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on Semiconductor and Electronics, Information and Communications Technology and Energy

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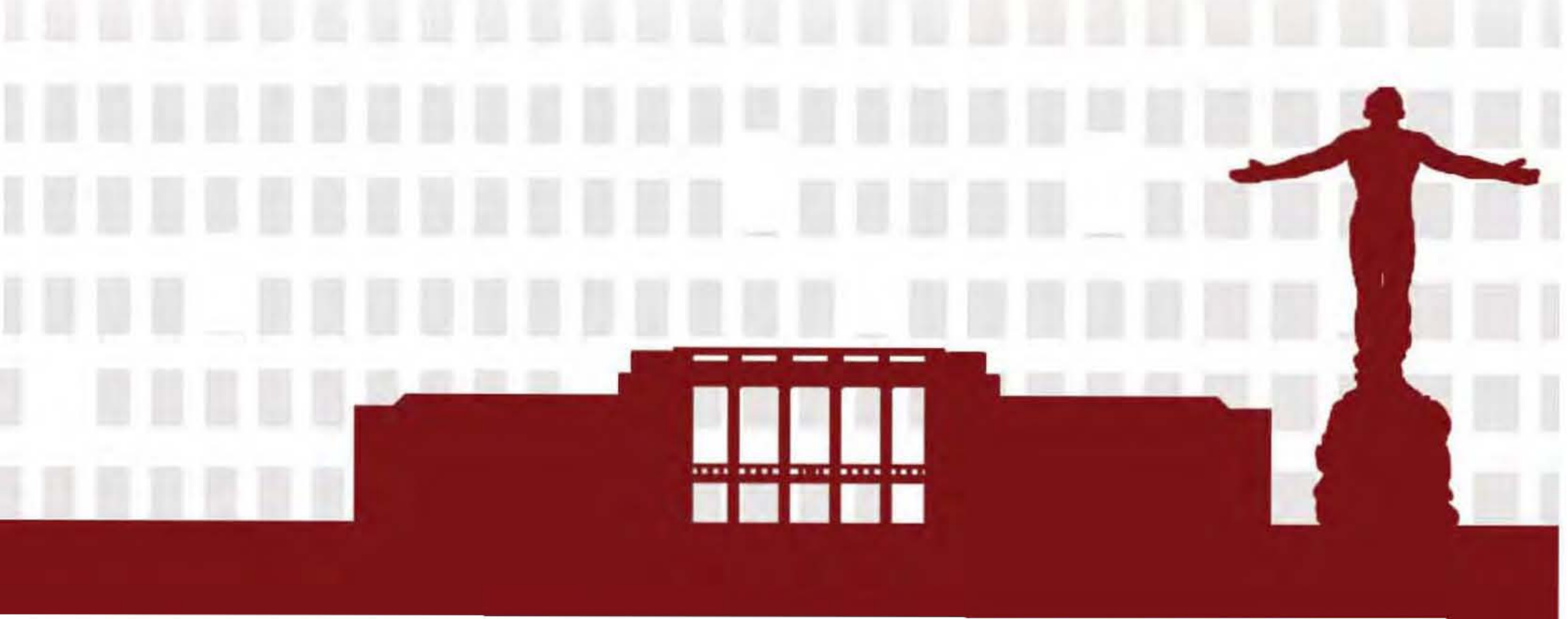

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ENERGY PROFILING USING A BUILDING ENERGY MONITORING SYSTEM

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ABSTRACT
With the rising cost of fossil fuel and the need to decrease our carbon footprint, reducing energy use has become imperative. This is especially true for large consumers wherein the electric bill accounts for a significant percentage of the organization's operating expenses. Executives, building owners and administrators, however, typically do not have the information they need to make informed, proactive decisions about their facility's energy use. Research have shown that providing more detailed feedback to consumers of their energy usage can significantly reduce electrical consumption [1, 2]. A Building Energy Monitoring System (BEMS) is one such system that can provide this information. A BEMS gathers real-time energy consumption of branch circuits in building and allows users to plot this information for further analysis. BEMS are commercially available already, although such systems are typically very expensive.

A prototype of a low-cost BEMS was developed in a previous project undertaken at UP-EEEI. This work builds on that system by improving on the security aspects of the system and increasing the accuracy of the energy measurements by lowering the error from 8% in the previous work to 3% (or 97% accuracy). Additionally, the hardware modules are deployed at the University of Philippines, Diliman EEE Institute building for three months to characterize and build an energy profile of the usage of facilities in the EEE Institute.

Security was improved by migrating the embedded system hardware from Gizduino X to Arduino Yun. RSA-2048 encryption was then implemented to secure the messages from the branch meter data loggers to the centralized server. The communication between users and the web server was also secured by using the HTTPS protocol for all web accesses.

To improve the accuracy of the power and energy measurements, the calibration procedure was changed. Instead of a single value used as the set point, multiple test points with known loads were used and a python script was incorporated in the web server to automatically calculate the piecewise equation per metering channel. This resulted in improving the accuracy of the measurements in the whole range of operation from 1 to 15 Amperes. It also made it easier to perform the re-calibration procedure as the values are not hard-coded on the Arduino boards anymore and the function is performed by the server instead.

Table 1 shows the average percentage error of power as measured from eight randomly selected branch meters. The meters were attached to a known load, and the load was varied every 15 minutes from 0A to 15A (1A load change per 15 minutes over a period of 4 hours. The power readings as measured by the meters were then noted, and compared to a commercially available power meter which served as the ground truth for comparison. The data shows that the average error is 1.29%, which is within the target 3% error range of this project.