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The Impact of Implementing Energy Management System According to International Standard ISO 50001:2018 on Energy Performance of Industrial Companies: Case Study of Ain Touta Cement Company (SCIMAT)

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Abstract: The study aimed to assess the impact of the Energy Management System (ISO 50001:2018) on enhancing energy efficiency in the cement industry, specifically at Ain Touta Cement Company in Algeria. Using a descriptive-analytical approach and a case study method, the research relied on company documentation and interviews for data collection. The results showed that implementing the ISO 50001:2018 standard helped the company to significantly reduceits energy usage and improve its electrical energy performance. Nevertheless, the company faced difficulties in completely managing the performance indicators for thermal energy, highlighting areas for potential improvement.

Keywords: Energy Management System; Energy Performance Improvement; International Standard Specification (ISO 50001:2018); Industrial Enterprises.

1. Introduction

The industrial sector, characterized by its intensive energy consumption, stands at a crucial juncture in the global pursuit of sustainable development. The implementation of energy management systems, particularly those aligned with international standards like ISO 50001:2018, has emerged as a vital strategy for enhancing energy performance in this sector. (Schneider, Romer, Tschudin, & Bolio, 2011)This paper focuses on the impact of implementing the ISO 50001:2018 Energy Management System (EnMS) on the energy performance of industrial enterprises, with a specific case study of Ain Touta Cement Company, a significant entity in the Algerian Cement Industrial Group.

Energy management, fundamentally, involves planning and operation of energy production and consumption units with the objective of enhancing energy efficiency and reducing environmental impact. The ISO 50001 standard, established by the International Organization for Standardization, provides a framework for organizations to develop, implement, maintain, and improve an energy management system, facilitating a systematic approach towards energy efficiency.(International Organization for Standardization ISO, 2023)

The relevance of such systems is particularly pronounced in energy-intensive industries like the cement sector. The cement industry is a significant consumer of energy, primarily natural gas and electricity, making it a primary candidate for energy management interventions. The implementation of ISO 50001:2018 in such sectors not only addresses energy efficiency but also contributes to broader sustainability goals, aligning with global efforts to combat climate change.(International Organization for Standardization ISO, 2023)

Ain Touta Cement Company's implementation of ISO 50001:2018 in 2020 presents a compelling case for analyzing the real-world impact of such systems. The company's commitment to energy management is part of a larger trend in the Algerian industrial landscape, reflecting a growing recognition of the need for sustainable practices. This study aims to assess how the implementation of ISO 50001:2018 has affected the company's energy performance, focusing on key areas such as energy consumption rationalization, and operational efficiency.

This paper employs a descriptive-analytical method and a case study approach, leveraging company documents, interviews, and field observations to provide a comprehensive analysis of Ain Touta Cement Company's energy management journey. By examining the company's motivations, implementation stages, and the outcomes of implementing ISO 50001:2018, this study contributes valuable insights into the efficacy of energy management systems in industrial settings.

In essence, the implementation of ISO 50001:2018 by Ain Touta Cement company represents a microcosm of a larger movement towards energy sustainability in the industrial sector. This study not only evaluates the company's progress in energy management but also offers a blueprint for other industrial enterprises aiming to enhance their energy performance in line with international standards.

1.1 Study Problematic

Building on the foregoing, the main research problem can be formulated as follows:

- **What is the impact of implementing an Energy Management System in accordance with the International Standard (ISO 50001:2018) on the energy performance of Ain Touta Cement Company?**

To answer this, the main problem can be divided into the following sub-questions:

- What is meant by an energy management system? And what are its benefits?
- What are the requirements for implementing an energy management system according to ISO 50001:2018?
- What are the motivations for Ain Touta Cement Company to implement an energy management system?
- What are the stages of implementing an energy management system by Ain Touta Cement Company?
- What are the most significant uses of energy for Ain Touta Cement Company?
- What are the energy objectives and indicators for Ain Touta Cement Company?

1.2 Study Objectives

This study aims to analyze the impact of implementing the Energy Management System according to the International Standard ISO 50001:2018 on the energy performance of the Ain Touta Cement Company. The specific objectives under this main goal include:

- Clarify the concept, benefits, and requirements of implementing an energy management system according to ISO 50001:2018.

- Identify the motives for implementing the Energy Management System by Ain Touta Cement Company.
- Determine the most significant uses of energy for Ain Touta Cement Company.
- Identify the energy objectives and indicators for Ain Touta Cement Company.

