IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, May 2024

Off-Grid Power Management System using IoT

Praise C Cossam and Mtende Mkandawire
Department of Computer Science
DMI St John The Baptist Malawi, Lilongwe

Abstract: *The "Off-Grid Solar Power Management System Using IoT" project is a solution to address the energy needs of remote and off-grid locations through the integration of renewable solar power and Internet of Things (IoT) technology. In the face of limited access to conventional power sources, this project leverages IoT devices and smart technologies to create a robust energy management system. The systemallows for the efficient capture, storage, and distribution of solar energy while enabling real-time monitoring. Key features include data collection on solar panel performance, energy consumption, and user-friendly interfaces accessible through web applications. This project demonstrates the potential to provide sustainable, reliable, and environmentally friendly energy solutions for off grid communities here inMalawi, enhancing their quality of life and contributing to global efforts for clean energy adoption*

Keywords: Solar Power Management System

I. INTRODUCTION

The increasing demand for renewable energy sources has prompted the development of solar power systems as an alternative source of electricity. Solar power systems harness the energy from the sun's radiation and convert it into electricity that can be used to power homes, businesses, and industries. Despite theirbenefits, solar power systems are subject to various factors that can affect their efficiency and reliability. For instance, the efficiency of solar panels decreases when their temperature increases, while the power output is also affected by the intensity of sunlight and weather conditions. To address these challenges, monitoring systems have been developed to measure and optimize the performance of solar power systems.IoT based solar power monitoring systems have emerged as a popular solution to monitor solar power systems in real-time.

These systems measure critical parameters such as current, voltage, power, solar panel temperature, and continuously analyze the data to detect and address any issues that may affect the performance of the solar power system the Indian economy, web applications are a technology that every second citizen can access. The functioning of powerful decentralized devices has revolutionized internet computing.

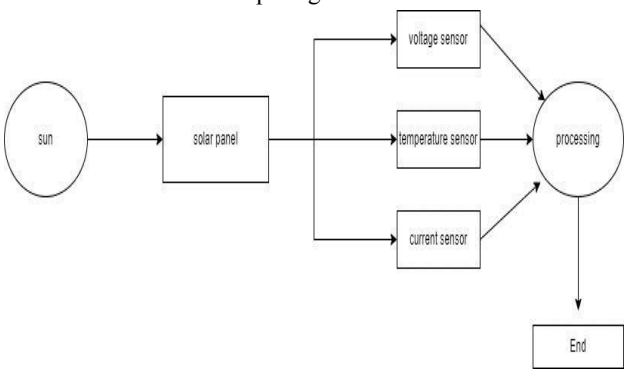


Figure 1: system Architecture diagram

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, May 2024

The architecture design of a system is a diagram that shows the architecture structure of the smartphone application, the architecture diagram represents the physical structure of the application usage and purpose

The benefits of the proposed system are,

Real-time Monitoring for Enhanced Performance

The IoT-based solar power monitoring system operates by continuously collecting and analyzing critical data points. This includes monitoring the current, voltage, power output, solar panel temperature, and light intensity. By leveraging IoT technology, users gain real-time insights into the performance of their solar power systems. Immediate access to this information empowers users to swiftly detect and address any anomalies or issues that may arise within the system. This proactive approach significantly enhances the efficiency and reliability of solar power systems by minimizing downtime and optimizing performance.

Predictive Maintenance for Improved Reliability

Moreover, the system's ability to continuously monitor parameters enables predictive maintenance. By analyzing historical data trends, it can predict potential faults or performance degradation, allowing for preemptive maintenance. Timely intervention prevents minor issues from escalating into major problems, ensuring consistent and reliable solar power generation over the long term.

Reduced Operational Costs and Increased Longevity The cost-effectiveness of the IoT-based solar power monitoring system lies in its capability to minimize operational expenses associated with solar power systems. Through real-time monitoring, it reduces the need for frequent manual inspections and maintenance visits. This not only saves on labor costs but also prevents potential damages or inefficiencies from escalating, thereby extending the lifespan of solar installations.

Optimized Efficiency for Financial Savings Additionally, the system's capacity to optimize the performance of solar power systems leads to increased energy production efficiency. This translates into higher energy yields without proportionally increased costs.

Users can expect improved returns on their investment through enhanced energy production and reduced expenses related to system upkeep.

Fostering Sustainable Energy Practices

The IoT-based solar power monitoring system plays a pivotal role in fostering the adoption of renewable energy sources, particularly solar power. By bolstering the efficiency and reliability of solar energy systems, it instills confidence in users regarding the viability and dependability of renewable energy sources.

