet days when the ON and OFF hours differ. To alleviate this power waste, a remotely operated Street Light surveillance system based on IoT is proposed. The fundamental goal of the "connected to the internet of Solar Street Light Management System" project is to use solar energy to supply electricity to street lights at night. The rising worldwide energy demand, fueled by population increase and economic development, highlights the critical need for creative energy solutions [2][3].

The technology is called "smart" since it not only powers lighting on streets but also uses motion sensing to brighten the way for walkers. Dimming the illumination during off-peak hours is a vital feature for optimising energy use. When motion is noticed, the illuminations brighten to their regular state. This strategy not only saves energy but also lowers the operating expenses of streetlights. Furthermore, the system supports continuous monitoring and solution of problems via the Internet of Things (IoT), allowing for remote access to verify the status of street lights [4].

II. PROPOSED SYSTEM

This paper proposes the complete reliance of street lights on solar energy by connecting them to PhotoVoltaic (PV) panels, supported by a battery equipped with a charge controller. This system aims to store energy during the day and utilize it for street lighting at night. Traditional street lights consume thousands of kWh, while the proposed smart street lights, powered by solar energy, reduce electricity consumption to just a few kWh. The key components of the system include the Arduino controller with Wifi ESP12 programmable microcontroller, a solar panel for battery charging, a LDR sensor for sending light intensity from sun data to the server, and a motion sensor to detect motion and activate the lights. The system is programmed with a timer to control light activation, and it ensures that the lights only turn on at night by monitoring the solar panel voltage. In

https://doi.org/10.46335/IJIES.2024.9.5.15 **e-ISSN: 2456-3463**
Vol. 9, No. 5, 2024, PP. 63-68

International Journal of Innovations in Engineering and Science, www.ijies.net

nighttime, when the panel voltage is zero, the LED lights are activated.

Fig. 1. Smart Street Light System

1) In this proposed system, we use both solar and main power supply to run street lights. As we all know, solar energy efficiently works during the daytime or in sunlight only. But during rainy and cloudy seasons, the efficiency of solar energy is reduced. At this time, power supply will be provided from an external AC source. Both sources will be attached to the system to run street lights continuously.

2) As this system is equipped with smart features, the initial cost of investment will be high. However, compared to normal street lights, it consumes very little electricity. Therefore, the cost of solar smart street lights will be recovered in 2 years. After that, it will provide continuous savings in both cost and electricity.

3) As per smart communication nowadays, it reflects all over India. Right from fiber optic cables connecting every gram panchayat in rural areas, the government provides a strong means of communication. Additionally, the use of smartphones is compulsory for every government work nowadays. Therefore, if such smart systems have already been initiated by the government for rural areas, then the use of IoT technology will definitely play an important role in progressing both urban and rural areas equally.

III. BLOCK DIAGRAM

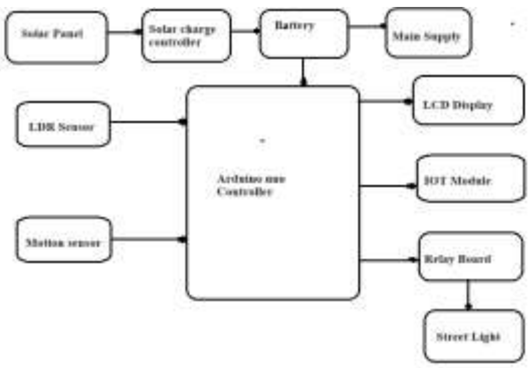

Fig.2. Block Diagram of system

IV. WORKING

The discussion revolves around employing sensors, actuators, and wireless communication protocols for intelligent and adaptive lighting solutions, emphasizing benefits like energy savings, reduced maintenance costs, and enhanced safety. An IoT (Internet of Things) based light control mechanism facilitates remote monitoring and control of lights via internet connectivity. The process involves:

Smart Lights: Utilizing smart lights with IoT capabilities, typically LED lights that enable remote control.

Communication Network: Connecting smart lights to a communication network through wireless technologies like Wi-Fi, Bluetooth, or cellular networks, enabling communication with a central control system or a user's device.

Central Control System: A cloud-hosted central control system managing and coordinating smart lights, acting as a bridge between lights and users for communication and control.

User Interface: Accessing the control system through interfaces such as mobile apps, web portals, or voice assistants, enabling users to interact with and control lights remotely.

Sensor Integration: Embedding sensors in IoT-based light control systems to provide automation. Light sensors detect nearby light levels, adjusting brightness accordingly, while motion sensors trigger lights based on detected movement.

Automation and Scheduling: Allowing users to set up automation rules and schedules for automatic light control. For example, programming lights to turn on at sunset and off at sunrise or automating lights based on specific events or conditions.