2. Study Methodology and Information Gathering Methods

To address the research problem and to cover all aspects of the topic, this study relies on the descriptive-analytical approach in its theoretical aspect. This approach is considered one of the most suitable research methodologies for stating facts and understanding the components of the study with precision and detail in order to determine its various dimensions.

In the field aspect, we relied on the case study method, through which the researchers explored the extent of the impact of implementing the energy management system according to the International Standard Specification (ISO 50001:2018) on the energy performance of Ain Touta Cement Company. To achieve the study objectives, the researchers used interviews and referred to the requirements of the International Standard Specification ISO 50001:2018, in addition to observations and field immersion in the departments and services of the company and reviewing its official documents, leading to the determination of results and proposing appropriate recommendations.

3. Theoretical Framework

3.1 Energy Management System (EnMS)

An Energy Management System (EnMS) is a systematic and structured approach designed to help organizations effectively manage and optimize their energy consumption. It involves a comprehensive set of policies, processes, and practices aimed at efficiently utilizing energy resources while simultaneously reducing waste and costs. EnMS plays a pivotal role in addressing the growing global concerns related to energy efficiency, environmental sustainability, and regulatory compliance. (Poveda-Orjuela, García-Díaz, Pulido-Rojano, & Cañón-Zabala, 2019)To delve deeper into the concept of EnMS, it's essential to consider the fundamental components that constitute its theoretical foundation.

3.2 Definition of Energy Management

Energy management, within the context of an Energy Management System, is the process of strategically planning, implementing, monitoring, and continuously improving energy-related activities within an organization.(Fichera, Volpe, & Cutore, 2020)

It encompasses a holistic approach to energy resource management, emphasizing the efficient use of energy to meet operational requirements while minimizing energy wastage and its associated environmental impact. Energy management encompasses various facets, including energy procurement, distribution, consumption, and conservation.

3.3 Benefits of Implementing an Energy Management System

The implementation of an Energy Management System offers a multitude of tangible benefits for organizations. These benefits extend across various dimensions, including financial, operational, environmental, and competitive advantages: (Bernabé-Custodio, et al., 2023)

Cost Savings: EnMS empowers organizations to identify and mitigate energy inefficiencies, resulting in a substantial reduction in energy consumption and subsequently lower energy bills. The accrued cost savings can significantly impact an organization's bottom line. (Harvard Business Review, 2012)

Enhanced Operational Efficiency: Through the optimization of energy use, EnMS enhances overall operational efficiency. Reduced energy-related disruptions and downtime lead to improved productivity and competitiveness. (Jin, et al., 2021)

Environmental Sustainability: EnMS promotes responsible energy resource utilization, resulting in a reduction of greenhouse gas emissions and environmental impact. This aligns with global sustainability goals and reinforces an organization's commitment to environmental stewardship.(Marimon & Casadesús, 2017)

Compliance and Certification: The implementation of EnMS can lead to certification according to internationally recognized standards, such as ISO 50001:2018. This certification signifies an organization's dedication to energy management and compliance with industry regulations.(Baxter, 2022)

Competitive Advantage: Organizations with efficient energy management systems can gain a competitive edge by offering eco-friendly products and services. This attracts environmentally conscious consumers and opens new market opportunities.

3.4 Origin and Development of ISO 50001 Series

The ISO 50001 series of standards, developed by the International Organization for Standardization (ISO), represents a significant milestone in the field of energy management. It was conceived in response to the growing recognition of energy efficiency as a critical global concern. The series commenced with ISO 50001:2011 as its initial standard, followed by the current version, ISO 50001:2018.(Da Silva Gonçalves & dos Santos, 2019)ISO 50001:2018 serves as the cornerstone of this series, laying down the essential requirements for establishing, implementing, maintaining, and continually improving an energy management system.

3.5 Requirements of the Energy Management System

ISO 50001:2018 delineates a set of critical requirements that organizations must fulfill to establish a robust energy management system. These requirements serve as the foundation for effective energy management and include: (Knodt & Ringel, 2018)

- **Energy Policy:** Organizations must define a clear and comprehensive energy policy that aligns with their objectives and demonstrates their commitment to energy efficiency.
- **Energy Planning:** Setting specific energy performance targets, monitoring energy usage, and formulating action plans to achieve energy-saving objectives are essential components of energy planning.
- **Energy Review:** Conducting regular energy reviews and assessments is crucial for identifying areas in need of improvement and optimization.
- **Monitoring and Measurement:** Continuous monitoring and measurement of energy performance are essential to ensure compliance with established targets and objectives.
- **Documentation and Record-Keeping:** Thorough documentation and record-keeping of energy management processes and activities are necessary for transparency and accountability. (Lewis, Elmualim, & Riley, 2011)
- **Internal Audits:** Regular internal audits help assess the effectiveness of the energy management system and identify areas for enhancement.
- **Management Review:** Periodic management reviews enable organizations to evaluate their energy performance and make necessary adjustments to optimize their energy management processes.

