**Smart Energy Saver for Budget Management**

**2. Introduction:**

**Electricity consumption is a major household and industrial expense. Many users struggle to track and control their electricity usage within a set budget. This project proposes an IoT-based Smart Energy Saver System that monitors real-time energy consumption, provides alerts when the budget limit is approaching, and offers data visualization for better decision-making. Additionally, Machine Learning (ML) will be integrated to predict future energy consumption and detect anomalies, enhancing efficiency and security.**

**3. Objectives:**

* **Develop an IoT-based system using ESP32 and energy sensors (ACS712 or PZEM-004T) to monitor real-time power usage.**
* **Transmit energy data to a Big Data system (Hadoop) for processing and storage.**
* **Implement Power BI dashboards for energy consumption analysis.**
* **Provide budget-based alerts when electricity usage nears the limit.**
* **Apply Machine Learning to predict energy consumption trends and detect anomalies.**

**4. System Components & Technologies:**

* **Hardware: ESP32 microcontroller, Energy Sensors (ACS712/PZEM-004T), Smart Plugs.**
* **Software: Arduino IDE, Python (Flask API), Hadoop (HDFS), Power BI, TensorFlow/Scikit-learn.**
* **Communication: WiFi (ESP32), HTTP/MQTT for data transmission.**
* **Storage & Processing: Hadoop HDFS for large-scale data storage, Apache Spark for data analysis.**
* **Machine Learning Models:**
  + **Predictive Energy Consumption: Time Series Forecasting (LSTM, ARIMA)**
  + **Anomaly Detection: Isolation Forest, Autoencoders**

**5. Expected Outcomes:**

* **Real-time monitoring of electricity consumption.**
* **Data-driven insights through Power BI dashboards.**
* **Alerts to help users stay within their electricity budget.**
* **Predictive analytics for future energy usage.**
* **Anomaly detection to identify faulty appliances or unusual consumption patterns.**
* **Efficient energy management and cost savings.**

**7. Conclusion:**

This project aims to help users **optimize their electricity usage, reduce costs, and promote energy efficiency** through IoT-based real-time monitoring and data analytics.

* **Flowchart** for your **Smart Energy Saver System**:

**The system sends alerts when energy usage nears the budget limit.**

**Power BI visualizes energy consumption data.**

**Apache Spark analyzes the data for trends and budget tracking.**

**ESP32 reads sensor data and transmits it via WiFi.**

**Data is sent to Hadoop for storage and processing.**

**Energy Sensors (ACS712/PZEM-004T) measure electricity usage.**