Real Time Power Monitoring and Demand Management System.

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ABSTRACT:

Energy management is an important requirement in modern electrical and industrial systems to reduce power wastage and improve operational efficiency. This paper presents a Real-Time Power Monitoring and Demand Management System using Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA)

1. INTRODUCTION

Efficient energy management has become essential in modern industries to reduce power wastage and improve system reliability. This paper presents a Real-Time Power Monitoring and Demand Management System using Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA). The proposed system continuously monitors electrical parameters such as voltage, current, power, and energy consumption in real time. The PLC collects data from sensors and meters installed in the electrical network and processes it to control loads based on predefined demand limits.

SCADA provides a graphical interface to display real-time data, alarms, and historical trends, allowing operators to monitor and manage power usage efficiently. When the demand exceeds a predefined threshold, the system automatically manages loads to prevent overload conditions and reduce peak demand charges.

This system improves energy efficiency, ensures better load management, and enhances the reliability of power distribution in industrial applications. The integration of PLC and SCADA enables automated control, remote monitoring, and better decision-making for effective energy management.

2. LITREATURE REVIEW

Real-time monitoring and efficient management of electrical power have become essential for modern industrial systems. Several researchers have developed automation-based solutions to monitor and control power consumption.

In [1], the authors presented a SCADA-based monitoring system for power distribution networks. The study explains how SCADA systems can collect real-time electrical data such as voltage, current, and power from various substations and display it through a centralized control system. The research highlights the importance of SCADA for improving system reliability and operational efficiency.

In [2], a PLC-based energy monitoring system was proposed for industrial applications. The system uses programmable logic controllers to monitor electrical parameters and control loads automatically. The results showed that PLC-based systems provide high reliability, fast response, and easy integration with industrial equipment.

Another study in [3] discussed the integration of PLC and SCADA for industrial automation. The authors demonstrated that the combination of PLC for control and SCADA for visualization provides an efficient solution for monitoring power consumption and detecting abnormal operating conditions in real time.

The work presented in [4] focuses on demand-side energy management in industrial systems. The researchers proposed an automated load management system that helps reduce peak demand by controlling non-critical loads. The system improves energy efficiency and reduces electricity costs.

In [5], the authors discussed the development of smart energy monitoring systems using advanced communication technologies. The study shows that real-time monitoring combined with automation can significantly improve energy management and reduce power wastage in industrial environments.

From the above studies, it can be concluded that PLC and SCADA based systems play a vital role in real-time monitoring, automation, and demand management of electrical power systems.

3. METHODOLOGY

The proposed system is designed to monitor electrical parameters in real time and manage electrical demand using PLC-based control and SCADA-based monitoring. The methodology consists of data acquisition, processing, monitoring, and load control.

1. Data Acquisition

Electrical parameters such as voltage, current, power, and energy consumption are measured using sensors and meters installed in the power distribution system.

Current Transformer (CT) is used to measure load current.

Voltage sensor or PT is used to measure system voltage.

These signals are converted into suitable analog or digital values and sent to the PLC input modules.

2. PLC-Based Data Processing

The Programmable Logic Controller (PLC) receives data from sensors and continuously processes the electrical parameters.

PLC executes a ladder logic program to calculate power usage and compare it with predefined demand limits.

If the power consumption exceeds the set limit, the PLC generates control signals to manage connected loads.

The PLC also stores and transfers monitoring data to the SCADA system.

3. Communication with SCADA

Communication between PLC and SCADA is established using industrial communication protocols such as Modbus or Ethernet.

Real-time data from the PLC is transmitted to the SCADA system.

SCADA acts as a supervisory system for monitoring and controlling the process.

4. SCADA Monitoring and Visualization

The SCADA software provides a graphical interface to display system parameters in real time.

Operators can monitor:

- Voltage
- Current
- Power consumption
- Energy usage
- System status and alarms

SCADA also records historical data, allowing analysis of power consumption trends.

5. Demand Management and Load Control

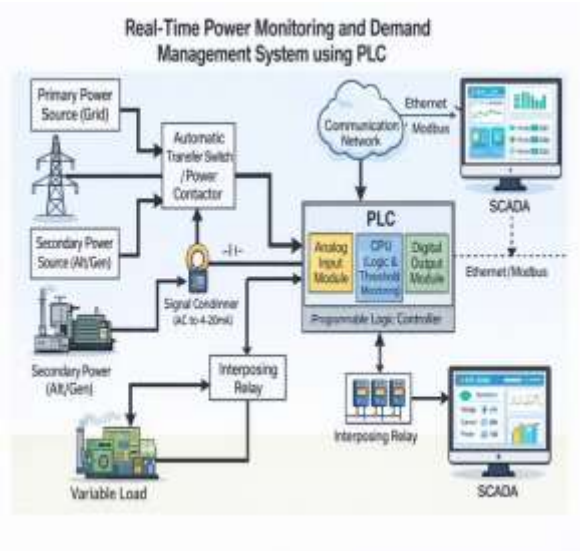
When the total power demand exceeds the predefined limit, the PLC automatically performs load management.

