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Article

Strategic energy efficiency plan aligned with artificial intelligence. Case study: CETis 91

Plan estratégico de eficiencia energética alineado con inteligencia artificial. Estudio de caso: CETis 91

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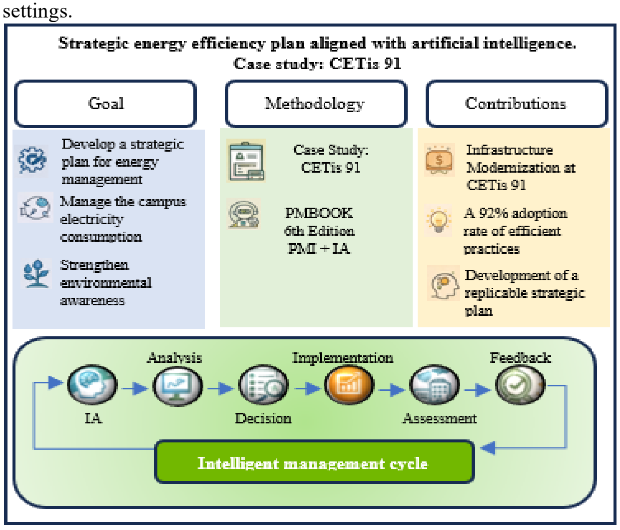
Abstract

This paper describes the design and implementation of an AI-powered energy efficiency strategic plan aligned with the Project Management Institute [PMI] guidelines. The plan aimed to optimize electricity consumption, reduce operating costs, and decrease the carbon footprint of a high school. A mixed-methods approach was employed in this research, using a case study at CETis 91. This study was supported by PMI processes, energy management systems [EMS], and data analysis using sensors and artificial intelligence tools to identify consumption patterns. The results demonstrate how a strategic plan allows for the precise identification of opportunities to improve environmental management, from replacing lighting with LED technology in high-traffic areas to promoting the adoption of energy-efficient practices by the school community. Finally, the paper describes how the integration of strategic planning, project management, artificial intelligence, and energy management systems fosters systematic, replicable, and sustainable institutional energy management in public educational settings.



Strategic plan, environmental management, PMI, Artificial Intelligence

Resumen

En este trabajo se describe la forma en que se diseñó e implemento un plan estratégico de eficiencia energética potenciado con inteligencia artificial y alineado a los lineamientos del Project Management Institute [PMI], orientado a optimizar el consumo eléctrico, reducir costos operativos y disminuir la huella de carbono en un plantel de educación media superior. En esta investigación se aplicó un enfoque metodológico mixto mediante un estudio de caso en el CETis 91 apoyado en los procesos del PMI, los sistemas de gestión de la energía [SGen] y análisis de datos obtenidos por sensores mediante herramientas de inteligencia artificial para la identificación de patrones de consumo. Los resultados obtenidos evidencian como un plan estratégico permite identificar de manera puntual las áreas de oportunidad para la mejora de la gestión ambiental, desde la sustitución de luminarias por tecnología LED en espacios más concurridos y la adopción de prácticas de uso eficiente de la energía por parte de la comunidad educativa. Finalmente se describe como la articulación entre planeación estratégica, gestión de proyectos, inteligencia artificial y sistemas de gestión energética favorece una gestión institucional sistemática, replicable y sostenible del consumo energético en contextos educativos públicos.

Plan estratégico, gestión ambiental, PMI, Inteligencia Artificial

Area: Development of strategic leading-edge technologies and open innovation for social transformation

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Introduction

At an international level, sustainable energy management is a strategic priority within the framework of the Sustainable Development Goals [SDGs] set out in the United Nations [UN] 2030 Agenda, Furthermore, several organisations, such as the International Energy Agency [IEA], have emphasised that energy efficiency represents one of the most cost-effective and efficient solutions for reducing greenhouse gas emissions [Iberdrola, 2025]. Among the countries making the most progress in energy consumption management, Denmark stands out, where comprehensive public policies have been implemented to transition towards a low-carbon economy [IEA, 2023].

In the 21st century, energy management has become a critical aspect for organisations in terms of economic, environmental and social commitment both globally and in Mexico, in response to the growing need to reduce operating costs and minimise environmental impact [Secretariat of Energy, 2015]. Consequently, the Ministry of Public Education has noted that energy management in educational institutions in Mexico has become a key focus for improving operational efficiency, reducing costs and fostering a culture of sustainability among students and teaching staff. Upper secondary schools, particularly within the public sector in Mexico, face challenges associated with the inefficient use of resources, a lack of monitoring strategies and limited institutional measures for the proper use of electricity.