4. Literature Review

Energy management, particularly in the context of ISO 50001, has garnered significant attention in recent years, with several studies exploring the influence of ISO 50001 implementation on various aspects of organizations and industries.

Study 1: Implementation of an Energy Management System based on the ISO 50001 Standard in a Hospital Clinic

Carmen Elizabeth Hernández-Rivera, Adrián Vidal-Santo, Mariel Morales-Martínez, and Alberto Jasso-Hernández conducted research involving the implementation of an Energy Management System (EnMS) based on ISO 50001 in a hospital clinic in Mexico. Despite atypical conditions due to the pandemic, the study revealed that electricity was the major energy source with significant potential for savings. The clinic achieved a 38% compliance level with ISO 50001, indicating room for improving energy efficiency. (Hernández-Rivera, Vidal-Santo, Morales-Martínez, & Jasso-Hernández, 2023)

Study 2*:* Energy Efficiency Management according to ISO 50001: A Case Study in the Brick Industry

Miguel Bernabé-Custodio, William Marín-Rodriguez, Daniel Andrade-Giron, Abraxane-Ayala, Jose Ausejo-Sanchez, Algemiro Muñoz-Vilela, Santiago Ramos–y Yovera, Angel Campos-Diaz, and Ernesto Diaz-Ronceros conducted research focusing on energy efficiency management in the brick industry using ISO 50001. The study demonstrated significant reductions in electricity consumption and monetary savings following ISO 50001 implemention, validating the feasibility of ISO 50001-based energy efficiency management in industries. (Bernabé-Custodio, et al., 2023)

Study 3: An Assessment of the use of the ISO 50001 Certified Energy Management Systems by Airports

Glenn Baxter's study examined airports worldwide that have implemented ISO 50001 certified Energy Management Systems (EMS). The research found that airports in various regions have embraced ISO 50001 to bolster their environmental management and optimize energy efficiency. The study highlighted the diverse energy conservation measures implemented by airports using ISO 50001 strategies. (Baxter, 2022)

Collectively, these studies contribute to our understanding of ISO 50001's impact on energy management and efficiency across diverse sectors and regions, providing valuable insights for organizations considering ISO 50001 implementation and highlighting its potential benefits in terms of cost savings, environmental impact, and improved energy performance. These studies serve as crucial references for practitioners and researchers, guiding the way toward sustainable energy management and resource optimization.

5. Case Study

5.1. Presentation of the Company Under Study

5.1.1 Overview of Ain Touta Cement Company

Ain Touta Cement Company is one of the branches of the Algerian Cement Industrial Group (GICA). It specializes in the production, packaging, and marketing of cement, as well as gravel and sand. The cement companybegan its activity in 1986 after the completion of the cement factory by the Danish company FLSMIDTH in duration of 32 months with a production capacity of the factory: 1,000,000 tons of cement annually. The factory is located on National Road No. 28, connecting Ain Touta district to the S'gana district in Batna Province.

5.1.2 Motivations for Implementing the Energy Management System by Ain Touta Cement Company

The key motivations that led the company to implement the energy management system have been translated into the policy of the energy management system of the company and put in the form of commitments, all aimed at the continuous improvement of the company's performance. These can be divided into external and internal motivations as follows:

Table .1. Motivations for Implementing the Energy Management System by Ain Touta Cement Company

External Motivations	Internal Motivations
- Enhancing the company's legal responsibility - Meeting the needs and expectations of stakeholders - Rationalizing and saving energy consumption - Protecting the environment and conserving natural resources - Improving the company's image and reputation - Achieving a competitive advantage that allows the company to strengthen its position in local markets and enter international markets	- Improving the energy performance of equipment and facilities, thus increasing operational efficiency - Utilizing energy more efficiently by reducing energy waste - Providing safe and healthy working conditions to reduce and eliminate risks and ensure occupational safety - Reducing costs associated with energy, thereby increasing productivity and profitability - Continuous improvement and enhancement of the company's performance