Energy Monitoring and Optimization: Monitoring energy consumption, tracking usage patterns, identifying energy-intensive areas, and suggesting energy-saving measures for optimization.

Integration with Other Systems: Enabling integration with other smart systems or devices, such as synchronization with security systems for enhanced safety or integration with smart home platforms for seamless control.

Data Analytics: Collecting and analyzing data from lights, sensors, and user interactions to generate insights, identify trends, and optimize lighting operations and energy efficiency.

In summary, an IoT-based light control mechanism provides convenience, flexibility, and energy efficiency by allowing remote control and automation of lighting systems, accompanied by data-driven insights and optimizations.

https://doi.org/10.46335/IJIES.2024.9.5.15 e-ISSN: 2456-3463
Vol. 9, No. 5, 2024, PP. 63-68

International Journal of Innovations in Engineering and Science, www.ijies.net

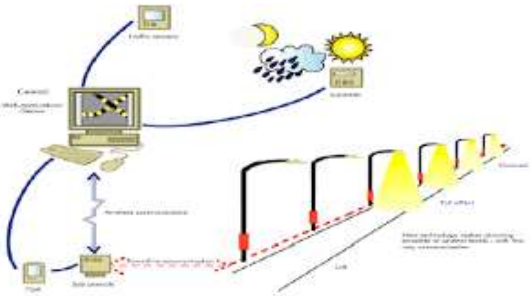

Fig. 3: Integrated System with IoT [5]

V. FLOW DIAGRAM

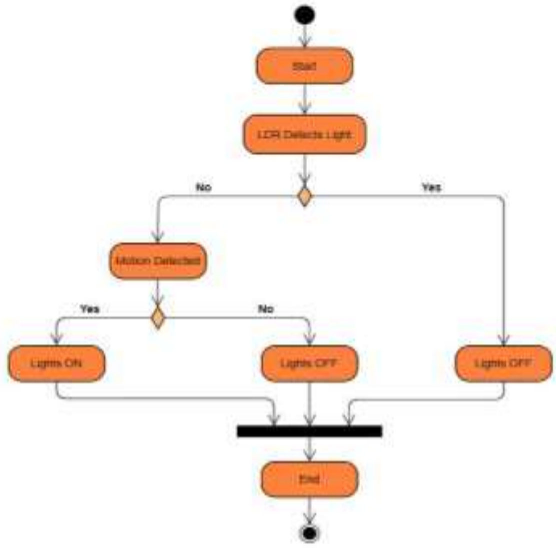

Fig. 4: Activity Diagram for IoT Based Smart Street Light System.

The section explores the integration of Solar Powered and IoT-based systems with EV charging points, emphasizing the synergies between solar power, IoT, and smart grid technologies. It delves into grid integration, load balancing, and energy management through advanced analytics and machine learning algorithms. The integration of these technologies offers multiple benefits for renewable energy generation, energy management, and grid optimization, as outlined below:

Solar Power Generation: Solar power systems, such as solar panels or solar farms, harness electricity from sunlight using photovoltaic (PV) technology. This clean and renewable energy source is applicable to various purposes.

IoT Connectivity: IoT facilitates device and system connectivity over the internet. In the realm of solar power, IoT is instrumental for monitoring and controlling solar installations, optimizing energy production, and enabling remote management.

a) Monitoring: IoT sensors in solar panels collect data on energy production, temperature, performance, and system health for analysis and monitoring.

b) Control and Optimization: IoT connectivity allows remote control and optimization of solar power systems, enabling real-time adjustments, issue detection, and improved efficiency.

Smart Grid Integration: The smart grid, an intelligent electricity distribution system, integrates advanced communication, control, and monitoring capabilities. Integrating solar power and IoT into the smart grid infrastructure provides several advantages:

a) Grid Stability and Resilience: Solar power integration contributes to grid balance, responding to demand and ensuring stability.

b) Energy Management and Demand Response: IoT enables real-time energy monitoring and demand response, optimizing energy dispatch and consumption for enhanced grid management.

c) Grid Integration and Flexibility: IoT-enabled smart grid infrastructure seamlessly integrates solar power systems, facilitating bidirectional power flow and supporting grid flexibility.

d) Grid Optimization and Fault Detection: IoT sensors and analytics aid in real-time identification of grid faults, power outages, and issues, enhancing grid reliability and resilience.

Components:

- Arduino Controller
- LDR sensor
- PIR Motion Sensor
- LCD Display
- 7805 IC Module
- Power supply unit
- Solar panel
- Solar charge controller
- Battery
- LED Light
- Frame
- AC Socket
- Inverter Module
- Others.

- **Arduino Uno (12v)**

Developed by Arduino.cc, the Arduino Uno is a free microcontroller board that is based upon the Microchip ATmega328P microprocessor. Sets of digital and analogue input/output (I/O) pins on the board allow it to be interfaced with other boards for expansion (shields) and other circuits.