Consequently, the significance of this research lies in the integration of an Energy Management System [EMS] based on guidelines from the Project Management Institute [PMI], which constitutes a proposal that has been little explored in the Mexican educational sector. Taking this as a starting point, most of the initiatives implemented in DGETI educational institutions have focused on isolated actions, such as the ad hoc replacement of equipment, the installation of monitoring technologies or temporary awareness campaigns, without being integrated into a strategic planning framework that would ensure their sustainability over time or the use of technological tools such as AI. This limits each institution's ability to make informed decisions, prioritise interventions and comprehensively assess the technical, economic and environmental impacts of the actions undertaken.

In this context, the design and implementation of a strategic energy efficiency plan enhanced by artificial intelligence and aligned with the guidelines of the Project Management Institute [PMI] represents an approach that has been little explored in the field of upper secondary education at DGETI schools in Mexico, in contrast to approaches focused exclusively on technology. This research is conducted from a methodological perspective that integrates strategic planning, operational data analysis and the evaluation of results, using artificial intelligence tools to support the identification of consumption patterns and the prioritisation of energy-related actions based on PMI processes.

Thus, the research explores the relationship between the lack of structured institutional strategies that enable the systematic management of energy consumption at DGETI campuses, against a vacuum where an applied strategic plan is proposed that combines professional management methodologies, information based on data analysed using AI, and concrete operational actions with the aim of optimising the use of electricity and strengthening environmental awareness within the educational community of a DGETI technical sixth-form college.

The aim of this article is to demonstrate how the implementation of a strategic energy efficiency plan supported by artificial intelligence and aligned with the PMI enabled improved energy management at a senior secondary school in Mexico, and to provide an option so that more institutions may have a replicable alternative through environmental education.

Methodology

Problem Statement

Energy is the engine that drives the world; however, "685 million people worldwide still live without electricity, and around 2.1 billion people depend on polluting traditional fuels and technologies" [Doignon, 2025]. This global scenario reflects inequality in access to energy resources, as well as the need to implement sustainable solutions that guarantee economic and social development without compromising the environment.

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In this context, energy efficiency and sustainability have become priorities for reducing operational costs and mitigating environmental impact, as set out in the UN's Sustainable Development Goals [SDGs].

Mexico is facing an energy crisis, as many parts of the country still lack basic energy services; for example, in Mexico City, hundreds of families have no access to electricity and other services [Mexico Climate Initiative, 2024]. This is why various researchers in Mexico agree that it is necessary to develop national energy management plans that establish specific indicators, enabling institutions to make informed decisions as a foundational tool to combat and mitigate the country's energy crisis [Campus Ensenada, 2024].

Currently, the allocation of federal funding to DGETI campuses is becoming increasingly difficult, as expenditure is rising on both the campuses' and the federal government's parts. In this regard, the rise in electricity tariffs, coupled with the lack of a sustainable environmental culture evident within the educational community, means that CETis 91's energy resources are being used disproportionately.

At CETis 91, although various Curricular Academic Units [UACs], work-related sub-modules and Academic Units [UAs] within the extended curriculum cover topics such as recycling, responsible energy use and rational water use—which are considered vital for fostering an environmental culture within the educational community— these are only addressed theoretically and not practically. Thus, as Rey [2025] mentions, teaching in a practical manner enables better learning: "experience-based learning is capable of generating deep knowledge". In other words, practical teaching—or, as is commonly put, 'learning by doing'—results in meaningful learning when it comes to forming habits of responsible use and a sustainable environmental culture that impacts our educational community.

Currently, the campus does not have an energy management system, which exacerbates the challenge of implementing sustainable practices, in addition to the lack of environmental education within the educational community.

Furthermore, the institution exhibited high electricity consumption due to continuous operation across two shifts, which generated significant operational costs and a considerable Scope 2 carbon footprint. This stems from the central problem of the lack of an efficient and sustainable energy management plan at CETis 91, which would enable the optimisation of energy use, reduce billing costs and minimise the educational community's Scope 2 carbon footprint.

Whilst the campus lacked automated systems, meaning there was no detailed understanding of energy consumption patterns or identification of critical areas for improvement, current access to Artificial Intelligence provided a framework for its application to analyse large amounts of data and use this to inform decision-making when developing the strategic plan.

Methodology

The methodology applied was developed using a mixed-methods approach, integrating quantitative variables—including electricity consumption measured in kWh and electricity bills quantified in Mexican pesos— and qualitative variables for the analysis of energy consumption and the evaluation of the effects of the implemented strategic plan. Among these, the level of education and environmental awareness were studied, as well as the implementation of activities promoting responsible energy consumption, which were assessed through interviews with the educational community of CETis 91.

The case study method was applied for the research, which consists of "analysing the phenomenon under study in its real context, using multiple sources of evidence, both quantitative and/or qualitative, simultaneously" [Villarreal & Landeta, 2010, p. 32]. The importance of this approach when applied to the DGETI stems from the fact that, in 2025, this institution comprised 256 campuses across the country, all of which share operational and structural characteristics, as each campus is governed by the same curriculum and guidelines, the infrastructure is designed in a similar manner, teachers and administrative staff are recruited through similar mechanisms and receive training under standardised guidelines; therefore, by studying one of its campuses, we can infer what happens in the others.

