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Integrated Energy Management System

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ABSTRACT:

The Energy Management System is developed to monitor and optimize power consumption and generation in an industrial setup. The system allows users to input multiple consumption parameters along with renewable energy sources such as solar and wind, and automatically calculates total consumption, generation, and energy balance. It also includes electricity cost estimation using slab-based tariff calculation and demand charge analysis based on sanctioned and maximum demand.
Additionally, the system stores historical data for future reference, enabling efficient energy tracking and decision-making. This project helps in improving energy efficiency, reducing costs, and providing a practical solution for real-world energy management.

INTRODUCTION:

In today's industrial environment, efficient energy management has become essential to reduce operational costs and improve sustainability. Traditional methods of tracking energy consumption and generation are often manual, error-prone, and lack real-time analysis. The proposed Energy Management System is designed to digitize and automate the monitoring of energy usage and generation across multiple units. It provides a centralized platform where users can input energy consumption values (C1–C5) along with renewable sources such as solar and wind, enabling accurate calculation of total consumption, generation, balance, and cost. The system improves decision-making by offering real-time insights into energy utilization.

OBJECTIVES:

- To monitor and manage energy consumption and generation
- To calculate energy balance and electricity cost accurately
- To implement demand charge calculations based on usage
- To reduce manual errors and improve efficiency

SCOPE:

The system can be used by:

- Industrial companies
- Power management departments
- Energy monitoring teams

LITERATURE REVIEW:

Existing energy management systems highlight the importance of automation in monitoring power consumption and generation.

Traditional systems rely heavily on manual data entry and lack real-time analytics, leading to inefficiencies and inaccuracies. Modern systems integrate digital tools to provide better monitoring, cost estimation, and energy optimization. However, many systems are either complex or not customized for specific industrial needs such as multi-source energy tracking and demand charge calculations. Therefore, there is a need for a simple, scalable, and efficient system tailored for energy monitoring and cost analysis**.**

PROPOSED SYSTEM:

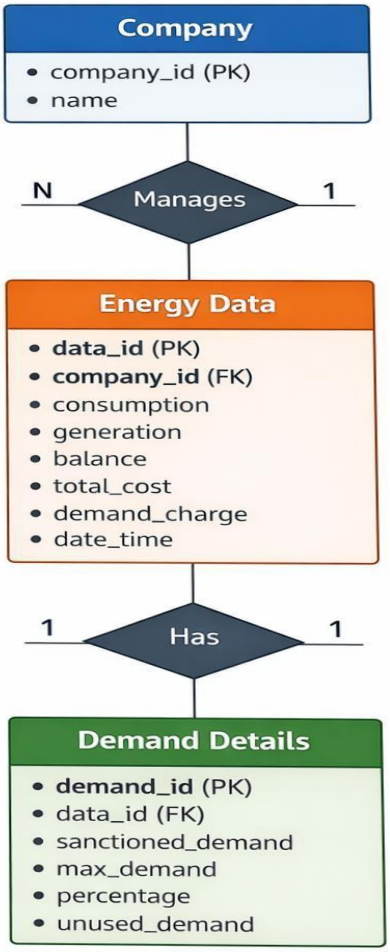
The proposed Energy Management System is a user-friendly application designed to automate energy monitoring and cost calculation. It allows users to input multiple consumption values and renewable energy inputs such as solar and wind. The system calculates total consumption, total generation, energy balance, and electricity cost using predefined formulas and slab-based calculations.

Additionally, the system includes demand charge analysis, which evaluates the percentage of maximum demand achieved against sanctioned demand and calculates penalties for under-utilization. It ensuring scalability and ease of use.

SYSTEM ARCHITECTURE:

The Energy Management System is designed using a layered architecture consisting of the Presentation Layer, Application Layer, and Data Layer. The Presentation Layer provides an interactive user interface where users can input energy consumption values (C1–C5) along with solar and wind data and view calculated results through a dashboard. The Application Layer handles all core functionalities including energy consumption calculation, generation analysis, cost estimation, and demand charge computation. The Data Layer is responsible for storing company details and historical energy records for future reference. This structured architecture ensures better performance, scalability, and easy maintenance, making the system efficient and reliable for real-time energy management.

ARCHITECTURE DIAGRAM:



SYSTEM IMPLEMENTATION:

The system is implemented using Flutter for front-end development, providing a responsive and user-friendly interface. The application allows users to input consumption values (C1–C5), solar, and wind data, which are processed in real-time. Calculations for total consumption, generation, balance, and cost are performed dynamically. The system also implements energy billing logic based on slab rates and includes demand charge calculations. Data storage is handled using local storage mechanisms, enabling users to save and retrieve historical records. The implementation ensures smooth performance, accuracy, and ease of use.

RESULTS AND DISCUSSION:

The implementation of the Energy Management System shows significant improvement in monitoring and analyzing energy usage. The system successfully calculates consumption, generation, balance, and cost with high accuracy. It reduces dependency on manual calculations and minimizes errors. The inclusion of demand charge analysis provides better insights into energy utilization and cost optimization. The dashboard interface allows users to easily interpret results, making the system effective for real-time decision-making. Overall, the system enhances efficiency, accuracy, and usability**.**

CONCLUSION:

The Energy Management System effectively automates the process of monitoring and analyzing energy consumption and generation. It reduces manual effort, improves accuracy, and provides valuable insights into energy usage and cost. The system is user-friendly, scalable, and suitable for real-world industrial applications. Future enhancements may include cloud integration, advanced analytics, and real-time monitoring features. Overall, the system serves as a reliable solution for efficient energy management.

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