



Development of a Data-Driven Energy Management Plan for Lighting and Air-Conditioning Systems in a Private University Based on RA No. 11285 Compliance Assessment and Enabler–Barrier Modeling

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Article Info

ISSN (Online): 2582-7138
Impact Factor (RSIF): 8.04
Volume: 07
Issue: 03
May-June 2026
Received: 22-02-2026
Accepted: 24-03-2026
Published: 26-04-2026
Page No: 243-250

Abstract

This study aimed to develop a data-driven Energy Management Plan (EMP) for lighting and air-conditioning systems in a private university based on Republic Act No. 11285 or the Energy Efficiency and Conservation (EEC) Act compliance assessment and enabler–barrier modelling. A descriptive–developmental design was used, employing surveys, interviews, document analysis, and a Level I Energy Walkthrough Audit. Findings showed high compliance in operational practices and reporting, while policy institutionalization and monitoring systems were moderate. Enablers were moderately present, with strong management support and behavioral practices, while financial, technical, and organizational constraints limited advanced energy management implementation. Barriers such as financial limitations, organizational gaps, and underutilization of energy audit results affected performance. Audit results revealed inefficiencies in air-conditioning systems due to non-inverter units and temperature inconsistencies. A comprehensive EMP was developed, integrating energy conservation measures and monitoring systems aligned with ISO 50001. The study concludes that a structured approach can improve energy efficiency and support sustainable practices.

Keywords: Energy Efficiency, RA No. 11285, Energy Management Plan, Compliance Assessment, Lighting and Air-Conditioning Systems

1. Introduction

Energy efficiency and sustainable energy management have become critical priorities for institutions worldwide, particularly following the implementation of Republic Act No. 11285, also known as the Energy Efficiency and Conservation (EEC) Act. This law institutionalizes energy efficiency measures in the Philippines by mandating designated establishments to implement energy management systems, conduct periodic energy audits, and submit compliance reports to regulatory agencies ^[1]. According to ^[2], the EEC Act aims to promote efficient energy utilization, reduce dependence on imported fuels, and mitigate environmental impacts associated with excessive energy consumption. Globally, regulatory frameworks have been shown to significantly improve institutional accountability and promote energy conservation practices ^[1].

Higher education institutions are among the key sectors affected by this policy due to their complex and energy-intensive operations. Universities function not only as centers of instruction and research but also as large-scale operational environments requiring continuous energy supply for classrooms, laboratories, offices, and support facilities. Globally, ^[3] and ^[4] report that educational institutions significantly contribute to energy consumption in the commercial sector. In the Philippine context, commercial and institutional buildings accounted for approximately 12.4% of total final energy consumption in 2022, with projections indicating continued growth due to urbanization and expansion of educational infrastructure ^[2]. This increasing demand places financial strain on institutions while intensifying environmental concerns such as greenhouse gas emissions and reliance on non-renewable energy sources.

Despite advancements in energy-efficient technologies, inefficiencies in energy utilization persist across many university

campuses. Studies on building energy performance reveal that common issues include outdated equipment, inefficient scheduling, and lack of awareness in energy conservation practices^[5]. Among building systems, lighting and air-conditioning consistently account for the largest share of electricity consumption in academic facilities, making them priority areas for efficiency improvements^[6].

Energy audits are widely recognized as fundamental tools for identifying inefficiencies and improving energy performance. A Level I Energy Audit, also known as a walkthrough audit, provides an initial assessment of energy consumption patterns, identifies major energy users, and recommends preliminary energy conservation measures^[7]. Under the provisions of Republic Act No. 11285, designated establishments, including universities, are required to conduct such audits as part of compliance requirements. However, existing literature suggests that compliance alone does not guarantee effective implementation, as audit findings are not always integrated into long-term energy management strategies^[3].

This disconnect reveals a critical gap between compliance and actual implementation of energy efficiency measures. While previous studies have explored energy audits and conservation practices, there remains limited research integrating compliance assessment with operational analysis to develop structured Energy Management Plans, particularly in higher education institutions in developing countries^[8].

