



# Designing an intelligent smart energy monitoring system for optimizing the utilization of PV energy

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## Abstract

Consumers in both residential and commercial settings are increasingly interested in reducing their energy consumption, influenced by feed-in tariffs for renewable resources and the recent surge in electricity rates. This study introduces a central control system and a smart power plug utilizing the XBee communication protocol to effectively manage energy usage. Smart energy management systems are employed to measure and optimize power consumption at the consumer premises level. The primary objective of this paper is the design and development of wireless smart plugs capable of assessing various power characteristics and collecting real-time data on individual consumer appliances' power usage. The SEMS setup establishes a Consumer Area Network through an XBee transmitter and receiver node, enabling real-time data collection at the central node for scheduling and prioritizing appliances. Utilizing the SEMS setup, consumer appliance datasets are generated and additional datasets aid in load disaggregation. The system configuration enables wireless data transfer from smart outlets to a central controller. Control instructions derived from data analysis are then used by the system to turn connected devices to the smart plug on or off. Test results indicate that the proposed smart plug accurately assesses power consumption up to eighteen meters away without compromising data integrity. The central controller, guided by a planned user program code, effectively manages multiple plugs based on the test findings. The Smart Energy Management algorithm suggests that employing smart plugs as load controllers results in a significant decrease in energy consumption (0.811 kW min or 0.0134 kWh) when accompanied by the appropriate scheduling algorithm. This technology holds potential in a comprehensive smart energy management system. The data's insights highlight the superiority of the proposed approach compared to current standard practices.

**Keywords** Intelligent smart energy management system · Smart meter · Smart plug · ZigBee · Monitoring system · Internet of things · Renewable energy

## Abbreviations

AMI      Advanced metering infrastructure

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