Journal of Engineering and Technology for Industrial Applications

ITEGAM-JETIA

Manaus, v.12 n.57, p. 612-619. January/February, 2026.
DOI: https://doi.org/10.5935/jetia. v12i57.2903

ISSN ONLINE: 2447-0228

RESEARCH ARTICLE OPEN ACCESS

COMPREHENSIVE ENERGY AUDIT AND EFFICIENCY ASSESSMENT OF A UNIVERSITY CAMPUS: A CASE STUDY AT THE UNIVERSITY OF EASTERN PHILIPPINES

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ARTICLE INFO

Article History
Received: November 7, 2025
Revised: December 20, 2025
Accepted: January 15, 2026
Published: February 28, 2026

Keywords:
Energy audit;
Energy management;
Energy conservation measures (ECMs);
University energy consumption;
Sustainable campus operations

ABSTRACT

This study presents a comprehensive energy audit of the University of Eastern Philippines (UEP) aimed at assessing electricity consumption patterns, identifying inefficiencies, and proposing energy conservation strategies for institutional sustainability. The audit followed a three-phase framework—pre-audit planning, detailed audit and analysis, and post-audit evaluation—guided by the standards of the International Energy Agency (IEA) and ASHRAE. Data were collected from 25 major campus facilities using electricity billing records (2016–2018), field measurements, and stakeholder interviews. Results revealed a 51.4% increase in total electricity expenditure over three years, from ₱4.77 million to ₱7.22 million, driven by infrastructure expansion, increased equipment usage, and reliance on air-conditioning systems. The Cocofed Building, College of Business Administration (CBA) Building, and Bio-Physical Laboratory were identified as the highest energy-consuming structures, accounting for a substantial portion of total campus demand. Seasonal variations showed peak energy use from May to October, corresponding to high cooling loads. Based on audit findings, the implementation of targeted Energy Conservation Measures (ECMs)—including LED retrofitting, HVAC optimization, behavioral reforms, and potential solar photovoltaic integration—could achieve up to 15% reduction in energy use, equivalent to approximately ₱692,000 in annual savings. The study concludes that systematic energy auditing provides an essential framework for data-driven decision-making and long-term sustainability in higher education institutions, particularly in tropical and developing regions.

I. INTRODUCTION

Electricity is a fundamental form of energy that underpins modern economic activities and daily life, enabling essential services such as lighting, heating, cooling, and the operation of appliances in residential, commercial, and institutional buildings. Its absence would impair the operation of systems and hinder even simple activities that depend on it [1]. Energy consumption in buildings represents one of the major contributors to global energy demand and greenhouse gas emissions. The building sector accounts for approximately 30% of the world's total final energy consumption and nearly 28% of energy-related carbon dioxide emissions, primarily due to heating, cooling, lighting, and appliance use [2]. In the Philippines, commercial and residential buildings collectively constitute a major source of energy use and related greenhouse gas emissions, with commercial buildings alone representing approximately 10% of total national energy consumption according to the DOE's Energy Efficiency and Conservation Action Plan. Buildings and structures contribute significantly to the country's emissions profile, and subnational inventories — such as those from Pasig and Parañaque — estimate that buildings can account for up to 37% of local greenhouse gas emissions, driven primarily by lighting, cooling, and appliance loads.

These findings align with global trends, where buildings represent roughly one-third of total final energy use and energy-related CO_2 emissions, reinforcing the importance of energy audit and efficiency measures in mitigating both energy consumption and carbon outputs [3], [4]. As developing economies expand, public institutions such as universities are experiencing a rapid increase in energy demand because of infrastructure growth, increased occupancy, and the integration of technology-intensive facilities [5], [6]. Consequently, energy audits have become a fundamental tool for identifying inefficiencies and implementing conservation measures in academic and institutional environments [7]. Studies show that energy consumption in university campuses is highly dependent on building type, occupancy schedule, and operational factors. A bibliometric analysis of energy uses in higher education institutions found that electricity — especially for cooling, lighting, and equipment — is the primary energy load in campus buildings, and that functional differences between academic, residential, and research facilities significantly influence consumption patterns [8]. Statistical modeling of building energy use further demonstrates that operational schedules and environmental conditions significantly influence consumption patterns in campus buildings [9]. Local Philippine studies confirm that building function affects load distribution, with air-conditioning systems dominating in office and library buildings and lighting and plug loads varying by facility type [10].