In response to this gap, the present study assesses the level of compliance with Republic Act No. 11285 and examines the enablers and barriers influencing compliance in the UPHSL College Building. The findings serve as the basis for developing a proposed Energy Management Plan (EMP) specifically focused on improving the efficiency of lighting and air-conditioning systems, thereby contributing to sustainable energy practices and enhanced institutional performance.

This study aims to assess compliance with Republic Act No. 11285 or the Energy Efficiency and Conservation Act and develop a data-driven Energy Management Plan (EMP) for lighting and air-conditioning systems in the UPHSL College Building.

Specifically, it aims to:

- a. Determine the level of compliance with RA No. 11285 based on Government Energy Management Program (GEMP) guidelines in terms of institutionalization, electricity conservation measures, and reports and inventories;
- b. Identify the enablers and barriers affecting compliance; and

Develop a structured Energy Management Plan to improve energy efficiency and support sustainable energy management practices.

2. Method

A descriptive–developmental research design was employed. Data were collected through surveys, interviews, and document analysis. A Level I Energy Walkthrough Audit was conducted to evaluate existing systems. The study analyzed compliance with RA No. 11285 and assessed enablers and barriers affecting energy management practices. Data were synthesized to develop a comprehensive EMP aligned with ISO 50001 standards.

The study utilized both primary and secondary data sources

to ensure a comprehensive assessment of energy management practices.

Primary data were obtained through the administration of survey questionnaires to selected respondents, as well as through semi-structured interviews with facility personnel to gather in-depth insights into operational practices and compliance conditions. In addition, on-site observations were conducted to assess the actual conditions of lighting and air-conditioning systems, supported by the collection of equipment inventory and operational data. Available electricity consumption records were also reviewed to analyze energy usage patterns.

On the other hand, secondary data were gathered from academic journals, previous studies, government publications, policy guidelines, and established energy management standards. These sources provided both theoretical and empirical foundations that supported the analysis of findings and guided the development of the proposed Energy Management Plan.

Respondents were selected using purposive sampling, focusing on individuals directly involved in building operations, energy management, and compliance within the UPHSL College Building. This approach ensured the inclusion of participants with relevant knowledge and experience^[9]. A total of 13 respondents participated, including five key informants for interviews and others for survey data collection. The sample size is appropriate for targeted, mixed-methods research, where depth and relevance of information are prioritized over quantity^[10] and is supported by studies indicating data saturation can be achieved with small, homogeneous groups^[11]. Respondents included facilities administrators, safety officers, engineering and maintenance personnel, and management representatives, all of whom are directly involved in energy practices and compliance with RA No. 11285.

To measure the level of compliance with Republic Act No. 11285 and the implementation of energy management practices, a 5-point Likert scale was utilized in the survey questionnaire. This scale is appropriate for assessing perceptions, attitudes, and levels of agreement, allowing the quantification of qualitative responses into measurable data^[12].

Each response was assigned a corresponding numerical value, where 5 represents the highest level of agreement and 1 represents the lowest level. The responses were analyzed using the weighted mean to determine the overall level of compliance and implementation.

Table 1 shows the computed weighted mean values were interpreted using the descriptive scale.

Following the established evaluation and scoring procedures, appropriate research instruments were utilized to collect both quantitative and qualitative data for the study.

A standardized survey questionnaire adopted from the Department of Energy Philippines (DOE) was used to gather quantitative data on the level of compliance with Republic Act No. 11285 and energy management practices. The instrument is aligned with the guidelines and provisions of the law, ensuring that the indicators reflect nationally recognized standards for energy efficiency and conservation. The questionnaire employed a 5-point Likert scale, consistent with the evaluation method discussed, allowing for systematic measurement and interpretation of responses.

To support the energy audit component, an Energy Audit

Data Collection Checklist was used to document equipment inventory, operating schedules, and observable conditions of lighting and air-conditioning systems. Additionally, measurement tools such as a lux meter and thermo-hygrometer were used during site inspection to assess illumination and temperature conditions.

To ensure the validity and reliability of the instruments, all tools, including the standardized DOE-based survey questionnaire, interview guide, checklist, and proposed Energy Management Plan (EMP), underwent content validation by experts. The panel consisted of a Certified

Energy Manager (CEM), a statistician, a doctoral degree holder, and a qualitative research expert. The validation process focused on clarity, relevance, and alignment with the study objectives and the requirements of Republic Act No. 11285.