.

- **Liquid Crystal Display (5v)**

Liquid Crystal Display is what LCD stands for. Due to LCD's capacity to show numbers, characters, and drawings, LEDs (seven segmented LEDs or other multi segmented LEDs) are being replaced by LCDs more and more. LEDs, on the other hand, are restricted to a few letters and numbers.

https://doi.org/10.46335/IJIES.2024.9.5.15 e-ISSN: 2456-3463
Vol. 9, No. 5, 2024, PP. 63-68

International Journal of Innovations in Engineering and Science, www.ijies.net

- **Relay Board (12v)**

Typically, an electrical current acts as the activation source for an electromechanical relay. One circuit's current flow determines whether another circuit opens or closes. Similar to remote control switches, relays are employed in a wide range of applications due to their excellent dependability, longevity, and relative simplicity.

- **PIR Motion Sensor (5v)**

Passive infrared (PIR) sensors work by detecting infrared radiation emitted by any item that generates heat. Although this kind of emission is invisible to the normal eye, it may be detected by infrared-detecting devices.

- **LDR sensor**

Light Dependent Resistor is referred to as LDR for short. Little light-sensing devices, or photoresistors, are referred to as LDRs. An LDR is a resistance that varies in resistance in response to variations in the quantity of light it receives. When light intensity rises, the LDR's resistance falls, and vice versa.

- **Voltage Regulator (7805 IC)**

The purpose of a voltage regulator is to regulate 12V DC voltages into 5V DC voltages so that the LED, microcontroller, and other components may be powered.

- **Battery**

An electrochemical device, the battery transforms chemical energy to electrical energy. The battery's primary function is to supply current so that the controller and various other electrical components can run. Details.

1) Voltage 12 V
2) Current 5Ah

- **Solar cell**

It is possible to store solar energy for use at night and in overcast weather. Since constant availability is a crucial necessity of current energy consumption, storage plays a key role in the growth of solar energy. The only time solar energy is accessible is during the day. A solar panel, sometimes referred to as a photovoltaic cell assembly or photovoltaic module, is a bundled, linked assembly of solar cells.

1) Voltage – 12 V dc
2) Power – 25 W.

- **Solar Charge controller**

An integral component of a solar cooling system that charges batteries is a charge controller. Its goal is to maintain a battery safely and correctly charged over time. A controller's core functions are quite straightforward. A solar panel experiences fluctuations in solar radiation whenever sunlight strikes it. In a solar refrigeration system, a charge controller is used to prevent sun fluctuations on solar panels.

- **IOT Module**

The term "Internet of Things" (or "IoT") describes how common things may transmit and receive data over the Internet. With its inbuilt TCP/IP protocol stack, the self-contained SOC ESP8266 WiFi Module allows any microcontroller to connect to your WiFi network. The ESP8266 may either run an application on its own or let another application processor to handle all Wi-Fi networking tasks.

- **Inverter (12V DC to 220 v AC)**

An electrical device or circuit that converts direct current, or DC, to alternating current, or AC, is called a power inverter, or inverter. The design of the particular device or circuitry determines the input voltage, final voltage and rate, and total power handling. The DC source provides the electricity; the converter does not create any.

https://doi.org/10.46335/IJIES.2024.9.5.15 e-ISSN: 2456-3463
Vol. 9, No. 5, 2024, PP. 63-68

International Journal of Innovations in Engineering and Science, www.ijies.net

CAD Model

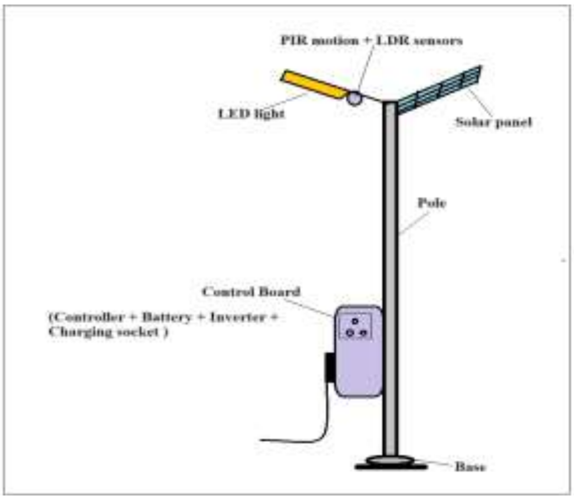

Fig.5.CAD Model

- Solar panel is attached to pole in the direction of sunlight. When sun rays fall into solar panel, light energy convert into electrical energy.
- This electrical energy is passed through solar charge controller and stored in battery. This controlling setup is mounted on separate box attached to pole. Inside this box control board, battery unit, power supply unit, inverter module and ac charging socket will place.
- Two sensors are use, PIR motion sensor are use to sense the presence of any motion detected and LDR sensors used in day and night time.
- This will place at near to LED light system at top portion of pole. All information where send via IOT module and will monitoring using smartphone application.