Contributing to a Sustainable Future

The promotion of renewable energy adoption is crucial in reducing dependence on traditional, non-renewable energy sources. By encouraging the widespread implementation of solar power systems, this monitoring solution contributes to a more sustainable energy landscape. It aligns with global efforts aimed at mitigating climate change by reducing greenhouse gas emissions and fostering a transition towards cleaner, more sustainable energy alternatives.

Problem Statement

In remote and off-grid areas worldwide, the absence of centralized power grids perpetuates a dire lack of reliable and sustainable electricity. Residents in these regions often resort to nonrenewable and environmentally harmful energy sources like diesel generators or kerosene lamps due to the unavailability of dependable power. This scarcity not only profoundly impacts their quality of life, hindering basic tasks such as lighting and access to clean water but also creates economic and educational limitations. Businesses struggle to operate efficiently, while educational institutions face challenges in providing modern resources and technologies. Additionally, the reliance on non-renewable energy sources poses environmental risks, contributing to pollution and health hazards. The sporadic availability of power sources further jeopardizes public safety and health, particularly in healthcare facilities. Overall, this lack of consistent electricity inhibits community progress, hindering socio-economic advancement and perpetuating inequalities in these

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, May 2024

regions. Addressing these challenges through sustainable electricity solutions is crucial to improving living standards, fostering economic growth, and enhancing overall well-being.

II. LITERATURE REVIEW

Jianbin Xiong, Xinjun Mao, and Jun Li [2021] present a comprehensive review of IoT-based energy management systems for industrial manufacturing processes. The authors analyze recent advancements in IOT technologies, data analytics, and optimization techniques for energy efficiency in industrial settings.
They discuss various components of the energy management system, such as sensing devices, data communication protocols, data processing, and control strategies. The paper highlights the challenges and future directions in this field, providing valuable insights for researchers and practitioners in the domain of industrial energy management.

Zaher Mohammed Alsaffar and Hongbo Sun [2022] present a comprehensive survey on energy efficiency management in industrial IoT networks. The authors review recent research on energy optimization techniques, communication protocols, and network architectures for industrial IoT applications. They discuss the integration of advanced technologies such as edge computing, machine learning, and blockchain to enhance energy efficiency in industrial environments. The paper also covers case studies and practical implementations, providing insights into the current state of the field and future research directions.

Varun Sood, Naveen Chauhan, and S. N. Singh [2022] propose an integrated approach for an industrial energy management system based on IoT and artificial intelligence. The authors present a framework that combines IoT devices, advanced data analytics, and AI- based algorithms to optimize energy consumption in industrial settings. The system collects real-time energy data, performs predictive analysis, and generates energy- saving recommendations for industrial operations. The paper discusses the implementation details and experimental results, demonstrating the effectiveness of the proposed approach in achieving significant energy savings and cost reductions.

Jun Wei, Sheng Liu, and Xuewei Li [2022] propose a novel IoT-enabled energy management system for smart factories. The authors introduce a comprehensive framework that integrates IoT devices, cloud computing, and data analytics to monitor and optimize energy consumption in industrial settings. The system collects real-time energy data from various sensors and equipment, processes the data using advanced algorithms, and provides actionable insights for energy management. The paper presents experimental results and case studies, demonstrating the effectiveness of the

proposed system in achieving energy savings and improving operational efficiency in smart factories. Mohammed El Mohajir, Badr-Eddine Azzam, and Abderrahmane Baadoui [2023] propose a real-time energy management system for industrial IOT applications using a machine learning approach. The authors present a system that utilizes IOT devices, machine learning algorithms, and predictive models to optimize energy consumption in industrial environments. The system collects real-time energy data, performs data analysis, and employs machine learning techniques to predict energy demand and optimize energy usage. The paper presents experimental results, showcasing the effectiveness of the proposed system in achieving energy efficiency and cost savings in industrial IOT applications.

III. PROPOSED METHODOLOGY

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, May 2024

Is a type of model that is used during the development of this project. Continues integration deployment happens as the code is continually integrated and tested throughout the development process. This ensures that any issues are identified andaddressed early in the development process, reducing the risks of delays or errors. Implementing an Agile methodology can be beneficial for developing an IOT-based industrial energy management system that uses Arduino Uno and includes a mobile app for monitoring and controlling appliances.