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Thus, any improvement made at CETis 91 can be adapted and applied to its counterpart campuses.

Figure 1 illustrates the key steps of the case method for evaluating strategies, analysing longitudinal change processes and understanding strategic phenomena from an applied perspective [Villarreal & Landeta, 2010].

The process began with the definition of aims, objectives and research questions; following this, the conceptual context was defined; followed by the selection and identification of the analysis, which involved choosing the research methods and resources to enable the application phase—that is, the fieldwork phase—to take place. This was subsequently followed by the formalisation of data recording and classification to allow for the individual analysis of each case, the overall analysis, and finally the definition of the study's rigour and quality. The nine steps to be applied in this technique are shown sequentially.

Box 1

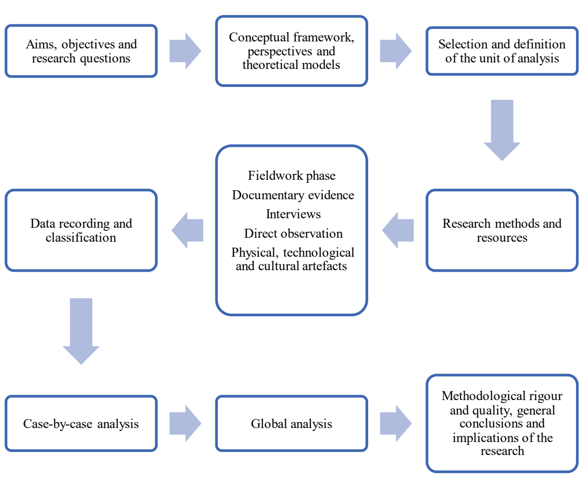

Figure 1
Steps in the case study
Source: based on Villarreal and Landeta, 2010

Furthermore, this research drew on the approach of the Project Management Institute [PMI] and the best practices set out in the PMBOK Guide [Project Management Body of Knowledge], specifically in versions 6 and 7. These methods provide a methodological framework, shown in Figure 2, which integrates the processes of project planning, execution, monitoring and control, thereby enabling the systematic implementation of a strategic energy management plan across DGETI campuses.

Box 2

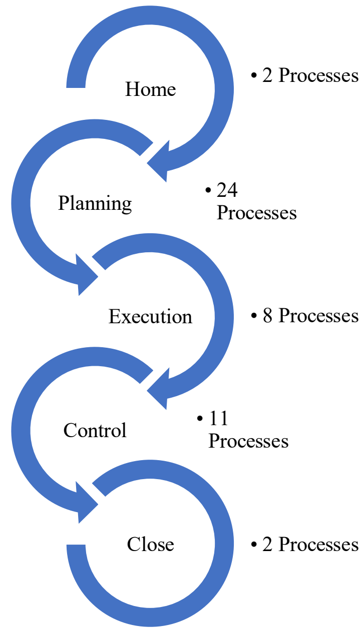

Figure 2
PMI Processes
Based on the PMBOK Guide, 6th Edition, 2017

Approaching the project within this context facilitates alignment between the institutional objectives of the DGETI and the principles of environmental sustainability enshrined in the national, state and municipal legislation applicable to the institution under study, through management based on processes, risks, quality and resources. In this way, the combination of the case study methodology with the guidelines on PMI methods and tools contributes to the generation of applied knowledge, the strengthening of the institutional energy culture and the validation of a replicable sustainable management system for upper secondary education institutions.

In the methodological process, the application of artificial intelligence tools for data analysis was employed, as shown in Figure 3, as a mechanism to support strategic decision-making, specifically for identifying energy consumption patterns by zone, prioritising areas for intervention, and monitoring the effects of the actions implemented. In this research, AI does not constitute a central methodological pillar of the study, but rather a complementary resource that enabled the strengthening of the analysis of the operational information generated by the project and supported the decisions adopted within the framework of the strategic plan for the campus.

Box 3

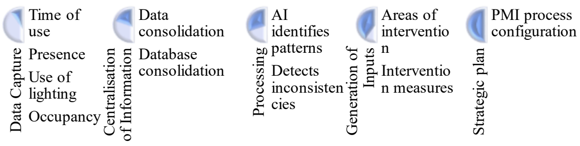

Figure 3
Application of AI

Own work

Another method that is vital to the conduct of this research is meetings, which, according to Menas et al. [2007], "well-managed project meetings enable teams to overcome distractions and obstacles to achieve results". The meeting method constitutes a fundamental tool within project management, as outlined by the PMI, by enabling effective team coordination, collaborative decision-making and monitoring of progress towards established objectives [Project Management Institute, 2017].

Theoretical Framework

The Project Management Institute [PMI] is a non-profit professional organisation founded in 1969 in Pennsylvania, United States, with the aim of establishing standards, methodologies and best practices for project management across various sectors [Project Management Institute Central Mexico, 2026].