Furthermore, data triangulation was employed by comparing multiple data sources such as survey responses, interview data, audit observations, and energy consumption records. This strengthened the credibility and reliability of the findings, consistent with the principles outlined by John W. Creswell and J. David Creswell (2018) ^[9].

Table 1: Five-Point Likert Scale

Assigned Points	Numerical Range	Categorical Response	Verbal Interpretation
5	4.21-5.00	Strongly Agree	Very High Compliance
4	3.41-4.20	Agree	High Compliance
3	2.61-3.40	Neutral	Moderate Compliance
2	1.81-2.60	Disagree	Low Compliance
1	1.00-1.80	Strongly Disagree	Very Low Compliance

The study followed a systematic procedure in collecting data on energy audit practices, RA No. 11285 compliance, and energy efficiency conditions in the UPHSL College Building. Approval was secured from the university administration prior to data collection. Respondents, including engineering personnel, facility staff, safety officers, and administrators, were selected based on their involvement in energy-related activities. Data were gathered through face-to-face administration of structured questionnaires, supplemented by semi-structured interviews with key informants. In addition, a Level I Energy Walkthrough Audit was conducted using an audit checklist, supported by on-site observations and measurements of lighting and temperature using a lux meter and thermo-hygrometer. This approach ensured reliable and comprehensive data collection aligned with the study objectives.

The collected data were analyzed using descriptive statistical tools. The weighted mean was used to determine the level of compliance with RA No. 11285, assess energy management practices, and evaluate enablers and barriers. Standard deviation measured the consistency of responses, indicating the variability around the mean. Mean values were interpreted using a 5-point scale. For qualitative data,

thematic analysis ^[13] was applied to identify key enablers, barriers, and insights for improving energy management. These methods provided a comprehensive basis for analysis and development of the proposed Energy Management Plan.

3. Results and Discussion

Findings indicated high compliance in operational practices and reporting, while policy institutionalization and monitoring systems were moderately implemented. The institution demonstrated an overall high level of compliance with RA No. 11285 (WM = 4.68), with strong performance in electricity conservation and documentation, but with noted gaps in policy formalization and monitoring systems. Enablers (WM = 3.70) and barriers (WM = 3.48) were both moderately present, indicating that while management support and behavioral practices facilitate compliance, financial, technical, and organizational constraints limit full implementation. Energy audit results further revealed inefficiencies in air-conditioning systems, particularly due to the prevalence of non-inverter units and inconsistent temperature control. Based on these findings, a comprehensive and highly valid Energy Management Plan (EMP) (WM = 4.59) was developed.

Table 2: Summary of Key Findings

Category	Indicator	Weighted Mean (WM)	Interpretation	Key Observations
Compliance with RA NO. 11285	Overall Compliance	4.68	High	Strong compliance in operations and reporting
	Institutionalization	4.33	High	Gaps in policy formalization and monitoring
	Electricity Conservation Measures	4.71	Very High	Effective behavioural and operational practices
	Reports and Inventories	5.00	Very High	Strong documentation, but monitoring inconsistencies
Enablers	Overall	3.70	Moderate	Strong management support and behavioural practices; weak knowledge/awareness
Barriers	Overall	3.48	Moderate	Financial constraints, organizational gaps, limited audit utilization
System Efficiency	ACU Performance	—	—	Inefficiencies due to non-inverter units and temperature mismatch
EMP Validation	Overall Validity	4.59	Highly Valid	Strong in relevance, feasibility, and applicability

Table 2 presents that the findings highlight that while the UPHSL College Building demonstrates strong compliance with RA No. 11285, particularly in operational practices and documentation, gaps remain in policy institutionalization, monitoring systems, and technical implementation. The presence of moderate enablers and barriers indicates the need for a more structured and resource-supported approach to energy management. The identified inefficiencies in air-conditioning systems further emphasize the importance of system optimization and technology upgrades. Overall, the results validate the need for a comprehensive Energy Management Plan, which serves as a strategic framework to enhance energy performance, strengthen compliance, and promote sustainable energy practices within the institution^[14]

[15] [16] [17] [18].