Source: Prepared by the researchers based on the company's energy policy

5.2 Stages of Implementing the ISO 50001 Energy Management System in Ain Touta Cement Company

The commitment of the top management of the company to implement an energy management system for the cement production unit dates back to 2019, during a management review meeting. It was agreed to develop an action plan to localize and implement the energy management system according to the ISO 50001:2018 standard, and to work on obtaining the corresponding international certification. The process went through several steps according to the requirements of the standard and based on the continuous improvement cycle (Plan, Do, Check, Act), also known as the Deming Wheel. These steps can be listed in the following table:

Table .2. Stages of Implementing the ISO 50001 Energy Management System at Ain Touta Cement Company

	N°	Activity	Output data according to the standard specification clauses (process/documentation)
PLAN	**01**	**Establish the inputs for the EMS.**	Context (4.1)
			Stakeholders &Needs and Expectations (4.2)
			Legal and Regulatory Requirements (4.2)
	02	**Define the EMS.**	Scope (4.3)
			Process Mapping (4.4)
			Process Manuals (4.4)
			Energy Policy (5.1, 5.2)
			Roles and Responsibilities: Pilot decisions, internal auditors, and energy team (5.3)
	03	**Develop documents related to process activities.**	Risk Analysis (6.1)
			Energy Review (6.2, 6.3, 6.4, 6.5, 6.6)
			Training Plan (7.2)
			Awareness Plan (7.3)
			Communication Plan (7.4)
			Operational Control - Operation (8.1)
			Operational Control - Maintenance (8.1)

			Design and Procurement (8.2, 8.3)
	04	**Establish EMS procedures.**	Energy planning (6.2/3/4/5/6 et 9.1)
DO	**05**	**Implement the processes.**	Disseminate the energy policy and documentation.
			Implement the procedures.
			Execute improvement action plans.
			Calculate Key Performance Indicator (KPI) values.
			Implementation of programs: (Training, Awareness, Procurement, etc.)
CHECK	**06**	**Monitoring and measurement**	Monitoring and measurement plan (9.1).
	07	**Internal audit.**	Audit program / Audit plan / Audit report (9.2).
	08	**Management review.**	Management review meeting minutes (9.3).
ACT	**09**	**Non-conformity and corrective action handling.**	Deviation records (10.1).
	10	**Improvement**	Actions plan (10.2)

Source: Compiled by the researchers based on ISO 50001 standard and interviews with the head of the Company's energy management team.

5.2.1 Identifying Significant Energy Uses (UES) for the Company

As defined by the standard, each energy use represents a significant portion of energy consumption and/or offers significant opportunities for improving energy performance. Based on this criterion, the significant energy uses for the Company have been identified, with opportunities for improvement at various stages of the Company's production process as follows:

Table.3. Important Energy Uses for the Company

Energy Type	**Fuel**	**Electricity**	**Natural Gas**
Ratio	2%	11%	87%

Source: Prepared by the researchers based on Company data.

This table provides information on the important energy uses for the company, including fuel, electricity, and natural gas. It shows the consumption percentages for each type of energy source. Natural gas accounts for the largest share at 87%, followed by electricity at 11%, while fuel consumption is relatively low at 2%.

Table .4. Distribution of Energy Uses in the Company Across Production Stages

Production Stage / Energy Type	Raw Material Extraction and Preparation	Pre-homogenization of Raw Materials	Raw Material Grinding	Raw Material Homogenization	Clinker Production Cooking	Clinker Grinding for Cement Production	Cement Storage	Cement Packing and Dispatch
Electricity %	9%	1%	28%	3%	18%	35%	1%	5%
Natural Gas %	-	-	-	-	100%	-	-	

Source: Compiled by the researchers based on Company data.

This table illustrates the distribution of energy consumption across various production stages and processes within the company. It indicates the percentage of electricity and natural gas consumption for each stage. Key observations include :

- Energy consumption varies significantly among different production stages and processes.
- The stages of clinker grinding, raw material grinding, and clinker production are the most electricity-intensive processes, accounting for 35%, 28%, and 18% of electricity consumption, respectively.
- Clinker production is the only process that requires the use of natural gas, specifically in the firing zone of the kilns. This stage consumes 100% of the natural gas.

5.2.2 Energy Objectives for the Company and Performance Indicators (IPE)

After identifying the important energy uses for the company with potential for improvement, energy performance indicators (EPIs) and objectives to enhance energy performance were established. These are monitored through leadership dashboards as follows:

Table .5. Energy Objectives for the Company

Energy Type	Objective	Target Indicator
Electricity	Electricity consumption reduction	5%
Natural Gas	Natural gas consumption reduction	3%

Source: Energy Review Meeting Report for the Company.