Since its inception, the PMI has had a significant impact on the professionalisation of project management globally, by promoting a structured approach based on processes, competencies and results. Currently, the PMI has millions of certified professionals in over 185 countries, demonstrating its widespread adoption across sectors such as construction, information technology, manufacturing, energy, healthcare and education.

In the context of institutional and public projects, such as those carried out in the education sector, the PMI's approach enables the alignment of strategic objectives, resources, risks and outcomes, facilitating informed decision-making and accountability.

The PMBOK Guide [Project Management Body of Knowledge] is the main normative and methodological framework published by the PMI. Its first edition was published in 1996 as a formal compilation of internationally recognised knowledge, processes and best practices for project management [Kopko, 2016].

Since then, the PMBOK has been updated periodically, approximately every 4 to 5 years, with the aim of adapting to changes in organisational, technological and economic environments. To date, seven editions have been published, each with significant conceptual adjustments; thus, the PMBOK 6th edition was published in 2017 and the PMBOK 7th edition in 2021.

The impact of the PMBOK on various economic sectors lies in its ability to standardise management, reduce uncertainty, improve resource utilisation and increase the likelihood of project success. In sectors such as energy and education, its application enables the structuring of continuous improvement initiatives, even where budgetary or technological constraints exist.

Energy Management Systems [EMS] constitute a set of practices aimed at optimising the use of energy resources, reducing operating costs and minimising environmental impacts. These systems are based on continuous improvement, energy performance measurement and data-driven decision-making. In educational institutions, EnMSs have not only an economic impact but also an educational one, by fostering environmental awareness and the adoption of sustainable practices among teachers and students. The integration of these systems with project management methodologies strengthens their viability, scalability and replicability.

Meanwhile, AI is defined as adaptive, self-learning technological systems that can be applied depending on the technologies, purposes, or types of agents [United Nations, 2025].

Likewise, a strategic plan is a document that guides the organisation and provides it with a direction to achieve the goals and objectives it has set by implementing operational plans, defining short- and long-term actions using finite processes and objectives that are defined, measurable, specific, realistic and relevant to the company [Plaza, 2019].

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Results and discussion

In accordance with the PMI methods listed in the PMBOK Guide 6th edition, as shown in Figure 4, the project charter was drawn up and signed with the participation of CETis 91 management and the project leader, in which the aspects to be developed through the research were defined.

Box 4

MINUTES OF THE PROJECT'S FOUNDING MEETING

Date: 13/11/2024	Project Name: Strategic Plan for Sustainable Energy Management Using AI in DGETI Campuses: The Case of CETis 91.

Justification
The project aims to create a strategic plan for sustainable energy management at CETis 26, based on the use of artificial intelligence [AI], to optimise energy resources, reduce operating costs by 10% in the first year and minimise the environmental impact of Scope 2 carbon emissions, promoting a culture of sustainability and efficiency within the educational community and fostering an environment that is environmentally conscious and responsible.

In this way, the campus's daily activities will be aligned with the objectives of the DGETI, in accordance with the regulations of the CONUEE and SEMARNAT, bringing the campus into line with the aims of the municipality, state and country to contribute to the achievement of the Sustainable Development Goals [SDGs].

Strategic objectives:	Success criteria
To install sensors and transmission systems that operate continuously, fulfil their intended function and enable the collection of accurate data in real time.	The sensor network is installed and monitoring signals within the first month of the project.
To develop a strategic energy management plan for CETis 91.	A plan that meets the indicators provided by the National DGETI.
To strengthen environmental awareness and environmental education within the CETis 91 community.	Fostering an environmental culture within the CETis 91 community.

Brief description of the project

The project will apply the case study methodology and the methods recommended by the PMI to develop a strategic plan tailored to the specific characteristics of the CETis 91 campus. This will involve the use of artificial intelligence to analyse data from sensors, thereby identifying the campus's energy consumption patterns.

The aim is to implement a system of sensors linked to artificial intelligence to determine the campus's consumption patterns in real time, and then, using the analysed data, to plan actions that will enable the creation of a strategic energy management plan based on CONUEE's SGEn methodology.

In addition, the project focuses on improving electricity usage and raising environmental awareness by involving the CETis 26 educational community in the project's implementation.

Key stakeholders:
Management team:
Teachers:
Administrative staff:
Students:
CEAP CETis 91

General requirements and restrictions
The project must comply with the indicators of the SGEn methodology proposed by CONUEE, as well as the DGETI guidelines for the operation of campuses and the institutional regulations of CETis 26.

Key risks

1) Retrasos en la importación de materiales para la construcción del sistema de censado o de transmisión de información
2) Cambios en el equipo directivo y por lo tanto cambios en el plan de trabajo (retrasos)
3) Cambio en el CEAP CETis 26 generando perdida del apoyo al proyecto.