Table 3 shows the proposed Energy Management Plan (EMP). The developed Energy Management Plan (EMP) provides a comprehensive and structured framework for improving energy efficiency in the UPHSL College Building. It outlines key components including the energy policy, objectives, scope and coverage, and organizational structure to support systematic energy management. The plan integrates energy audit program planning, monitoring and evaluation mechanisms, and prioritized Energy Conservation Measures (ECMs) to guide implementation. It also includes cost and financial considerations, an implementation plan with assigned responsibilities, and a Gantt chart to ensure timely execution.

Table 3: Proposed Energy Management Plan for UPHSL College Building

Objectives	Basis from Findings	Key Strategies / Actions	Responsible Unit	Time Frame	Performance Indicators
Strengthen compliance with RA No. 11285	Inconsistent submission of AEECR/AEUR; gaps in policy implementation	Develop and implement formal energy policy; ensure submission of required DOE reports; establish reporting system	Administration, Energy Management Team (EMT)	Continuous	100% compliance with DOE reporting requirements
Establish energy management structure	Absence of dedicated energy management team; organizational gaps	Create EMT (CEM, EECO, focal persons); define roles and responsibilities	University Administration	Within 6 months	Functional EMT with defined roles
Improve energy monitoring system	Shared meter limitation; lack of detailed monitoring and inventory	Develop monthly energy tracking; maintain inventory of lighting and ACUs; recommend sub-metering	Engineering / Maintenance Team	Monthly / Annual	Availability of energy reports; improved monitoring accuracy
Optimize lighting system efficiency	Some areas below recommended 300–500 lux; uneven illumination distribution	Maintain 100% LED usage; improve illumination levels; reconfigure lighting layout; implement switching controls and maintenance	Facilities / Maintenance Team	Continuous	Improved illumination levels; reduced energy wastage
Enhance ACU system performance	Only 30% inverter ACUs; inconsistent cooling performance	Increase inverter ACU usage (target: 50–70%); maintain $\geq 24^{\circ}\text{C}$ thermostat setting; ensure regular maintenance	Facilities / Engineering Team	Annual / Continuous	Reduced energy consumption; increased inverter ACU percentage
Strengthen awareness and behavioural practices	Moderate awareness levels; behavioural gaps in energy use	Conduct training and awareness campaigns; enforce switch-off policies and proper ACU use	HR Department, Safety Officer	Quarterly	Increased participation rate; improved compliance behavior
Improve utilization of energy audit results	Underutilization of audit findings; lack of follow-through	Implement audit recommendations; integrate audit results into planning and operations	Energy Management Team	Continuous / Every 3 years	% of audit recommendations implemented
Address financial constraints	Budget limitations affecting energy efficiency initiatives	Prioritize low-cost, high-impact measures; allocate budget for energy-efficient technologies	Administration, Finance Office	Annual	Budget allocation; return on investment (ROI)
Implement risk management strategies	Risks in budget, technical capacity, and system limitations	Identify risks and apply mitigation (phased implementation, training, monitoring improvements)	Energy Management Team	Continuous	Reduced implementation delays; improved system reliability

Table 4 presents the identified ECMs provide a structured approach to improving the energy performance of the UPHSL College Building. High-priority measures focus on cost-effective and impactful interventions such as system replacement and operational improvements, while medium-priority measures support long-term optimization through technology and monitoring systems. The implementation of these ECMs, when aligned with the Energy Management Plan, is expected to enhance energy efficiency, strengthen compliance with RA No. 11285, and support sustainable energy management practices within the institution.

Based on the findings of the energy audit and assessment of system efficiency, a set of Energy Conservation Measures (ECMs) was identified for the UPHSL College Building.

These measures aim to improve energy performance, particularly for lighting and air-conditioning systems, while addressing identified gaps in compliance, monitoring, and operational practices. The ECMs are prioritized based on their potential energy savings, cost implications, and ease of implementation to ensure practical and effective application within the institution.

Table 5 shows the cost efficiency and financial considerations of ECMs. The implementation of the proposed ECMs requires careful evaluation of cost efficiency and financial feasibility to ensure sustainable and practical adoption. This section outlines the financial considerations associated with the identified ECMs, focusing on cost-effectiveness, return on investment, and prioritization of low-

cost, high-impact strategies suitable for the UPHSL College Building.