According to the International Energy Agency (IEA), global energy demand in the buildings sector — including educational facilities — continues to rise due to modernization of infrastructure, extended operational hours, and the growing integration of digital technologies, which increase electricity loads for computing, lighting, and environmental controls. Buildings now account for roughly one-third of final energy consumption worldwide, making energy efficiency improvements critical in educational institutions that operate complex facilities with varied end-uses [11]. Universities, as microcosms of urban systems, possess a diverse mix of energy loads — ranging from classrooms, dormitories, and administrative offices to laboratories, libraries, and research centers. Each facility typically exhibits distinct consumption patterns influenced by building function, occupancy schedules, equipment utilization, and climatic conditions, highlighting the need for campus-wide diagnostic assessment. International systematic reviews of higher education institutions confirm that building function and operational characteristics are key determinants of energy demand, with heating, ventilation and air conditioning (HVAC), lighting, and plug-load equipment driving energy use across mixed-use campus buildings [8]. Thus, institutional energy audits serve as an essential diagnostic process to systematically assess where, how, and why energy is consumed within a university campus, forming the basis for benchmarking, identifying priority efficiency measures, and informing decision-making toward sustainable campus energy management [12], [13].

At the University of Eastern Philippines (UEP), rising energy costs have become a major operational concern. Annual electricity expenditures increased from PHP 3.2 million in 2012 to over PHP 7.2 million in 2018, marking a 51.4% escalation over six years. This trend underscores the urgent need for strategic energy management to improve operational efficiency and reduce financial strain. By implementing a systematic energy audit and management framework, the institution can potentially achieve a 15% reduction in energy use, equivalent to approximately PHP 692,000 in savings—funds that could be reallocated to academic and infrastructure development. Recent research reinforces the importance of university-based energy audits in improving energy performance. A study [14] demonstrated that implementing solar-assisted retrofits and control measures in university residential buildings reduced electricity use by 21%. Similarly, [15] performed a comprehensive audit on Moroccan university facilities, identifying HVAC inefficiencies as the largest contributors to wastage. In Malaysia, [16] emphasized that energy efficiency management frameworks are critical to ensuring sustainable campus operations, while [10] developed a procedural model for Philippine academic buildings, highlighting the significance of systematic energy monitoring.

Laboratories and specialized research centers are among the most energy-intensive campus facilities, consuming five to ten times more energy per square meter than standard offices due to ventilation, lighting, and specialized equipment requirements [9]. Therefore, targeted auditing approaches that address equipment scheduling, process optimization, and environmental control systems are crucial for such facilities. As the study [13] and [17] argue, integrating audit data with management systems and policy reforms is essential to establishing long-term sustainability across higher education institutions. This study aims to conduct a comprehensive energy audit at the University of Eastern Philippines (UEP) to evaluate existing energy utilization patterns, identify high-consumption areas, and propose actionable conservation measures. Specifically, the research (1) inventories energy-consuming facilities, (2) assesses consumption trends across multiple years, and (3) recommends efficiency interventions supported by cost–benefit analysis. The overarching goal is to establish a data-driven foundation for an institutional energy management framework that can serve as a model for other public universities in the Philippines and comparable tropical regions. Ultimately, the findings contribute to the global discourse on energy-efficient educational campuses by demonstrating how systematic auditing can foster operational savings, sustainability, and environmental stewardship in developing contexts.

