

**ENERGY AUDIT AND EFFICIENCY ANALYSIS OF INDUSTRIAL SECTORS IN NIGERIA: A
STUDY OF ENERGY CONSUMPTION PATTERNS AND OPPORTUNITIES FOR ENERGY
SAVINGS**

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ABSTRACT

Energy plays a critical role in industrial productivity and economic development, yet inefficient energy utilization remains a major challenge within many industrial sectors in Nigeria. This study examined energy consumption patterns and efficiency levels in selected industrial sectors in order to identify opportunities for energy savings through energy audit and efficiency analysis. The study adopted a descriptive survey design combined with an energy audit approach. Data were obtained from selected industrial facilities and technical personnel responsible for production and energy management. Descriptive statistical techniques were used to analyze energy consumption patterns and equipment efficiency levels within the industries. The findings revealed that energy consumption varies across industrial sectors, with the cement and chemical production industries recording the highest levels of energy demand due to the energy intensive nature of their production processes. The results further showed that many industries operate with equipment efficiency levels below recommended benchmark standards, resulting in considerable energy losses. In addition, the study identified several opportunities for energy savings through measures such as waste heat recovery systems, replacement of inefficient electric motors, improved insulation of steam distribution systems, and the adoption of energy monitoring technologies. The study concluded that significant improvements in industrial energy efficiency can be achieved through systematic energy audit practices and the modernization of industrial equipment. The study therefore recommends the strengthening of national energy efficiency policies, increased investment in energy efficient technologies, and the adoption of structured energy management systems within industrial organizations. Implementing these measures will reduce energy costs, improve industrial productivity, and support sustainable industrial development in Nigeria.

Keywords: Energy audit, industrial energy efficiency, energy consumption, manufacturing sector, energy management, Nigeria.

INTRODUCTION

Industrial development remains one of the major drivers of economic growth and structural transformation in developing economies. In Nigeria, the industrial sector, particularly manufacturing, plays an important role in job creation, value addition, and national productivity. However, industrial production is heavily dependent on energy availability and reliability. Energy is a fundamental input

in industrial operations, powering machinery, production processes, and supporting infrastructure. As a result, the level of industrial productivity and competitiveness in many countries is closely linked to the efficiency and sustainability of their energy systems. In Nigeria, energy consumption has historically been dominated by fossil fuels, while electricity supply challenges have forced many industries to rely on alternative sources such as diesel and gas-powered generators to maintain production activities (Buba, 2025; International Energy Agency, 2023).

Despite Nigeria's abundance of natural energy resources, including oil and natural gas, the country continues to face persistent energy supply constraints that affect industrial operations. The power sector has struggled with inadequate generation capacity, transmission inefficiencies, and unreliable distribution networks, leading to frequent power outages and high production costs for industries. Studies indicate that inadequate and inefficient electricity supply has discouraged industrial production and slowed the growth of the manufacturing sector in Nigeria (Adeniran & Sanyaolu, 2021). These challenges often compel industrial firms to adopt energy-intensive coping strategies such as self-generation of electricity, which significantly increases operational costs and reduces energy efficiency. Consequently, energy consumption patterns within Nigerian industries tend to be inefficient and poorly monitored, highlighting the need for systematic energy management practices. The industrial sector represents a significant portion of Nigeria's total energy demand. Recent estimates suggest that industry accounts for roughly 15% of the country's total energy consumption, although this proportion fluctuates depending on economic activity and energy supply conditions (CEIC, 2023). Energy intensity in manufacturing industries varies widely depending on the type of industrial activity, with sectors such as cement production, metal processing, and chemical manufacturing consuming significantly higher levels of energy relative to their economic output (International Energy Agency, 2023). Inefficient energy use in these sectors not only increases production costs but also contributes to environmental challenges such as increased carbon emissions and resource depletion. Therefore, improving energy efficiency within industrial operations has become a key policy priority for sustainable industrial development.

Energy audits have emerged as an effective tool for identifying inefficiencies in energy use and providing actionable strategies for energy savings within industrial systems. An energy audit involves a systematic assessment of energy flows within a facility to determine how energy is consumed and where improvements can be made. Through energy audits, industries can identify opportunities for reducing energy losses, improving equipment performance, optimizing operational processes, and adopting cleaner technologies. Research has shown that comprehensive energy audits can significantly reduce operational costs and improve overall energy performance by enabling organizations to implement targeted efficiency measures and adopt energy management systems (Lawal, 2024).