Cronograma de hitos principales (si existieran)

Fase 1: Diseño aprobado Febrero 2025
Fase 2: Salones asignados Febrero 2025
Fase 3: Instalación de sensores Marzo 2025
Fase 4: Instalación de trasmisores Abril 2025
Fase 5: Análisis de datos mediante IA Mayo 2025
Fase 6: Elaboración de plan estratégico Noviembre 2025
Fase 7: Cierre de proyecto Diciembre 2025

Presupuesto global preliminar (si existiera)

Entre $20,000.00 y $30,000.00

Director del Proyecto **Daniel Nicolas Peña**	**Nivel de autoridad** [X] Acceder a la información del cliente y negociar cambios [X] Programar reuniones del proyecto con los gerentes funcionales [X] Aprobar el presupuesto del proyecto y sus modificaciones [X] Negociar con los gerentes funcionales los miembros del equipo Otro:
Patrocinador Rubén Vidal García Martínez	**Firma del patrocinador**

Figure 4
Memorandum of Association
Original document based on the format of the Memorandum of Association for the Pablo Lledó Project

Figure 5 shows the definition of a work breakdown structure [WBS], as outlined by the Project Management Institute [2017], which illustrates how various activities are carried out across the five phases of the project life cycle in order to conduct the research. Each WBS identifies the phase to which it corresponds and its deliverables; this formed the basis for the schedule and development of the research within CETis 91.

Box 5

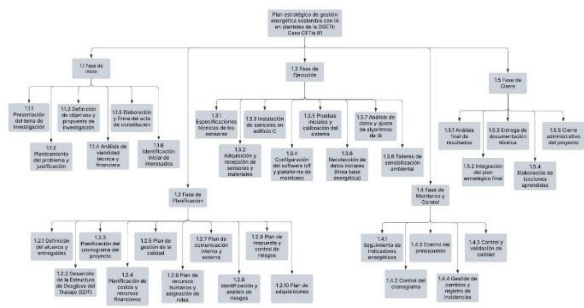

Figure 5
Project EDT:
Own work

As outlined in the PMI processes, a schedule [Gantt chart] is drawn up to determine the time, material resources and human resources required for each phase of the research. Figure 6 illustrates the aspects covered in the applied research carried out at CETis 91.

Box 6

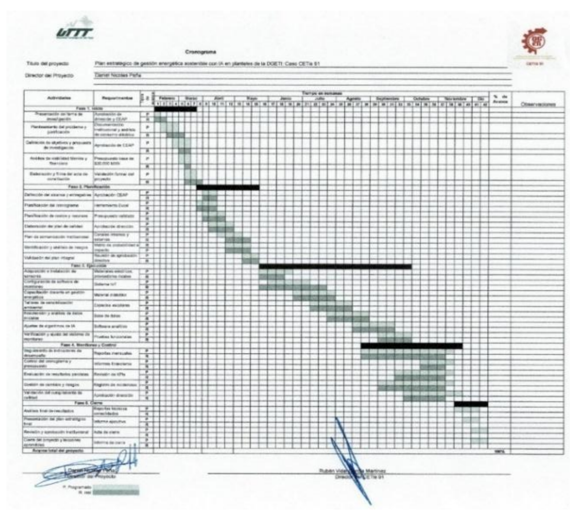

Figure 6
Project timeline
Own work

Figure 7 shows the quality plan which, according to the PMI, must be reported to and approved by the project sponsor, thereby ensuring the direction and quality of the research carried out.

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Box 7

Nombre del Proyecto: Plan estratégico de gestión energética sostenible con IA en planteles de la DGETI: Caso CETis 91		Director del Proyecto Daniel Nicolas Peña		Fecha última actualización 21/06/2025	Versión 1.0
EDT #	**Entregable**	**Especificaciones**	**Método de Verificación**	**Criterio aceptación**	**Responsable**
1.1	Acta de constitución del proyecto	Debe incluir justificación, objetivos, alcance, presupuesto preliminar y responsables.	Revisión documental; validación con directivos.	Firma del Director y CEAP; alineación con PMI.	Dirección del plantel / DP
1.2	Definición del alcance y EDT	Claridad, no ambigüedad, alineado al PMI.	Validación cruzada entre DP, planeación y CEAP.	Aprobación formal del equipo directivo.	Jefatura de Planeación
1.3	Cronograma del proyecto	Actividades secuenciadas, dependencias claras, holguras definidas.	Revisión de consistencia; control del camino crítico.	Cronograma validado y aprobado por Dirección.	DP
1.4	Plan de costos	Debe mostrar costos desglosados por fase, con reserva de contingencia.	Revisión financiera; comparación con presupuesto base.	No exceder el presupuesto de $30,000.	Jefa de Servicios Administrativos
1.5	Instalación y calibración de sensores	Funcionamiento 100%, conexión estable, monitoreo continuo.	Pruebas funcionales, checklist técnico.	48 horas de operación continua sin fallas.	Jefatura de Vinculación / Técnicos
1.6	Datos iniciales de la línea base energética	Datos completos por edificio, horario y cargas críticas.	Auditoría de integridad de datos; validación estadística.	Dataset sin valores nulos y con consistencia interna.	Jefatura de Planeación
1.7	Ajuste de algoritmos IA	Precisión mínima del 85% para detectar patrones de consumo.	Prueba A/B; comparación contra línea base.	Algoritmo cumple el umbral >85%.	Equipo de programación IA
1.8	Plan estratégico de gestión energética	Conforme a SGEn CONUEE; incluye indicadores y acciones sectorizadas.	Revisión metodológica; validación de expertos.	Documento final aprobado por Dirección y CEAP.	Dirección del plantel / DP
1.9	Informe de cierre y lecciones aprendidas	Debe documentar resultados, desviaciones, KPIs y mejoras.	Revisión documental; reunión final.	Aprobación institucional con acta de cierre.	DP y Dirección
Director del Proyecto Daniel Nicolas Peña			**Firma**		
Otros interesados (director del plantel, equipo directivo)			**Firmas**		