II. MATERIALS AND METHODS

II.1 RESEARCH DESIGN AND FRAMEWORK

This research adopted a mixed-method design integrating both quantitative and qualitative approaches to systematically evaluate energy consumption patterns at the University of Eastern Philippines (UEP). The methodological framework was anchored on energy auditing guidelines and practices adopted in the Philippines, drawing primarily from the Department of Energy (DOE–Philippines) Energy Efficiency and Conservation (EEC) guidelines, and was supplemented by internationally recognized standards such as those of the International Energy Agency (IEA) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). The selection of this approach was informed by previous Philippine-based studies on energy audits in higher education institutions, which demonstrated that a structured audit process combining baseline data collection, field measurements, and consumption analysis is effective in identifying major energy loads and efficiency opportunities in university buildings [10]. The study was implemented in three phases: (1) pre-audit planning and baseline data collection, (2) detailed energy audit and consumption analysis, and (3) post-audit evaluation and formulation of energy efficiency recommendations.

This phased approach is consistent with methodologies applied in local university energy audit studies, which emphasized the importance of systematic assessment and post-audit evaluation to ensure practical and policy-aligned energy conservation measures [18]. [19], [20]. Each phase followed a systematic and sequential process to ensure comprehensive assessment of the university's facilities and an accurate representation of its energy consumption behavior within the local institutional and regulatory context.

II.2 STUDY SITE AND SCOPE

The study was conducted at the University of Eastern Philippines (UEP), a state university located in Catarman, Northern Samar, Philippines. The university comprises several academic, administrative, residential, and auxiliary buildings, each with distinct energy consumption characteristics. A total of twenty-five major facilities were included in the energy audit, encompassing both academic and non-academic structures such as the Cocofed Building, College of Business Administration (CBA) Building, Bio-Physical Laboratory, UEP-RCCC & Criminology Building, Diagnostic Center, and Hostel. These buildings were selected based on their relative energy intensity and their substantial contribution to the total electricity expenditure of the university between 2016 and 2018. The scope of the study focused primarily on electricity consumption, as it represented the dominant component of institutional energy use.

II.3 PHASE I: PRE-AUDIT PLANNING AND DATA COLLECTION

The pre-audit phase established the foundation for the detailed audit through data gathering and coordination with relevant university units. Initial consultations were conducted with facility managers, deans, administrative officers, and maintenance staff to obtain operational insights regarding building functions, occupancy schedules, and typical energy usage patterns [7]. A series of walkthrough inspections were then performed across all selected buildings to observe lighting systems, air-conditioning units, laboratory and computing equipment, and other major electrical installations. During this phase, historical electricity billing records from 2016 to 2018 were obtained from the Accounting and Facilities Management Offices to establish the university's baseline energy consumption and cost profile. In addition to data collection, process flow and energy utility diagrams were developed to map the flow of electricity within individual buildings and across the campus. This initial phase provided critical information on the distribution of energy loads, enabling the research team to identify the most energy-intensive areas for further investigation [15]. The combination of documentary data, physical observation, and stakeholder interviews provided a holistic understanding of how energy was consumed and managed within the university.

II.4 PHASE II: DETAILED ENERGY AUDIT AND ANALYSIS

The second phase involved conducting a detailed energy audit following ASHRAE Level II standards, which emphasize the integration of utility data analysis, field measurements, and performance evaluation [16]. Real-time consumption data were gathered from sub-meters and smart monitoring devices installed in high-consumption buildings such as the Bio-Physical Laboratory and Cocofed Building. For structures without sub-metering, consumption estimates were derived using connected load analysis, considering equipment wattage, operational hours, and occupancy patterns [6]. The audit team used portable digital analyzers to measure electrical parameters, including voltage, current, and power factor, while lighting levels were measured using a lux meter to assess efficiency and illumination adequacy. HVAC performance was evaluated based on system runtime, thermostat settings, and coefficient of performance (COP). These measurements were complemented by direct observations to identify operational inefficiencies such as equipment left running during idle periods or inadequate temperature control. Data analysis focused on determining consumption trends, load distributions, and seasonal variations in energy use.