The company has set energy reduction objectives, as indicated in Table Number 5. These objectives aim to reduce electricity and natural gas consumption by 5% and 3%, respectively. The achievement of these objectives is measured by comparing the estimated energy consumption with the actual consumption.

After establishing the energy objectives for the company, the targeted energy performance indicators (EPIs) were determined as follows:

Table.6. Energy Performance Indicators for the Company

Indicators	Targeted Indicator
Electrical Energy Performance Indicator	100 kilowatt-hours per ton of cement production
Specific Electricity Consumption	170 kilowatt-hours per ton of cement production
Specific Gas Consumption	1050 thermies per ton of clinker production
Thermal Energy Performance Indicator	1000 thermies per ton of clinker production

Source: Energy Review Meeting Report for the Company.

Table (06) presents the company's implementation of the IPé (Energy Performance Indicator) in its leadership dashboard. The IPé represents the energy directed to produce one ton of cement for electricity and one ton of clinker for natural gas. It does not consider energy consumed outside the production process, such as losses, lighting, and building energy. The Specific Consumption (Cs) represents the ratio of total consumption based on invoices from the main supplier (Sonalgaz) divided by the number of units produced.

5.2.3 Preparation of Action Plans

After forming an energy management team by senior management, this team developed action plans based on the established energy objectives and the leadership dashboard mentioned in Table Number 5. The actions and measures taken can be listed as follows:

Table .7. Energy Management Team Action Plan for the Company

Type of Action	Natural Gas	Electricity
Energy Use-Related Measures	- Avoid operating furnaces at low flow rates - Eliminate parasitic air and material leaks	- Avoid running machines empty - Eliminate air, water, and material leaks
Other Measures	- Raise awareness among workers and implement training - Put a gas analysis device into service -Install an energy measurement system -Provide necessary workforce to maintenance departments -Implement recommendations from APRUE	- Review settings related to electricity meters - Maintain and renew lighting in administrative buildings - Schedule maintenance operations during peak hours - Work on increasing employee awareness and implementing training programs - Install interactive energy compensation batteries

Source: Compiled by the researchers based on the Energy Review Meeting Report of the Company.

5.3 Study and Analysis of Energy Performance for Ain Touta Cement Company

5.3.1 Energy Consumption Rationalization for the Company

This indicator reflects the difference between the annually estimated quantities of energy and the actual quantities consumed in the same year. Energy rationalization refers to the rational or optimal use of energy, not merely reducing its consumption. The following table, Table No. 8, illustrates the energy rationalization achieved by the company for the years 2020-2021-2022.

Table.8. Energy Consumption Rationalization for the Company

Energy Type	Years Target	2020	2021	2022
Electricity Ratio	Saved Electrical Energy (Kilowatt-hours)	3,416,006	15,412,264.44	16,444,334.42
	Percentage %	2.54	11.57	12.72
Gas Ratio	Saved Gas (Thermal Calorie)	33,603,102.5	22,712,519.47	15,117,407.18
	Percentage%	3.75	2.36	1.64

Source: Compiled by researchers relying on the company's data

Table 8 above shows that the quantities of electrical energy saved by the company exceeded the targeted percentage for the years 2021 and 2022, which was estimated at 5%. It increased from 11.57% in 2021 to 12.72% in 2022. As for rationalizing gas consumption, despite the achieved savings in this type of energy, the percentage couldn't reach the targeted 3%, except for the year 2020.

Rationalizing the consumption of both electricity and natural gas by the company leads to reducing production costs, providing the company with a competitive advantage.

5.3.2 Electric Energy Performance

In contrast to thermal energy, electric energy serves as the general driver for all stages of the production process. Therefore, the efficiency and technical condition of the equipment and devices used play a crucial role in the electric energy performance of the company. The following table presents the indicators of electric energy performance for the company for the years 2020-2021-2022.

Table.9. Electricity Energy Performance for the Company

Indicator	Target Indicator	2020	2021	2022
Electricity Energy Performance	100 Kilowatt-hours per ton of cement production	97.8	96.29	90.04
Specific Electricity Ratio	170 Kilowatt-hours per ton of cement production	165.23	137.0	138.69

Source: Compiled by researchers relying on the company's data

Table measures the performance of electricity energy, and the following observations can be made:

- There is a continuous improvement in the electricity energy performance of the company. The indicator decreased from 97.8 kilowatt-hours per ton of cement production in 2020 to 96.29 kilowatt-hours in 2021, reaching its maximum level in 2022 at 90.04 kilowatt-hours. Over the three years, the indicator did not exceed the targeted indicator, indicating good control over electricity energy performance by the company.