Figure 7
Quality Plan

Figure 8 shows the organisational chart used in the conduct of the research; this enabled the research to be managed effectively and each project deliverable to be completed.

Box 8

Figure 8
Project organisation chart

Created by the author

Following this, steps were taken to draw up a communications plan and establish the process for implementing it; Figure 9 illustrates the process used to carry out communication within the research project at CETis 91.

Box 9

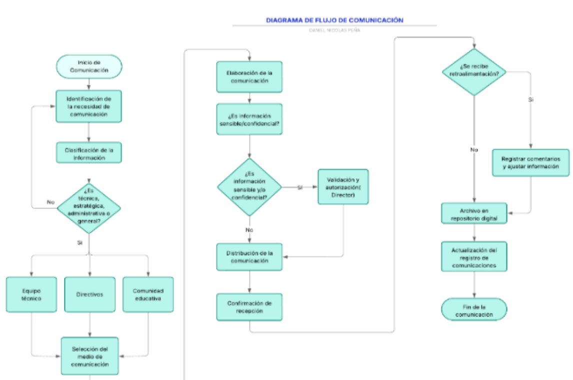

Figure 9
Communications plan

Own work

In accordance with the PMBOOK 6th edition guide, the procurement process was carried out as part of the research conducted, as shown in Figure 10.

Box 10

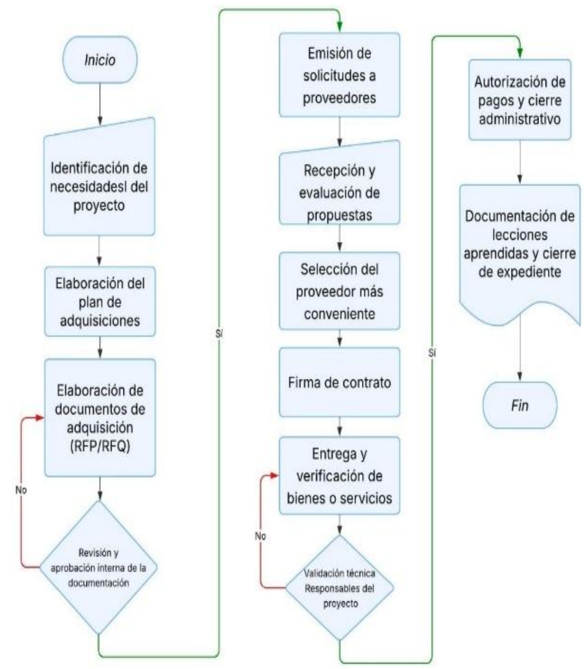

Figure 10
Procurement plan

Own work

The implementation of the AI-supported strategic energy management plan made it possible to directly identify critical areas for improvement in the campus lighting systems; this highlighted the need for technological upgrades in high-usage areas, as per the 2025–2026-1 academic term, which were incorporated into the design of the strategic plan; it was also possible to justify, using information related to the use of the facilities, decisions regarding facility maintenance and actions in the operational management of energy consumption.

The research highlighted the need to upgrade the technological infrastructure of the lighting systems, as well as to maintain the electrical installation, update automatic lighting control systems, and use high-quality luminaires to maximise their cost-effective lifespan. It also highlighted the need to develop and strengthen environmental awareness regarding energy management within the educational campus.

This provided the basis for carrying out an efficient technological replacement of lighting within the campus, switching from fluorescent technology to LED technology.

As shown in Figure 11, at the start of the methodology's implementation, it was observed that the educational community possessed a high level of knowledge regarding energy-saving measures, as revealed by a 10-question questionnaire; however, this did not correspond with what was observed in terms of consumption habits, meaning that environmental awareness had yet to be developed.