Monthly and annual consumption were computed and compared across buildings to identify "energy guzzlers" or facilities with disproportionate consumption relative to their size or function. The study also employed normalized performance indicators such as energy use intensity (kWh/m²/year) to facilitate comparison among different types of buildings. Statistical analysis was performed using descriptive and trend analysis techniques, consistent with methodologies applied in similar university audits [14], [15]. The results provided insights into the operational dynamics driving the university's increasing energy expenditures. Energy Conservation Measures (ECMs) were identified based on the audit findings, focusing on both technical and behavioral opportunities for improvement. The potential measures included upgrading lighting systems to energy-efficient LEDs, optimizing HVAC temperature settings, improving equipment maintenance, introducing occupancy sensors, and exploring renewable energy options such as solar photovoltaic installations [5], [10], [14]. Each proposed intervention underwent cost-benefit evaluation, estimating potential savings, implementation costs, and payback periods to determine their feasibility and prioritization [9].

II.5 PHASE III: POST-EVALUATION AND RECOMMENDATIONS

The final phase of the study involved consolidating the audit results into a comprehensive Energy Management Plan (EMP) for the university. This plan detailed the recommended interventions, ranked according to their cost-effectiveness, energy-saving potential, and implementation feasibility. Follow-up consultations were held with the university administration to validate the findings and ensure alignment with institutional priorities and budgetary capacities. The EMP also proposed the establishment of an Energy Management Committee responsible for monitoring the implementation of energy-saving measures, verifying their performance, and institutionalizing continuous improvement practices in line with sustainable campus operations.

II.6 DATA ANALYSIS TOOLS AND EVALUATION

Quantitative data analysis was conducted using Microsoft Excel and SPSS software to process numerical data, generate statistical summaries, and produce graphical representations of energy consumption trends. Correlation analyses were employed to identify relationships between energy use and factors such as building function, occupancy rate, and seasonal variation.

Qualitative data gathered from interviews and observations were coded thematically to identify recurring issues related to operational practices and equipment management. To ensure methodological rigor, triangulation was applied by cross-verifying information from billing data, field measurements, and personnel interviews, thereby enhancing the reliability and validity of the results [7], [13], [16].

II.7 ETHICAL AND ADMINISTRATIVE CONSIDERATIONS

Prior to data collection, formal approval was secured from the University Research Office and the Office of the Vice President for Research, Development, and Extension. All building data and energy records were treated as confidential and used solely for research purposes. The study also adhered to the ethical standards of institutional research, ensuring that participation from staff and personnel during interviews was voluntary and conducted with informed consent.

III. RESULTS AND DISCUSSION

III.1 OVERVIEW OF ENERGY CONSUMPTION TRENDS

As shown in Fig. 1, the total energy expenditure of the university increased significantly from 2016 to 2018, reflecting the growth in infrastructure and equipment usage. The analysis of the University of Eastern Philippines' (UEP) electricity records from 2016 to 2018 revealed a continuous rise in total energy consumption across the main campus. Annual energy expenditures increased from ₱4.77 million in 2016 to ₱7.22 million in 2018, representing a 51.4% growth over three years. This escalation mirrors global patterns observed in institutional and educational facilities, where energy use continues to rise due to campus expansion, higher equipment density, and intensified reliance on information technology [2], [6], [16].