Cost efficiency plays a critical role in the successful implementation of the Energy Management Plan.

By prioritizing low-cost, high-impact measures and strategically planning capital-intensive investments, the

UPHSL College Building can achieve sustainable energy performance improvements while addressing financial limitations. A balanced approach combining short-term savings and long-term investments ensures both economic viability and continuous energy efficiency improvement.

Table 4: Energy Conservation Measures (ECMs) with Prioritization

ECM	Description	Estimated Savings (targets)	Priority
Installation of Own Meter	Installation of meter to monitor energy consumption per floor or system	Establish Baseline (5-15%)	High
Energy Monitoring and Reporting System	Develop a structured system for tracking energy consumption and performance indicators (e.g., EUI)	5%–10% (indirect)	High
Creation of Energy Management Team	Establish a dedicated team responsible for planning, monitoring, and evaluating energy initiatives	5%–10%	High
Information, Education, and Communication (IEC) Campaigns	Implement awareness programs and behavioral interventions to promote energy-saving practices	3%–10%	High
ACU System Replacement	Replace non-inverter air-conditioning units with inverter-type systems to improve cooling efficiency and reduce energy consumption	20%–40%	High
Operational Scheduling	Implement proper scheduling and reduce unnecessary runtime of ACUs and lighting systems	10%–25%	High
Lighting Optimization	Upgrade remaining fixtures to LED and improve lighting layout for efficiency	5%–10%	Medium
Smart Control Systems	Install sensors, timers, and programmable thermostats to optimize system operation	10%-30%	Medim

Table 5: Cost Efficiency and Financial Considerations of ECMs

ECM	Priority	Savings Potential	Payback Period	Financial Priority	Remarks
Installation of Own Meter	High	Establish Baseline (5-15%)	Long-term	High	Enables better monitoring and control
Energy Monitoring and Reporting System	High	5%–10% (indirect)	Long-term	High	Support decision-making and performance tracking
Creation of Energy Management Team	High	5%–10%	Short-term	High	Organizational improvement; no major cost
Information, Education, and Communication (IEC) Campaigns	High	3%–10%	Short-term	High	Promotes behavioral change with minimal cost
ACU System Replacement	High	20%–40%	Medium-Long Term	Medium	Implement in phases due to high capital requirement
Operational Scheduling	High	10%–25%	Short-term	High	Low-cost, immediate impact on performance
Lighting Optimization	Medium	5%–10%	Medium-Long Term	Medium	Cost-effective with long-term savings
Smart Control Systems	Medim	10%-30%	Medium-Long Term	Medium	Requires initial investment but improves automation

Note: Financial estimates are based on standard benchmarks due to Level 1 audit limitations. Estimated cost savings are derived from reduced energy consumption (kWh) multiplied by the prevailing electricity rate

Table 6 presents the implementation plan and responsibility matrix. The successful implementation of the EMP requires a clear assignment of roles, responsibilities, timelines, and monitoring mechanisms. This section outlines the implementation plan and responsibility matrix to ensure that all identified ECMs are effectively executed, monitored, and continuously improved. The matrix also supports accountability and coordination among key personnel involved in energy management within the UPHSL College Building.

The Implementation Plan and Responsibility Matrix provide a structured approach to executing the proposed Energy Conservation Measures. By clearly defining responsibilities, timelines, and performance indicators, the UPHSL College Building can ensure accountability, effective coordination, and continuous monitoring of energy performance. This systematic approach supports the successful implementation of the EMP and aligns with ISO 50001 principles of continuous improvement.