Box 11

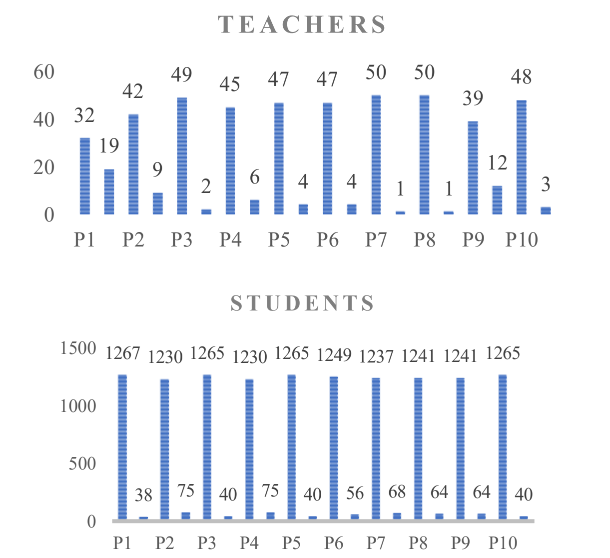

Figure 11
Assessment of energy use
Based on the diagnostic questionnaire administered to the school community

Consequently, following the investigation, 70% of the school's lighting system was upgraded from halogen and fluorescent lights to LED lamps. This was achieved by analysing sensor data on usage time and frequency, which revealed which administrative offices, laboratories, workshops and classrooms and by applying AI, it was possible to identify the energy consumption patterns of the educational community.

Based on this, the decision was made to replace the lighting in the busiest areas, thereby reducing the installed power capacity and leading to immediate energy savings in the most heavily used parts of the campus. This is because each fluorescent lamp consumed 32 W, with two tubes per fixture, whilst these were replaced by 18 W LED lamps providing greater illumination and generating immediate energy savings in each room. Thus, with each lamp installed, approximately 72% is saved, as shown in Equation 1:

$$\%\ Savings = \frac{Currente\ Power}{Past\ Power} = \frac{64W-18W}{64W} = \frac{46W}{64W} \times 100 = 71.9\% \quad [1]$$

In addition to the benefits this project brings in terms of upgrading lighting fixtures, it also delivers greater luminous efficiency, as LED lamps provide more light per watt consumed, thereby improving the quality of lighting in offices, laboratories and workshops. According to Stouch's lighting specialists [2023] this can boost productivity and reduce eye strain, as "LED lights provide brighter, more focused lighting, which makes reading and working with materials easier", whilst also reducing visual fatigue, thereby improving concentration.

Meanwhile, the specific emission factor for electricity in Mexico, updated for the National Electricity System, is approximately 0.444 tonnes of CO_2 equivalent per megawatt - hour [tCO_2 e/MWh] generated, which is the correct figure for performing local Level 2 emissions savings calculations in Mexico according to the Energy Regulatory Commission and reported to the Ministry [SEMARNAT, 2024]. Thus, based on the electricity consumption avoided by each luminaire, considering an average of 8 hours per day that the lamps remained on in the areas where they were replaced—as analysed using AI based on data obtained from the sensors—and projecting this over 365 days a year, the CO_2 calculation is performed using equations 2 and 3:

$$46W \times 8h/day \times 365days = 134.48kWh/year = 0.13448MWh/year \quad [2]$$

With an emission factor of 0.444 tCO_2e/MWh, the emissions avoided annually by each light fitting are:

$$0.13448MWh/year \times 0.444tCO_2e/MWh = 0.0597tCO_2e/year = 59.7kgCO_2e/year \quad [3]$$

This means that for every 10 LED lights installed, approximately 0.597 tonnes of CO_2 equivalent are avoided each year, representing a significant reduction in indirect emissions from electricity generation.

Furthermore, once the usage habits and needs of the staff had been identified through the analysis of data using AI, it was possible to identify the areas where the replacement of electrical equipment should be prioritised.

Consequently, 50 computers were replaced with more energy-efficient models in Laboratory 2, and the equipment that was in good condition was placed in laboratories 1 and 3 to make up the total of 50 units for student use. The existing equipment consisted of HP 280 Slim Tower units with a typical power consumption of 120W. The Ghia Frontier SLIM specifies 55.5 Wh per unit of operating time [equivalent to an average of 55.5 W in use]. Using this, in equation 4 we can calculate the saving per unit:

$$120W - 55.5W = 64.5W \quad [4]$$

Therefore, for the 50 units that were upgraded, this represents a total saving calculated using the equation:

$$64.5W \times 9h/day \times 180days = 104.49kWh/year \quad [5]$$

$$Total\ savings = 50 \times 104.49kWh/year = 5{,}224.5kWh/year = 5.225MWh/year \quad [6]$$

This represents a 53.8% reduction in consumption per unit, optimising the infrastructure to serve students in Laboratory 2 without additional acquisition costs.