Non-critical loads are temporarily disconnected or shifted.

This prevents system overload and reduces peak demand charges.

6. System Operation

The overall operation of the system includes continuous monitoring, automatic decision-making by the PLC, and supervisory control through SCADA. This integrated approach ensures efficient energy utilization, improved reliability, and effective demand management in industrial power systems.



4.Problem Statement

In modern industrial and commercial environments, electrical energy consumption is increasing rapidly. Many industries still rely on manual monitoring and conventional electrical systems, which do not provide real-time information about power usage. Due to the lack of continuous monitoring, industries face problems such as power wastage, inefficient load management, and high peak demand charges.

Traditional systems also make it difficult to detect abnormal conditions such as overload, excessive power consumption, or equipment faults in time. As a result, this can lead to energy inefficiency, increased operational costs, and reduced system reliability.

Therefore, there is a need for an automated system that can monitor electrical parameters in real time and manage power demand effectively. The integration of Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) technology can provide an efficient solution for monitoring, controlling, and managing electrical power systems.

5. Objectives of the Study

1. To design and develop a real-time power monitoring system using PLC and SCADA.
2. To continuously monitor electrical parameters such as voltage, current, power, and energy consumption.
3. To implement automated demand management to control electrical loads when the power demand exceeds a predefined limit.
4. To provide a user-friendly SCADA interface for real-time visualization and monitoring of system parameters.
5. To improve energy efficiency and reduce power wastage in industrial electrical systems.
6. To enhance system reliability and operational safety through automated monitoring and control.

5. LIMITATIONS OF STUDY

Limited Monitoring Parameters
The system mainly monitors electrical parameters such as voltage, current, and power. Other factors affecting power quality, such as harmonics and power factor variations, may not be analyzed in detail.
Dependence on Sensor Accuracy
The accuracy of the monitoring system depends on the performance of sensors such as current transformers and signal conditioning circuits. Any sensor error may affect the accuracy of the measured data.
Limited Load Control Capability
The system can control only the loads that are connected to the PLC control circuit. Loads that are not integrated into the PLC system cannot be managed automatically.
Initial Installation Cost
Implementation of PLC, SCADA software, sensors, and communication modules may require a relatively high initial setup cost for small-scale industries.
Communication Dependency
The system relies on communication protocols such as Modbus or Ethernet between PLC and SCADA. Any communication failure may interrupt real-time monitoring.
Limited Scalability in Basic Design
The proposed system is designed for a specific setup. Expanding the system to monitor a large number of loads or multiple locations may require additional hardware and configuration

6. Results and Discussion

The developed Real-Time Power Monitoring and Demand Management System using PLC and SCADA was tested to observe its performance in monitoring and controlling electrical loads. The system successfully measured electrical parameters such as current and power consumption through the current transformer and signal conditioning circuit.

The PLC received the processed signals and continuously compared them with the predefined demand limit. When the load demand approached or exceeded the set threshold, the PLC executed the programmed logic and activated the interposing relay to manage the load. This helped in preventing overload conditions.

The SCADA interface displayed real-time data such as current, power consumption, and system status, allowing operators to monitor the system efficiently. Historical data and graphical trends also helped in analyzing power consumption patterns. The experimental results demonstrate that the system provides reliable monitoring, quick response, and efficient load management, making it suitable for industrial energy management applications.

7. Advantages of the System

1. Provides real-time monitoring of electrical parameters.
2. Helps in reducing power wastage through proper demand management.
3. Improves system reliability and safety.
4. Enables automatic load control when power demand exceeds the set limit.
5. Provides visual monitoring through SCADA interface.
6. Reduces the need for manual monitoring and human intervention.
7. Helps industries reduce peak demand charges and operational costs.

8. Conclusion

This paper presented a Real-Time Power Monitoring and Demand Management System using PLC and SCADA for efficient monitoring and control of electrical power consumption. The system continuously measures electrical parameters and processes the data through the PLC to detect overload or excessive demand conditions.

The integration of PLC and SCADA provides an effective platform for real-time monitoring, automated control, and efficient load management. The proposed system helps improve energy efficiency, reduce power wastage, and enhance the reliability of industrial power systems. Therefore, the developed system can be effectively implemented in industries for better energy management and operational efficiency.

9. Future Scope

1. Integration with IoT technology for remote monitoring through the internet.
2. Implementation of cloud-based data storage for large-scale energy analysis.
3. Use of Artificial Intelligence (AI) and Machine Learning for predictive energy management.
4. Expansion of the system for smart grid and smart building applications
5. Development of mobile applications for real-time monitoring and control.
6. Addition of power quality analysis such as harmonics and power factor monitoring.

5. References

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