Table 6: Cost Efficiency and Financial Considerations of ECMs

ECM / Activity	Key Actions	Responsible Unit / Person	Support Unit	Timeline	Performance Indicator
AC System Replacement (Inverter Upgrade)	Identify units for replacement, procure inverter ACUs, install and commission	Administration, Facilities Manager	Engineering Team, Procurement	Phased (Annual)	% of inverter ACUs installed, reduction in kWh
Preventive Maintenance	Conduct regular cleaning, inspection, and refrigerant checks	Maintenance Team	Engineering Team	Quarterly	Maintenance records, improved ACU performance
Operational Scheduling	Develop and implement ACU and lighting schedules	Facilities Team	Department Heads	Monthly / Continuous	Reduced operating hours, energy savings
Smart Control Systems	Install sensors, timers, and programmable thermostats	Engineering Team	External Vendors	Medium-term (6–12 months)	System functionality, reduced energy use
Lighting Optimization	Replace remaining non-LED fixtures and optimize layout	Facilities Team	Procurement	Medium-term	% LED installation, improved illumination efficiency
IEC Campaigns	Conduct awareness programs, install signages, promote energy-saving practices	Safety Officer, HR Department	EMT, Department Heads	Quarterly / Continuous	Participation rate, behavioral compliance
Creation of Energy Management Team (EMT)	Establish team, assign roles and responsibilities	University Administration	CEM, HR	Short-term (Immediate)	Formation of EMT, defined roles
Sub-metering Installation	Install submeters for monitoring per floor/system	Engineering Team	Procurement	Medium-term	Availability of sub-meter data
Energy Monitoring and Reporting System	Develop reporting system, track EnPIs and EUI	Energy Management Team (EMT)	Engineering, IT Support	Monthly / Continuous	Monthly reports, EnPI tracking accuracy

Table 7 represents the Gantt Chart for the implementation timeline of the proposed EMP, outlining the sequence and duration of each ECM. It provides a clear schedule of activities, ensuring proper coordination, prioritization, and monitoring of implementation efforts.

The Gantt Chart demonstrates a phased and systematic approach to implementing the EMP, highlighting immediate, short-term, and long-term actions. This structured timeline supports effective execution, continuous monitoring, and sustained improvement in energy performance.

Table 7: Gantt Chart for Implementation of EMP

ECM / Activity	Timeline	Q1	Q2	Q3	Q4	Year 2 Onwards
Creation of Energy Management Team (EMT)	Immediate	✓				Continuous
IEC Campaigns (Awareness Programs)	Quarterly / Continuous	✓	✓	✓	✓	Continuous
Preventive Maintenance (ACU & Lighting)	Quarterly	✓	✓	✓	✓	Continuous
Operational Scheduling Implementation	Monthly / Continuous	✓	✓	✓	✓	Continuous
Energy Monitoring & Reporting System	Monthly / Continuous	✓	✓	✓	✓	Continuous
Lighting Optimization (LED Upgrade)	Medium-term		✓	✓	✓	Continuous
Smart Control Systems Installation	Medium-term (6–12 months)		✓	✓	✓	Continuous
Sub-metering Installation	Medium-term		✓	✓	✓	Continuous
AC System Replacement (Inverter Upgrade)	Phased (Annual)			✓	✓	Continuous

The proposed EMP is aligned with the requirements of Republic Act No. 11285 or the EEC Act and incorporates key principles of ISO 50001:2018 Energy Management Systems (EnMS). Specifically, the plan supports:

1. Institutionalization of Energy Efficiency through the establishment of policies, procedures, and an Energy Management Team
2. Regular Energy Audits in accordance with DOE requirements
3. Submission of Mandatory Reports such as the Annual Energy Utilization Report (AEUR) and Annual Energy Efficiency and Conservation Report (AEECR)
4. Implementation of Energy Conservation Measures (ECMs) based on audit findings
5. Monitoring and Reporting Systems to track energy consumption and performance indicators (e.g., EUI, kWh)

Through these components, the EMP ensures that the UPHSL College Building meets regulatory obligations while strengthening internal energy management practices.

Expected Outcomes

The implementation of the EMP is expected to produce the following outcomes:

1. Improved Energy Efficiency
2. Reduction in electricity consumption through optimized use of lighting and air-conditioning systems
3. Enhanced Compliance with RA 11285
4. Consistent submission of required reports and adherence to energy efficiency policies
5. Reduced Operational Costs
6. Lower electricity expenses resulting from energy-saving measures
7. Strengthened Monitoring and Decision-Making
8. Availability of accurate data to support planning and performance evaluation

9. Improved Organizational Capacity
10. Increased awareness, technical capability, and stakeholder participation in energy management
11. Sustainable Energy Management Practices
12. Establishment of a culture of energy conservation and continuous improvement

The alignment of the EMP with RA No. 11285 and ISO 50001 principles ensures that the plan is both compliant and strategically effective. The expected outcomes demonstrate its potential to improve energy performance, reduce costs, and support sustainable energy management in the UPHSL College Building.