VI. ADVANTAGES

• Solar street lights operate independently of the grid, resulting in significantly lower operating costs.
• Maintenance costs are much lower compared to conventional street lights.
• The environmentally friendly design produces no harmful emissions.
• Solar street lights have a longer lifespan compared to conventional street lights.
• Power consumption is significantly lower in solar street lights.
• Light-Dependent Resistors (LDRs) are sensitive, cost-effective, and widely available devices with good power and voltage handling capabilities, similar to conventional resistors.
• LDRs are small and can fit into virtually any electronic device, serving as a basic component in many electrical systems worldwide.
• Photoresistors convert light into electricity independently of any other force.
• The simple design of photoresistors, using widely available materials, allows for the mass production of hundreds of thousands of units each year.

VII. DISADVANTAGES

• The initial investment for solar street lights is considerably high.
• Rechargeable batteries need periodic replacement.
• Lack of sunlight during rainy and winter seasons poses a challenge.
• Dust accumulation on the panel surface can create operational issues.
• The functionality of IoT is dependent on internet connectivity.

VIII. CONCLUSION

The integration of solar power, IoT, and smart grid technologies presents a significant opportunity to transform the energy landscape. By merging the clean energy generation of solar power with the connectivity and intelligence of IoT and smart grid systems, we can establish a more efficient, sustainable, and reliable energy infrastructure. Solar power offers a renewable and eco-friendly energy source, reducing dependence on fossil fuels and addressing climate change concerns. IoT facilitates the monitoring, control, and optimization of solar power systems, enabling real-time data analysis, remote management, and improvements in energy efficiency. Smart grids enhance grid stability, enable bidirectional power flow, and optimize energy management for reliable and efficient electricity distribution.
The proposed system has the potential to contribute to carbon emissions reduction, improve grid stability, empower energy consumers, and drive the transition to a cleaner and more connected future. By offering a comprehensive analysis of solar-powered IoT-based street light control and EV charging points, this research paper aims to add to the existing knowledge in this field. It serves as a valuable resource for researchers and policymakers interested in comprehending and implementing these technologies to promote a greener and smarter future.

REFERENCES

[1] *Ms. M. Kokilavani, Dr. A. Malathi "Smart Street Lighting System using IOT" Government Arts College, Coimbatore, Tamilnadu.*
[2] *K.Tamilselvan, K.S. Deepika, A.Gobinath, S.Harhini, S.Gokhulraj "IOT Based Street Light Monitoring System" Nandha Engineering College, Erode, Tamilnadu.*
[3] *Nithyashree CM, Vinutha TS, M. Dakshayini, P. Jayarekha "IOT-Smart Street Light System" BMSCE, Bengaluru, Karnataka, India*
[4] *Jessin Mathew, Riya Rajan, Rangit Varghese "IOT Based Street Light Monitoring & Control With loRa/LoRaWAn Network" Mount Zion College of Engineering, Kadammanitta, Kerela, India.*
[5] *Dr.A.S.C.S.Sastry, K.A.S.K.Bhargav, K.Surya Pavan, M.Narendra "Smart Street Light System using IOT" K L E F, Andhra Pradesh, India.*
[6] *P. Keni et al., "Automated street lighting system using IoT," vol. 4, no. 3, pp. 1970–1973, 2018.*
[7] *M. Revathy, S. Ramya, R. Sathiyavathi, B. Bharathi, and V. M. Anu, "Automation of street light for smart city," Proc.*

https://doi.org/10.46335/IJIES.2024.9.5.15 **e-ISSN: 2456-3463**
Vol. 9, No. 5, 2024, PP. 63-68

International Journal of Innovations in Engineering and Science, www.ijies.net

2017 IEEE Int. Conf. Commun. Signal Process. ICCSP 2017, vol. 2018- January, pp. 918–922, 2018.

[8] *O. Rudrawar, S. Daga, J. R. Chadha, and P. S. Kulkami, "Smart street lighting system with light intensity control using power electronics," Int. Conf. Technol. Smart City Energy Secur. Power Smart Solut. Smart Cities, ICSESP 2018 - Proc., vol. 2018-January, pp. 1–5, 2018.*

[9] *P. C. Veena, P. Tharakan, and H. Haridas, "Smart Street Light System based on Image Processing," 2016.*

[10] *A. Rajesh, A. Antony, F. Jose, and R. S. Kumar, "IoT Based Smart Street Light System," vol. 2, no. 1, pp. 312–320, 2018.*