- Although the specific electricity consumption did not exceed the target, it is relatively high and fluctuates. It transitioned from 165.23 kilowatt-hours per ton of cement production in 2020 to 137.70 kilowatt-hours in 2021, rising to 138.69 kilowatt-hours per ton of cement production in 2022. This indicates a lack of control over electricity losses outside the production process.

5.3.3 Thermal Energy Performance

Improving the efficiency of natural gas usage and rationalizing its consumption significantly reduces cement costs, thereby increasing the company's competitive advantage.

Table.10.Thermal Energy Performance for the Company

Indicator	Targeted Indicator	2020	2021	2022
Thermal Energy Performance	1000 Thermies per ton of clinker production	1023.29	1029.37	1070.75
Specific Gas Ratio	1050 Thermies per ton of clinker production	1132.58	1081.03	1139.05

Source: Compiled by researchers relying on the company's data

- A reading of Table No. 10 reveals the following:

- Natural gas is used in a single stage during the production process, which is the clinker production stage. This stage is characterized by intensive natural gas consumption. The table above shows a continuous increase in thermal energy performance indicators and specific gas consumption indicators. These indicators exceeded the targeted values over the three years, indicating a lack of good control over these indicators or improper formulation of the targeted indicators. Additionally, several factors can influence thermal energy performance and natural gas consumption, including:

- Production volume and product type: The production process for clinker varies depending on the type of cement to be produced, affecting energy consumption and performance indicators.

- Quality of raw materials: The quality of raw materials used can impact the clinker production process.

- External environmental factors such as temperature.

- Frequency of shutdowns and startups.

6. Conclusion

This study has provided an in-depth analysis of the impact and implications of implementing the ISO 50001:2018 Energy Management System at Ain Touta Cement Company. The company, being a significant entity in the Algerian cement industry, serves as a valuable case study for understanding the role of international standards in enhancing energy management in industrial operations. The extended conclusions of this study are presented below:

- Cement Company Ain Touta relies on an integrated management system in accordance with modern international standards ISO 50001:2018, ISO 9001:2015, ISO 14001:2015, and ISO 45001:2018.

- The organizational structure of the ISO 50001:2018 High-Level Structure (HLS) allows for the integration of multiple management systems in accordance with modern international standards.

- Cement Company Ain Touta is among the energy-intensive organizations.

- Energy consumption varies within the organization depending on the different stages of production.

- The implementation of an energy management system based on ISO 50001:2018 by Cement Company Ain Touta has led to significant energy savings, achieving a reduction of 12.72% in electricity and 3.75% in natural gas consumption.

- The implementation of the energy management system by Cement Company Ain Touta has improved its electrical energy performance, with the energy performance indicator decreasing from 97.8 KW/H to 90.04 KW/H per ton of cement produced.
- Despite rationalizing natural gas consumption by the company, it has not been able to control thermal energy performance indicators.

- Recommendations

In light of the comprehensive analysis and findings of this study, it is clear that while Ain Touta Cement Company has made commendable strides in improving its energy performance through the implementation of ISO 50001:2018, there remain areas for further enhancement. These areas present opportunities for the company to not only refine its energy management practices but also to align more closely with sustainability goals and enhance operational efficiency.

The following recommendations are proposed to address these opportunities. They are designed to build upon the company's existing strengths and address the challenges identified, particularly in the realm of thermal energy management. These suggestions aim to guide Ain Touta Cement Company towards a more sustainable, efficient, and environmentally responsible future.

- It is imperative to review the thermal energy performance indicators during the energy review meeting, taking into account the reference energy condition, in accordance with the standard.
- Intensification of internal energy audits and submission of reports to the management for review and necessary corrective actions is essential.
- The company should focus on recovering lost thermal energy and utilizing it for heating office and administrative spaces, in addition to its use in the pre-heating stage of raw materials to reduce their residence time in the kilns.
- The necessity of using high-quality raw materials, such as pozzolan and iron ore, for the production of Portland pozzolana cement and/or Portland iron cement instead of limestone-based Portland cement is recommended.
- Continuous awareness-raising among workers regarding the company’s energy objectives is crucial.
- Evaluate the effectiveness of implemented actions.
- Use solar energy for lighting.

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