IV. RESULTS AND DISCUSSION

Figure 1 shows the homepage of the web app, which offers a management system. The web app claims to be a one-stop destination for the effective management of solar, and it lists a number of features that it offers,

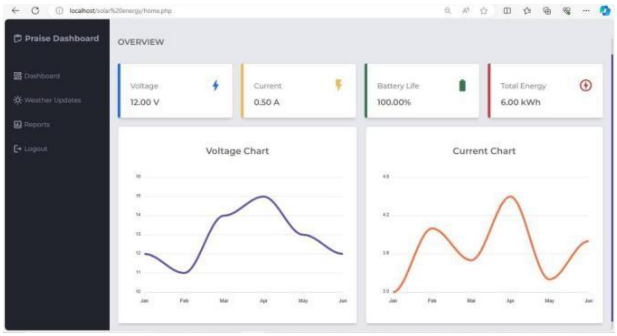
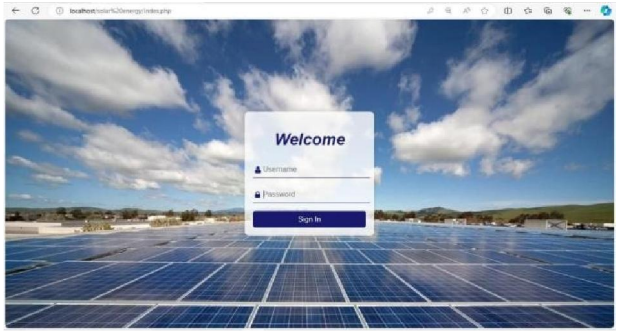
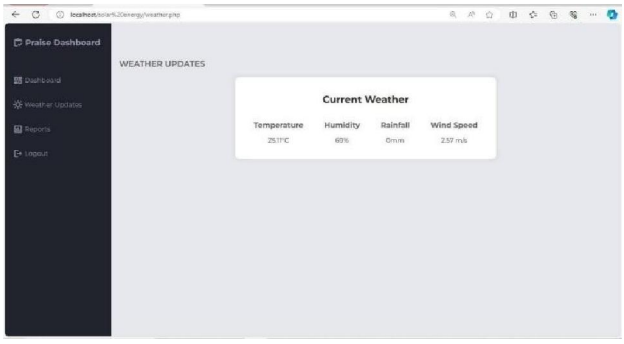


Figure 2 shows the login page for users, admins



Figures 3 show the dashboards of the admin, where they can monitor



V. CONCLUSION AND FUTURE SCOPE

A solar energy management system embodies a transformative approach to energy generation, delivering an array of benefits in a single, comprehensive solution. By efficiently capturing and utilizing solar power, these systems offer immediate cost savings through reduce reliance on conventional energy sources, fostering a more sustainable and environmentally friendly energy model.

Moreover, their adaptability across residential, commercial, and industrial settings ensures scalability and applicability to diverse energy needs. This technology not only provides reliable, independent energy but also contributes

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 5, May 2024

significantly to reducing carbon emissions and enhancing grid resilience, marking a pivotal step toward a cleaner, more sustainable future while continually advancing through technological innovation and refinement. Adding a battery so that the power can be saved in it. To make power more efficient every time it is need.

REFERENCES

[1]. D.Koutsouris Member "A new method for profile generation in an Internet of Things environment: An application in ambient assisted living" IEEE Internet of Things Journal.

[2]. Gomes, T. ; Centro Algoritmi - University of Minho, Portugal ; Pinto, S. ; Gomes, T. ; Tavares, A." Towards an FPGA-based edge device for the Internet of Things"Emerging Technologies & Factory Automation (ETFA).

[3]. IEEE Transactions on Industrial Electronics 10.1109/TIE.

[4]. Jeya Padmini, J.; Kashwan, K.R." Effective power utilization and conservation in smart homes using IoT," in Computation of Power, Energy Information and Commuincation (ICCPEIC), International Conference on , vol., no., pp.0195-0199, 22-23 April.

[5]. Jinsoo Han; Chang-sic Choi; Wan-Ki Park; Ilwoo Lee; Sang-Ha Kim," Smart home energy management system including renewable energy based on ZigBee and PLC in 2014 .

[6]. José G. de Matos, Member, IEEE, Felipe S. F. e Silva, Student Member, IEEE, and Luiz A. de S. Ribeiro, Member, IEEE "Power Control in AC Isolated Microgrids with Renewable Energy Sources and Energy Storage Systems"

[7]. Mohanty, S.; Panda, B.N.; Pattnaik B.S., "Implementation of a Web of Things based Smart Grid to remotely monitor and control Renewable Energy Sources," in Electrical, Electronics and Computer Science (SCEECS),2014 IEEE Student Conference on vol no pp,1-5,1-2

[8]. Shiu Kumar "Ubiquitou Smart Home System Using Android Application" International Journal of Computer Networks & Communications (IJCNC) Vol.6, No.1, January

[9]. W.Huiyong, W. Jingyang, and H. Min, "Building a smart home system with WSN and service robot," in Proc. 5th Int. Conf. Measuring Technol. Mechatronics Autom., Hong Kong, China.

[10]. J. Zhang, Y. Li, and X. Wang, "IoT-based Industrial Energy Management System for Enhanced Efficiency and Sustainability," in Proceedings of the IEEE International Conference on Industrial Internet of Things (IoT), Singapor