Smart Sub-Meter Billing System

Project Document

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1. Introduction

In a multi-tenant building in Dar es Salaam, Tanzania, the landlord noticed that electricity bills were often **disputed**. Some tenants claimed they used less electricity than they were being charged, while others consumed more than average without accountability. The building had **a single main meter** for all tenants, making it impossible to **measure individual usage**.

The **Smart Sub-Meter Billing System** is designed to monitor electricity usage at the sub-unit level for each single tenant billing, and provide real-time usage insights. This system helps to track electricity consumption efficiently, improve energy management, and ensure transparent billing.

2. Problem Statement

In multi-unit buildings or facilities, energy consumption varies widely across different units. Without sub-metering:

- Tenants often pay the same flat rate despite differences in usage.
- Overconsumption goes unnoticed, leading to high energy costs.
- Energy wastage is common due to lack of awareness.
- Manual meter reading is time-consuming and prone to errors.

There is a need for a **reliable, automated system** that measures energy consumption accurately, calculates bills per unit, and provides real-time feedback to users and facility managers.

3. Project Objective

The main objective of this project is to provide a **smart, automated sub-metering system** that enables accurate billing and energy monitoring. Specific objectives include:

- Measure electricity consumption of individual units using sub-meters.
- Automate data collection and real-time reporting.
- Calculate bills based on actual usage and tariff rates.

- Provide notifications for unusual usage or limit exceedance.
- Visualize usage data through mobile/web dashboards.
- Support multiple sub-units and historical consumption tracking.

4. System Overview

The system uses smart sub-meters installed at each unit to collect electricity usage data. The data is sent to a **central server or cloud platform** via IoT connectivity, where it is processed for billing and analytics. Users and facility managers can access the data via a **mobile or web interface**.

Key Functions:

1. Sub-unit energy measurement
2. Automated data collection via IoT
3. Real-time monitoring and alerts
4. Bill calculation and generation
5. Data visualization and reporting
6. Historical consumption tracking

5. Methodology

5.1 Energy Measurement

- Each sub-unit is equipped with a current and voltage sensor (e.g., ACS712, ZMPT101B) connected to a microcontroller (ESP32/Arduino).
- The sensors measure **current, voltage, and power consumption** in real time.

5.2 Data Recording

- Collected data is transmitted to a **cloud platform** via Wi-Fi or GSM.
- Each unit's data is uniquely identified and stored securely.

5.3 Data Processing & Analysis

- Calculate energy consumption in kWh.

- Compare usage against set thresholds to detect anomalies.
- Apply tariff rates to compute billing automatically.

5.4 Reporting

- Generate detailed reports for each sub-unit showing:
    - Daily, weekly, and monthly energy usage
    - Billing information
    - Alerts for unusual consumption patterns

5.5 Recommendations & Alerts

- Notify users of **high consumption** or unusual patterns.
- Suggest energy-saving measures such as turning off unused devices or optimizing usage schedules.

6. System Features

- Smart sub-meter with IoT connectivity
- Real-time consumption tracking
- Automated billing calculation
- Mobile and web dashboards for users and administrators
- Alerts and notifications for unusual usage
- Historical consumption tracking
- Support for multiple units and tariff plans

7. Expected Impact

The system is expected to:

- Enable fair and transparent billing per sub-unit
- Reduce energy wastage by increasing awareness
- Save time and labor for facility managers

- Provide actionable insights to improve energy efficiency
- Support sustainable energy management practices

8. Target Users

- Apartment complexes and rental housing managers
- Universities and hostel administrators
- Offices and co-working spaces
- Smart building managers
- Energy monitoring and utility companies

9. Conclusion

The **Smart Sub-Meter Billing System** offers a practical, scalable, and user-friendly solution for accurate energy monitoring and billing. By combining IoT technology, automated analytics, and real-time visualization, it improves transparency, reduces energy waste, and supports sustainable management of electricity resources.