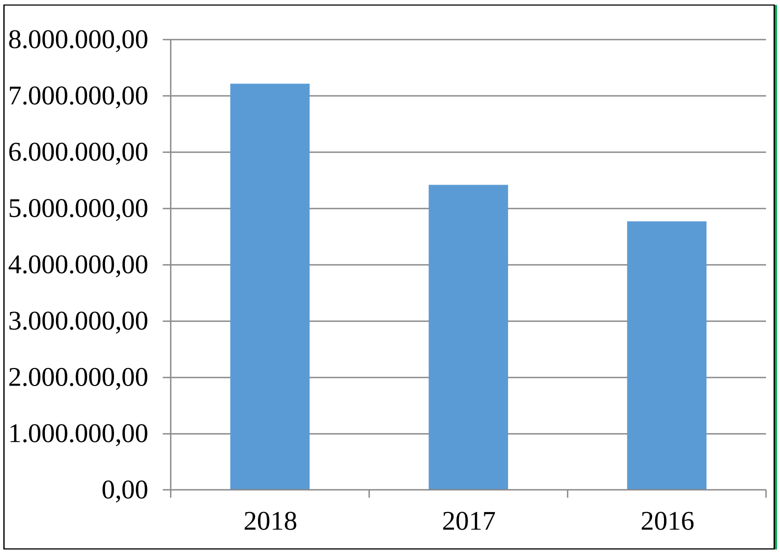

Figure 1: Annual Eelctricity Expenditure of the University of Eastern Philippines, 2016-2018.
Source: Authors, (2026).

Comparable trends were reported by [5] in Oman, who observed a 35% increase in energy demand in higher education institutions due to infrastructure expansion and increased cooling loads. Similarly, [15] found that Moroccan universities experienced significant increases in electricity consumption attributed to inefficient lighting and HVAC systems. These studies collectively affirm that academic institutions, particularly in tropical and developing regions, are facing substantial challenges in balancing modernization with energy efficiency. The growth of UEP's consumption can thus be attributed to the proliferation of electronic equipment, extended operational hours, and the installation of air-conditioning systems across academic and administrative spaces. A study [16] and [21] emphasized that these factors—combined with low awareness of energy conservation—are major contributors to energy inefficiency in Southeast Asian campuses.

III.2 BUILDING LEVEL ENERGY DISTRIBUTION

A building-by-building analysis revealed in Figure 2 that a few key facilities were responsible for a disproportionately large share of total electricity consumption. The Cocofed Building recorded the highest energy use, followed by the College of Business Administration (CBA) Building, Bio-Physical Laboratory, and UEP-RCCC & Criminology Building. Between 2016 and 2018, the Cocofed Building's annual cost increased from ₱1.099 million to ₱1.235 million, while the CBA Building's rose from ₱643,000 to ₱822,000.

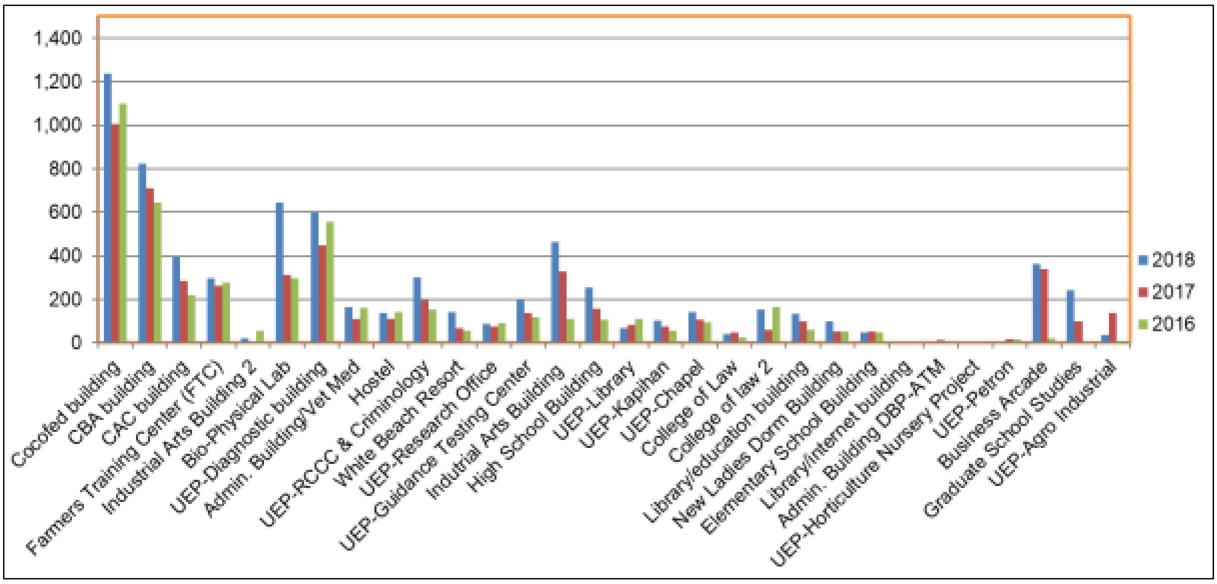

Figure 2: Comparative Annual Electricity Consumption by Building, 2016-2018.
Source: Authors, (2026).