Furthermore, there is also the benefit of a reduction in the Tier 2 carbon footprint, as applying the official factor of 0.444 tCO_2e/MWh, as shown in equation 7:

$$Avoided\ emissions = 5.225MWh/year \times 0.444tCO_2e/MWh = 2.32tCO_2e/year \quad [7]$$

Furthermore, once the research had been carried out and the awareness campaign for the 51 teachers implemented, 47 [92%] adopted energy-efficient practices such as switching off lights during the day, disconnecting idle loads and using natural light, generating energy savings through changes in habits within educational settings. This helps to foster a culture of sustainability among teachers and pupils, which can be replicated in laboratories and workshops and gradually extended to pupils' families, resulting from the application of knowledge or what is known in education as 'learning by doing'. Although the remaining 8% of teachers did not participate actively—whether due to unavailability for training [owing to other work commitments, conflicting schedules, or resistance to change]—it is understood that it is of vital importance to continue training through workshops and sessions that reinforce environmental awareness within the institution.

The presence sensors enabled the creation of a database of energy usage, and by applying AI, it was found that Building D had the highest concentration of student activity, and consequently, the classrooms with the highest inefficient use of lighting. Within this, Group 5A was identified, thanks to the sensors placed in the classroom and real-time analysis using AI, as the group that made the greatest use of lighting during the school day even when external lighting was sufficient. Consequently, an awareness-raising initiative was launched, and the group was used as a control group to validate its progress in developing environmental awareness.

Following the awareness-raising process, Group 5A demonstrated a significant improvement in energy culture: routinely switching off lights, avoiding charging mobile phones inside classrooms, opening curtains, and exercising collective self-control to avoid switching on lights during the day, as well as providing feedback to teachers who exhibited the same behaviour by communicating assertively.

Conclusions

The research enabled the identification, analysis and intervention regarding the main issues related to electricity consumption within CETis 91, as mentioned in the research by Pedroza et al [2025]: having an energy baseline that serves as a reference point for the implementation of corrective and preventive measures, demonstrating that energy management in public educational institutions can be significantly strengthened through a hybrid approach.

Thus, it can be concluded, as a first point, that a strategic plan based on methodologies [SGEn and case studies] and PMI processes enables the management of an organisation's energy consumption by identifying consumption patterns through the application of AI

With the development of this project, the contributions can be listed as follows:

1. It was demonstrated that the PMI, when applied to educational projects, facilitates planning, risk management, stakeholder engagement and quality control.

2. The use of sensors and data enabled the identification of actual consumption levels, thereby justifying technical and administrative decisions.

3. The campus's carbon footprint was reduced, and the foundations were laid for a continuous energy monitoring system.

4. A plan was developed that can be replicated in other educational institutions, strengthening organisational culture and sustainability practices whilst complying with energy consumption guidelines.

In conclusion, the research demonstrated that energy optimisation in an educational institution is possible even with limited resources, provided there is a data-driven assessment serving as a starting point, as well as a well-structured strategic plan that takes into account the campus's regulatory situation and available resources, whilst coordinating and fostering the active participation of the educational community. Furthermore, it involves specifying and designing professional management processes such as those of the PMI; this, combined with the application of AI, enables the streamlining of cyclical and repetitive tasks and the ability to obtain real-time information for concrete decision-making.

Furthermore, in accordance with the Climate Change Act, which requires organisations to measure their carbon footprint, this work serves as a spearhead to ensure continuity in the early adoption of this practice.

This will enable not only compliance with current regulations but also a responsible contribution to mitigating environmental impact and fostering a culture of sustainability within the educational sector.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest. They have no financial interests or personal relationships that could have influenced the article presented here.

Author contribution

Nicolas-Peña, Daniel: I contributed to the project concept, research design, development of the methodology, data analysis and systematisation of the results, drafting of the article, and design and application of the field instruments.

Resendiz-Vega, Marisol: I contributed to the design and application of the research methodology and techniques. I assisted in the design of the field instrument.

Availability of data and materials

The campus data are available at the CETis 91 premises, where electricity consumption can be identified via the CFE bill, whilst the implementation of environmental awareness strategies is archived in the project files.

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Abbreviations

CEAP	Participatory School Management Committee
CETis	Centre for Industrial and Service Technology Studies No. 91
CONUEE	National Commission for the Efficient Use of Energy
DGETI	Directorate-General for Industrial Technology Education
EDT	Work Breakdown Structure
IA	Artificial Intelligence
IEA	International Energy Agency
KwH	Kilowatt-hour [unit of electrical measurement]
LED	Light-emitting diode
ODS	Sustainable Development Goals
ONU	United Nations
PMBOOK	Project Management Body of Knowledge
PMI	Project Management Institute
SEMARNAT	Ministry of the Environment and Natural Resources
SGE	Energy Management System
SGEn	Energy Management System
UA	Academic Unit
UAC	Curricular Academic Unit

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