In recent years, growing concerns about energy security, environmental sustainability, and industrial competitiveness have intensified efforts to promote energy efficiency in Nigeria's industrial sector. The Energy Commission of Nigeria has introduced initiatives such as industrial energy efficiency databases and monitoring systems designed to help industries track energy consumption, benchmark performance, and adopt best practices for energy management. Such initiatives aim to support industries in identifying energy-saving opportunities and implementing efficiency improvements that could reduce energy consumption by up to 30% in some cases (Energy Commission of Nigeria, 2025).

Given the increasing demand for energy in Nigeria's industrial sector and the persistent inefficiencies in energy utilization, there is a growing need to systematically analyze energy consumption patterns across industrial facilities. Conducting energy audits and efficiency assessments can provide valuable insights into how energy is used within industrial processes and highlight potential opportunities for energy savings. By identifying areas of excessive energy consumption and recommending practical

efficiency measures, such studies can contribute to improving industrial productivity, reducing operational costs, and supporting Nigeria's broader goals of sustainable economic development and environmental management.

Statement of the Problem

Nigeria's industrial sector continues to face persistent energy challenges that significantly affect productivity, operational efficiency, and competitiveness. Although energy is a critical input for industrial production, many industries in Nigeria operate within a context of unreliable electricity supply, high energy costs, and inefficient energy utilization. As a result, several industrial establishments rely heavily on self-generated power using diesel or gas generators, which substantially increases production costs and reduces overall operational efficiency. In addition, the absence of systematic monitoring of energy consumption patterns in many industrial facilities has led to significant energy wastage and poor energy management practices. Studies have indicated that inefficient energy use and poor energy management contribute to increased operational costs and reduced industrial output in developing economies such as Nigeria (Adeniran & Sanyaolu, 2021; International Energy Agency, 2023).

Despite the growing recognition of energy efficiency as a key strategy for improving industrial performance, many industrial organizations in Nigeria have not fully adopted comprehensive energy audit practices that could help identify inefficiencies and opportunities for energy savings. Limited awareness of energy management strategies, inadequate technical capacity, and insufficient investment in energy-efficient technologies continue to hinder the implementation of energy efficiency measures within the sector. Consequently, industries often consume more energy than necessary to produce goods and services, resulting in higher energy intensity and increased environmental impacts (Energy Commission of Nigeria, 2022; Lawal, 2024).

Furthermore, existing studies on industrial energy consumption in Nigeria have largely focused on macro-level energy demand and electricity supply challenges, with relatively limited empirical attention given to detailed assessments of energy consumption patterns within industrial facilities. Without such analyses, it becomes difficult to identify specific areas of energy loss and the potential efficiency improvements that could reduce energy costs and improve industrial productivity. Therefore, there is a need for a comprehensive study that examines energy consumption patterns within Nigeria's industrial sector through energy audit and efficiency analysis in order to identify opportunities for energy savings and promote sustainable industrial development.

Aim and Objectives of the Study

The aim of this study is to examine energy consumption patterns in selected industrial sectors in Nigeria through energy audit and efficiency analysis in order to identify opportunities for energy savings and improved energy management.

1. To examine the pattern of energy consumption in selected industrial sectors in Nigeria.
2. To assess the level of energy efficiency in industrial operations within the selected sectors.
3. To identify potential opportunities for energy savings through energy audit practices in Nigerian industries.

Research Questions

1. What are the patterns of energy consumption in the selected industrial sectors in Nigeria?
2. What is the level of energy efficiency in the operations of these industrial sectors?
3. What opportunities exist for energy savings in the selected industrial sectors based on energy audit analysis?

LITERATURE REVIEW

Concept of Energy Audit

An energy audit refers to a systematic process of analyzing energy consumption within a facility, organization, or industrial process in order to identify areas of energy waste and opportunities for improving energy efficiency. It involves the collection, measurement, and evaluation of energy data related to equipment performance, operational processes, and energy management practices. Through energy audits, organizations are able to understand how energy is consumed, determine inefficiencies in energy usage, and recommend appropriate measures for reducing energy losses and improving overall energy performance. According to the International Energy Agency (2023), energy auditing is an essential tool for improving industrial energy management because it provides detailed insights into energy flows and identifies practical strategies for optimizing energy use.

Energy audits in industrial environments typically involve several stages including preliminary data collection, detailed energy assessment, identification of inefficiencies, and the development of recommendations for energy conservation measures. These assessments often focus on major energy consuming systems such as boilers, motors, compressors, heating systems, and lighting equipment. Lawal (2024) noted that industrial energy audits play a critical role in identifying operational inefficiencies, improving equipment performance, and reducing energy costs in manufacturing industries. By implementing the recommendations generated from energy audits, industries can achieve significant reductions in energy consumption while maintaining or improving production output.