This pattern is consistent with findings by [14], who identified that laboratory and administrative facilities exhibit the highest energy intensity due to equipment load, continuous operation, and greater cooling demands. Similarly, a recent benchmarking study conducted by [22] in Indonesia confirmed that laboratory buildings exhibited the highest Energy Consumption Intensity (IKE), exceeding 300 kWh/m² per year—significantly higher than classroom buildings. Furthermore, the unequal distribution of energy use across buildings aligns with the observations of [15], who found that just five university buildings in Morocco accounted for over 60% of total campus electricity use. This suggests that UEP's consumption profile—where a few buildings dominate total demand—is typical for higher education institutions, reinforcing the need for targeted, facility-specific energy interventions.

III.3 MONTHLY CONSUMPTION PATTERNS AND SEASONAL VARIATIONS

Monthly data analysis revealed cyclical consumption behavior influenced by both climatic conditions and the university's academic calendar. Electricity use peaked between May and October, coinciding with elevated outdoor temperatures and intensive academic activities. The Cocofed Building, for instance, recorded its highest monthly consumption in October 2018 (₱126,587.39), roughly double its January level. This trend highlights the strong relationship between tropical climatic conditions and increased HVAC load intensity. Studies by [14] and [23] report that cooling energy can account for up to 45% of total building energy consumption in humid regions. Similarly, research conducted at Nanjing Audit University in China [17] demonstrated that temperature-sensitive operations significantly contribute to monthly energy-use variability, particularly in facilities where ventilation and air-conditioning systems lack automated control mechanisms. In line with these findings, a pilot study [24] at the University of Eastern Philippines demonstrated the economic benefits of implementing automated electric fans, resulting in improved energy efficiency and reduced operational costs. Seasonal variations were also influenced by the academic schedule. Energy consumption typically declined during semester breaks, while examination and enrollment periods exhibited spikes in load due to extended operational hours. Such temporal fluctuations underscore the importance of load management strategies, including demand-side scheduling and programmable thermostats, as recommended by [16] and [10].

III.4 IDENTIFICATION OF HIGH-CONSUMPTION ZONES

The detailed audit revealed notable energy anomalies across several UEP buildings. The Bio-Physical Laboratory displayed monthly fluctuations between ₱26,762.05 in January and ₱76,211.21 in October, suggesting inconsistent operational management of laboratory equipment. Likewise, the Diagnostic Center showed a steady upward trend, doubling from ₱31,140 in January to ₱68,693 in December. Such variability is typical of research and medical facilities, where high plug loads associated with laboratory and medical equipment and stringent ventilation requirements contribute to substantial energy demand and operational losses. Laboratory fume hoods and high-level biosafety labs — common in research campuses — are known to be among the most energy-intensive building systems, often requiring constant air changes to maintain safety, which in turn increases HVAC energy use relative to conventional spaces. Similarly, medical facilities consume significant energy due to non-stop operation of equipment and environmental control systems, with refrigeration and specialized devices accounting for large shares of electricity use and continuous standby power draw.

Studies have shown that medical plug loads can constitute a significant portion of total electrical consumption in hospital laboratories, and that such equipment often exhibits high base-load and standby energy use even when not actively in operation, underscoring the importance of understanding load diversity in institutional energy audits [25], [26]. A 2022 study at Universiti Teknologi MARA (Malaysia) [27] reported that uncontrolled use of laboratory equipment and insufficient HVAC zoning led to 25% excess energy use annually. Similarly, [23] observed that without behavioral interventions, staff and student practices can negate the benefits of technical retrofits. The Industrial Arts Building exhibited a mid-year surge, likely linked to machinery-intensive workshops during training periods. These findings emphasize that operational scheduling, preventive maintenance, and behavioral modification are equally critical to energy efficiency as technological upgrades, a conclusion also reached by [7] and [22].

