University of South Wales
Prifysgol De Cymru

ENERGY METER WITH DATA COLLECTING AND MONITORING SYSTEM

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Module: Individual Project (IS3D660)

1. Introduction

Main Points:

- Purpose: Provide real-time, affordable energy monitoring.
- Solves limitations of traditional meters (cost, real-time visibility, accessibility).
- Utilizes ESP8266, ZMPT101B, SCT-013 sensors.
- Growing demand for smart meters in developing countries.
- Helps promote energy-saving habits and awareness.
- Key part of the move toward smart homes and sustainable living.

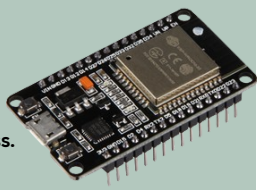


Fig1: ESP32 Module

2. Objectives

- Real-time monitoring and alerts.
- Energy saving and analysis.
- Affordable and user-friendly.
- Cloud-based data storage.
- Reduce energy wastage in households and small businesses.
- Provide visual data to support decision-making on appliance use.
- Create a flexible system that can be adapted or scaled.

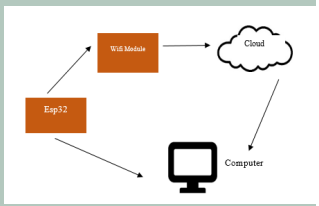
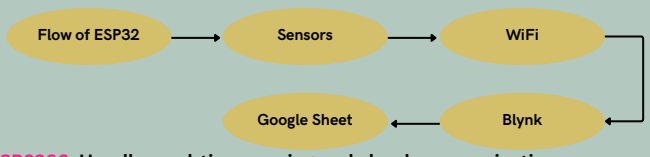


Fig 2: System flow chart

3. System Architecture & Components



- ESP8266: Handles real-time sensing and cloud communication
- Blynk: dashboard view on mobile
- Google Sheets: data logging and graphs
- SCT-013 current sensor detects real-time current flow (non-invasive clamp).
- ZMPT101B provides high precision for AC voltage measurements.
- Google Apps Script bridges Arduino data with Google Sheets.

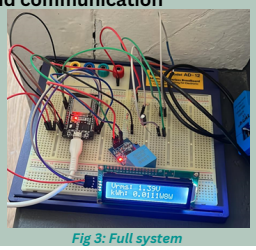


Fig 3: Full system

4. Real-Time Monitoring

- Users can track energy via the Blynk app.
- Get live data on voltage, current, and power.
- Visual feedback encourages users to modify usage patterns immediately.
- Data updates occur in intervals (e.g., every 1 second) for responsiveness.

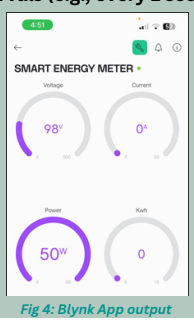


Fig 4: Blynk App output

5. Cloud Integration & Visualization

- Data logged to Google Sheets via Apps Script.
- Graphs and costs calculated.
- No paid services like IFTTT used.
- Data stored in the cloud allows for long-term tracking and reporting.
- Can be extended to mobile billing notifications or web dashboards.
- Google Sheets graphs auto-update with each new reading.

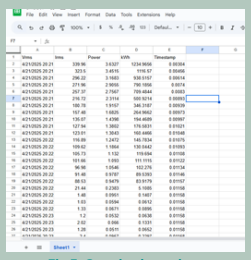


Fig 5: Google sheet data

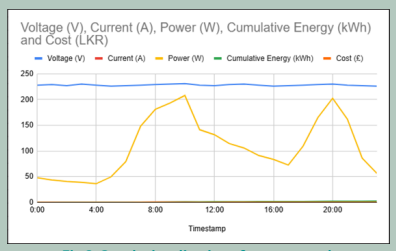


Fig 6: Graph visualization of energy trends

6. Comparison with Existing Systems

Feature	EMDCMS	OpenEnergyMonitor	Shelly EM
Cost	✅ Low	❌ High	⚠ Moderate
Open Source	✅ Yes	✅ Yes	❌ No
Mobile Friendly	✅	⚠ Limited	✅

Fig 7: OpenEnergyMonitor

Fig 8: Shelly EM

- EMDCMS is completely customizable and open to future expansion.
- OpenEnergyMonitor is effective but less affordable for local markets.
- Shelly EM is user-friendly but proprietary and cloud-dependent.

7. Limitations & Future Enhancements

The current system is limited to single-phase monitoring and depends entirely on a stable Wi-Fi connection for real-time data transmission. Manual sensor calibration is required, which may be difficult for non-technical users. The user interface, built with the Blynk platform, offers limited customization and lacks offline support. Additionally, the system is not legally certified for commercial billing and does not include built-in overload protection or automatic anomaly detection.

Future improvements include adding battery backup to maintain logging during power outages, expanding compatibility for three-phase systems, and integrating machine learning for predictive analytics and peak usage alerts. Other enhancements may involve developing a standalone mobile app, enabling SMS/email alerts, creating customizable dashboards via Node-RED, and adding voice assistant integration for easier interaction. These updates aim to improve the system's resilience, functionality, and adaptability for broader adoption.

8. Conclusion

This project successfully demonstrates the development of a cost-effective, real-time energy monitoring system using ESP8266, ZMPT101B, and SCT-013 sensors. By integrating the Blynk app and Google Sheets, it offers users an intuitive platform to track, log, and analyze energy consumption from anywhere. The system encourages more conscious and responsible energy use while highlighting the potential of affordable IoT solutions in addressing everyday challenges. With future enhancements such as three-phase support, AI-driven analytics, and broader connectivity, the system can be scaled for smart homes and energy-conscious communities, particularly in developing countries like Sri Lanka.

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Citations: (Source: Amazon, 2024), (Source: OpenEnergyMonitor, 2024), (Source: Shelly, 2024)
Note: Full references are included in the project report.