Overall, the proposed Energy Management Plan provides a comprehensive, data-driven framework that translates the study findings into actionable strategies for improving energy efficiency, compliance, and sustainability in the UPHSL College Building. By integrating policy strengthening, system optimization, monitoring mechanisms, and behavioral interventions, the EMP addresses existing gaps and enhances operational performance. Its implementation is expected to reduce energy consumption and costs, improve compliance with RA No. 11285, and promote environmental sustainability. Ultimately, the EMP supports continuous improvement and positions the institution toward long-term energy efficiency and responsible energy management.

4. Conclusions

Based on the findings of the study, the following conclusions were drawn:

- a. The UPHSL College Building demonstrates high operational compliance; however, full compliance is limited by weak policy formalization and inconsistent monitoring systems.
- b. Compliance is driven by leadership and behavior; however, reliance on basic, low-cost practices indicates the absence of more systematic and advanced energy management approaches.
- c. Financial, technical, and organizational limitations hinder full compliance despite existing knowledge and practices, indicating that resource limitations and lack of structured systems hinder full compliance.
- d. The proposed Energy Management Plan provides a structured, data-driven, and practical framework for addressing identified gaps and improving energy efficiency and compliance.

5. Recommendation

Based on the conclusions of the study, the following recommendations are proposed to further enhance energy management practices, ensure compliance with Republic Act No. 11285, and guide future research:

- a. Strengthen institutional policies and formalize energy management structures. Institutions should establish a fully functional Energy Management Team (EMT), ensure consistent reporting to the Department of Energy Philippines, and enhance internal monitoring systems. Clear roles and accountability mechanisms should be defined among administrative and technical units to sustain compliance and implementation.
- b. Enhance capacity-building and leadership engagement. Institutions should invest in continuous training programs, awareness campaigns, and professional development aligned with energy efficiency standards.

Leadership involvement must be strengthened to transition from basic compliance practices to a structured energy management system aligned with ISO 50001.

- c. Adopt standards-based implementation for lighting and air-conditioning systems. Future energy management initiatives should ensure that all lighting systems comply with illumination standards under the Occupational Safety and Health Standards Philippines and relevant provisions of the Philippine Electrical Code. Similarly, air-conditioning units (ACUs) should be evaluated based on thermal comfort and efficiency standards recommended by the Department of Energy Philippines and international guidelines such as ASHRAE. The use of lux standards for illumination and temperature setting point benchmarks should be integrated into monitoring systems.
- d. Implement cost-effective and data-driven energy projects. Institutions should adopt phased implementation of energy efficiency measures, strengthen coordination across departments, and maximize the use of audit findings. The adoption of tools such as sub-metering systems and energy tracking platforms is recommended to improve decision-making and resource allocation.
- e. Ensure effective implementation and continuous improvement of the Energy Management Plan (EMP). The EMP should be operationalized through coordinated actions among management, engineering personnel, and staff. Key Performance Indicators (KPIs), such as Energy Utilization Index (EUI) and consumption trends, should be regularly monitored. Periodic energy audits and continuous improvement cycles should be institutionalized in alignment with ISO 50001 principles.
- f. Future studies may expand this research by incorporating a wider scope of energy systems, including renewable energy integration and smart energy technologies. Researchers are encouraged to utilize standardized instruments from the Department of Energy Philippines and align their methodologies with national and international standards such as ISO 50001. Additionally, future researchers may explore longitudinal designs to assess long-term impacts of energy management interventions, apply advanced statistical modeling, or conduct comparative studies across multiple institutions to enhance generalizability. Further investigation on compliance with illumination and thermal comfort standards under OSH and engineering codes is also recommended.

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How to Cite This Article

Galos MC, Amaya FL. Development of a data-driven energy management plan for lighting and air-conditioning systems in a private university based on RA No. 11285 compliance assessment and enabler–barrier modeling. *International Journal of Multidisciplinary Research and Growth Evaluation.* 2026 May–Jun;7(3):243–250.

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