Furthermore, energy audits are widely recognized as a key strategy for promoting sustainable industrial development. Efficient energy utilization not only reduces operational costs for industries but also minimizes environmental impacts associated with excessive energy consumption. In many developing countries, including Nigeria, energy auditing has become increasingly important as industries seek to cope with rising energy costs and unreliable electricity supply. Consequently, energy audits serve as a practical approach for improving energy efficiency and strengthening industrial competitiveness.

Concept of Energy Consumption Patterns

Energy consumption patterns refer to the manner in which energy is used within a system over a specific period of time. In industrial environments, energy consumption patterns describe how different forms of energy such as electricity, natural gas, and diesel fuel are utilized across various production processes and operational activities. These patterns are influenced by factors such as the type of industrial activity, the level of technological development, production capacity, operational practices, and the efficiency of equipment used in production processes. Understanding energy consumption patterns is important because it helps organizations identify areas where energy is being used inefficiently and where improvements can be made to optimize energy utilization.

In industrial sectors, energy consumption patterns often vary significantly across different industries due to variations in production technologies and operational requirements. Heavy manufacturing industries such as cement, steel, and chemical production typically consume large amounts of energy due to their reliance on energy intensive thermal and mechanical processes. In contrast, industries such as food processing and light manufacturing generally consume relatively lower amounts of energy. Oyedepo (2019) explained that understanding industrial energy consumption patterns is essential for designing effective energy efficiency policies and strategies that target sectors with the highest energy demand.

In the Nigerian context, industrial energy consumption patterns are strongly influenced by the availability and reliability of electricity supply. Due to frequent power outages, many industries rely

on alternative energy sources such as diesel generators to sustain production. This situation results in complex energy consumption patterns where industries depend on a mix of grid electricity, fossil fuels, and other energy sources to meet their operational needs. Analyzing these patterns helps policymakers and industry managers develop strategies for improving energy efficiency and reducing energy costs.

Concept of Energy Efficiency

Energy efficiency refers to the ability to perform a given task or production process using the minimum amount of energy without compromising performance or output quality. In industrial settings, energy efficiency involves optimizing production processes, improving equipment performance, and implementing energy management practices that reduce unnecessary energy consumption. Higher levels of energy efficiency mean that industries are able to produce goods and services while consuming less energy, thereby reducing operational costs and environmental impacts.

Energy efficiency is widely regarded as one of the most effective strategies for improving industrial productivity and promoting sustainable economic development. According to the International Energy Agency (2023), improvements in energy efficiency can significantly reduce energy demand in industrial sectors while maintaining production capacity. This is particularly important for developing countries where energy supply constraints often limit industrial growth. By improving energy efficiency, industries can increase production output while minimizing the pressure on national energy infrastructure.

In many industrial facilities, energy inefficiencies arise from outdated equipment, poor maintenance practices, inefficient production processes, and lack of energy monitoring systems. Oyedepo (2019) emphasized that improving energy efficiency in industries requires the adoption of modern technologies, regular maintenance of equipment, and the implementation of structured energy management systems. When industries adopt energy efficient practices, they not only reduce energy costs but also improve their competitiveness in global markets.

Concept of Energy Savings

Energy savings refer to the reduction in energy consumption achieved through the implementation of energy efficiency measures, improved operational practices, or the adoption of energy saving technologies. Energy savings occur when industries are able to reduce the amount of energy required for production activities without reducing the level of output or service delivery. These savings can be achieved through several strategies such as upgrading inefficient equipment, optimizing production processes, improving insulation systems, and adopting energy monitoring technologies.

Energy savings play a crucial role in reducing industrial operating costs and improving overall economic performance. In many industrial settings, energy costs represent a significant portion of production expenses. As a result, reducing energy consumption through efficiency improvements can lead to substantial financial benefits for industries. Lawal (2024) noted that implementing energy saving measures identified through energy audits can reduce industrial energy consumption by significant margins, thereby improving operational efficiency and profitability.

In addition to economic benefits, energy savings also contribute to environmental sustainability. Reduced energy consumption leads to lower greenhouse gas emissions and decreased reliance on fossil fuels. For countries such as Nigeria that are striving to balance industrial development with environmental protection, promoting energy savings within the industrial sector represents an important policy objective.

Empirical Review

Adeniran and Sanyaolu (2021) examined the relationship between electricity consumption and manufacturing sector performance in Nigeria. The study adopted a time series research design using secondary data obtained from national energy statistics and manufacturing output records between 1980 and 2018. Econometric techniques such as regression analysis and error correction modeling were used to analyze the data. The findings revealed that electricity consumption has a significant positive effect on manufacturing sector productivity in Nigeria. However, the study also showed that unreliable electricity supply forces industries to rely on alternative energy sources such as diesel generators, which increases operational costs and reduces energy efficiency within the industrial sector. The study recommended improved energy infrastructure and better energy management practices to support industrial growth.