III.5 ENERGY CONSERVATION MEASURES (ECMs) AND EXPECTED IMPACT

Based on the audit results, several Energy Conservation Measures (ECMs) were proposed for implementation. These include replacing fluorescent and incandescent lamps with LED lighting, optimizing HVAC temperature settings, instituting preventive maintenance programs, installing occupancy sensors, and exploring on-site solar photovoltaic (PV) generation. LED retrofitting alone could yield 30–50% reductions in lighting energy use, while HVAC optimization could achieve an additional 15–20% reduction, consistent with results from previous university audits [5], [14], [15]. The integration of PV systems, particularly for high-load facilities like the Cocofed and CBA buildings, could further offset 10–15% of grid-supplied electricity, as demonstrated by [5] and [17]. A study [15] documented a 33% reduction in overall energy consumption following a comprehensive university retrofit in Morocco, while [17] achieved a 40% reduction through building-envelope improvements and smart control systems at Nanjing Audit University. These benchmarks suggest that UEP’s targeted 15% reduction is realistic and achievable under existing operational and financial constraints. The successful implementation of ECMs would translate to annual savings of approximately ₱692,000, which could be reallocated to support campus development and research. Moreover, the institutionalization of an Energy Management Committee would facilitate long-term monitoring, verification, and sustainability, as recommended by [13].

III.6 COMPARATIVE ANALYSIS WITH OTHER INSTITUTIONS

When compared with other international energy audit studies, UEP’s consumption profile and potential savings fall within a common range for tropical universities. [22] reported that Indonesian universities achieved 18–22% energy reductions after adopting targeted ECMs. In Malaysia, [16] and [21] documented up to 20% savings following the implementation of behavioral awareness programs and smart control technologies. Similarly, [17] in China achieved significant efficiency gains through green envelope retrofits and integrated energy management systems. These findings collectively indicate that universities operating in tropical and humid climates—like those in Southeast Asia—share common challenges related to air-conditioning dependence, inefficient equipment, and behavioral patterns. The consistency of UEP’s results with these studies confirms that systematic energy audits are effective diagnostic tools for identifying both technical inefficiencies and policy gaps, ultimately leading to sustainable institutional energy governance.

III.7 SUMMARY OF FINDINGS

The comprehensive audit established that UEP’s rising electricity consumption is driven by a combination of structural, operational, and behavioral factors. Buildings housing laboratories, administrative offices, and specialized facilities exhibited the highest energy intensities. Seasonal and academic-cycle variations further exacerbated load demands, particularly during the dry and hot months. By implementing cost-effective ECMs and adopting behavioral and policy-level strategies, the university could feasibly achieve a 15% reduction in energy use and align with international best practices in campus energy management. The study reinforces prior evidence that data-driven energy audits serve as essential foundations for developing institutional energy policies, improving operational efficiency, and advancing sustainability goals in public universities [6], [7], [15], [17], [22].

IV. CONCLUSIONS

This study conducted a comprehensive energy audit of the University of Eastern Philippines (UEP) to evaluate its electricity consumption patterns, identify inefficiencies, and propose data-driven conservation strategies. The analysis of three years of electricity records (2016–2018) revealed a 51.4% increase in energy expenditure, rising from ₱4.77 million to ₱7.22 million. This significant escalation highlights the growing energy demand associated with the expansion of academic infrastructure, increased equipment usage, and the intensified adoption of air-conditioning systems across campus. Building-level analysis showed that a small number of facilities—the Cocofed Building, College of Business Administration (CBA) Building, Bio-Physical Laboratory, and RCCC & Criminology Building—accounted for the majority of total energy consumption. These buildings exhibited high load densities due to continuous operations, specialized equipment, and extensive cooling requirements.

Monthly data indicated strong seasonal variation, with peak consumption occurring between May and October, corresponding to warmer weather conditions and heightened academic activity. The audit also uncovered several operational inefficiencies, including the use of outdated lighting systems, lack of zoning and control in HVAC units, and absence of automated energy management systems. By implementing targeted Energy Conservation Measures (ECMs) such as lighting retrofits, HVAC optimization, and behavioral reforms, UEP could feasibly reduce its electricity consumption by at least 15%, equivalent to an annual savings of approximately ₱692,000. Overall, the study demonstrates that systematic energy audits are essential tools for identifying both technical and behavioral inefficiencies in university environments. The findings provide a solid foundation for establishing a campus-wide energy management framework that promotes sustainability, reduces operational costs, and enhances institutional resilience against rising energy prices.

V. RECOMMENDATIONS

1. *Implement High-Impact Energy Conservation Measures (ECMs).* Immediate actions should prioritize cost-effective measures such as LED lighting retrofits, HVAC system maintenance, thermostat optimization, and installation of occupancy sensors. These interventions can yield substantial energy savings with minimal capital investment.
2. *Establish an Energy Management Committee (EMC).* A university-level EMC should be formed to coordinate and oversee all energy-related initiatives. This committee should develop policies, monitor energy performance, and ensure that efficiency measures are implemented and sustained over time.
3. *Adopt Smart Metering and Real-Time Monitoring Systems.* Installing sub-meters and digital energy monitoring tools will allow precise tracking of electricity usage per building, enabling early detection of anomalies, accurate benchmarking, and data-driven decision-making.

4. *Integrate Renewable Energy Technologies.* The university should explore the installation of solar photovoltaic (PV) systems on suitable rooftops, particularly high-load facilities such as the Cocofed and CBA buildings. Even partial adoption could offset a portion of grid-supplied electricity and demonstrate the university's commitment to sustainability.
5. *Strengthen Institutional Policies and Awareness Programs.* Energy efficiency should be embedded into university policies, procurement guidelines, and maintenance practices. Conducting awareness campaigns, student-led initiatives, and staff training can encourage responsible energy behavior and ensure long-term cultural change.
6. *Conduct Regular Energy Audits and Benchmarking.* The energy audit should be repeated every three to five years to evaluate progress and identify new opportunities for improvement. Establishing performance indicators such as energy consumption intensity (kWh/m²/year) will allow comparison with national and international benchmarks.
7. *Explore Long-Term Structural and Thermal Improvements.* Future infrastructure upgrades should consider energy-efficient building designs, thermal insulation, reflective roofing, and natural ventilation strategies to reduce dependency on mechanical cooling systems.

VI. AUTHOR'S CONTRIBUTION

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Investigation: Bless Ampuan*, Rem Laodeño and Merewina Llanie Tapong.
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Writing – Original Draft: Bless Ampuan.
Writing – Review and Editing: Bless Ampuan*, Rem Laodeño and Merewina Llanie Tapong.
Resources: Rem Laodeño.
Supervision: Bless Ampuan*, Rem Laodeño and Merewina Llanie Tapong.
Approval of the final text: Bless Ampuan*, Rem Laodeño and Merewina Llanie Tapong.

VII. ACKNOWLEDGMENTS

The researchers sincerely thank the University of Eastern Philippines (UEP) led by Dr. Cherry I. Ultra, for the financial support that made this study possible, and the University Administration, particularly the Office of the President and the Office of the Vice President for Research, Development and Extension, headed by Dr. Karina Cui-Lim, for their approval and support. Appreciation is also extended to the College of Engineering, the Facilities Management and Campus Development Office, the Accounting Office, the Electrical Services Division, and other university personnel for their cooperation and provision of essential data. The researchers likewise acknowledge the assistance of the Energy Audit Task Force, academic representatives, and administrative staff. Finally, heartfelt thanks are extended to the researchers' families, friends, and colleagues for their continued encouragement and support.

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