Oyedepo (2019) conducted a study on energy efficiency and conservation measures for sustainable industrial development in Nigeria. The study used a technical assessment approach to analyze energy consumption patterns in selected manufacturing industries including cement, steel, and food processing industries. Data were obtained through energy audit assessments and operational records from industrial facilities. The results indicated that a significant amount of energy is lost through inefficient equipment, poor maintenance practices, and lack of energy monitoring systems. The study found that energy consumption in some industries could be reduced by up to 25% through the adoption of energy efficiency measures such as waste heat recovery systems, efficient motors, and improved operational management. The study emphasized the importance of regular energy audits in identifying energy saving opportunities.

Olanrewaju, Jimoh, and Kolo (2020) investigated the impact of energy consumption on industrial productivity in Nigerian manufacturing industries. The study adopted a survey research design involving selected manufacturing firms across major industrial zones in Nigeria. Data were collected using structured questionnaires administered to industrial managers and engineers responsible for production and energy management. Descriptive and inferential statistical methods were used to analyze the data. The findings showed that energy consumption significantly influences industrial productivity and operational efficiency. The study also revealed that unstable electricity supply remains one of the major factors affecting energy efficiency in Nigerian industries, leading to increased reliance on self generated power systems.

Akinwale and Ogundari (2017) examined the effect of electricity supply on industrial development in Nigeria using panel data from manufacturing industries. The study utilized econometric analysis to assess the relationship between energy supply and industrial performance indicators such as production output and operational efficiency. The results indicated that inconsistent electricity supply negatively affects industrial productivity and increases the cost of production for manufacturing firms. The study concluded that improving energy supply reliability is essential for enhancing energy efficiency and industrial competitiveness in Nigeria.

Lawal (2024) conducted an empirical assessment of industrial energy efficiency practices in selected Nigerian manufacturing firms. The study employed an energy audit framework combined with survey methods to evaluate energy management practices in manufacturing plants. Data were collected from plant managers, maintenance engineers, and energy officers. The results revealed that most industries lack structured energy management systems and operate with inefficient equipment that contributes to excessive energy consumption. The study further found that industries that implemented energy monitoring systems and energy efficiency measures experienced noticeable reductions in energy costs and improvements in operational performance.

International Energy Agency (2023) carried out a global analysis of industrial energy efficiency trends with specific reference to emerging economies. The study analyzed industrial energy consumption data across multiple developing countries including Nigeria. The findings indicated that

energy intensive industries such as cement, steel, and chemical manufacturing account for the largest share of industrial energy consumption. The report also found that implementing energy efficiency technologies and energy management systems can reduce industrial energy demand by between 15% and 30%. The study emphasized that policy support and investment in modern industrial technologies are necessary to achieve sustainable energy efficiency improvements in industrial sectors.

METHODOLOGY

The study adopted a descriptive survey research design combined with an energy audit approach to examine energy consumption patterns and efficiency within selected industrial sectors in Nigeria. The descriptive design was considered appropriate because it enables the systematic collection and analysis of data relating to energy usage, operational practices, and energy management strategies within industrial facilities. The design also allows the researcher to assess existing energy consumption behaviors and identify areas where improvements in efficiency and energy savings can be achieved. The energy audit component of the study provided a structured framework for evaluating energy flows within industrial operations and identifying potential opportunities for reducing energy losses and improving operational efficiency.

The study was conducted in selected industrial sectors in Nigeria, focusing primarily on manufacturing industries that are known to have high energy consumption levels. These include sectors such as food and beverage processing, cement manufacturing, metal fabrication, and chemical production. These sectors were selected because they represent a significant portion of industrial energy demand and contribute substantially to the country's economic activities.

The population of the study consisted of industrial facilities operating within the selected sectors in Nigeria as well as key personnel responsible for energy management and production processes within those facilities. These personnel include plant managers, production supervisors, maintenance engineers, energy officers, and technical staff who are directly involved in energy utilization and operational management within industrial plants.

A purposive sampling technique was used to select industrial establishments that met specific criteria such as high energy consumption levels, availability of production data, and willingness to participate in the energy audit assessment. Within the selected industries, relevant technical and managerial personnel were also purposively selected because they possess the required knowledge about energy use and operational processes within their facilities.

Data for the study were collected through two major instruments: an industrial energy audit checklist and a structured questionnaire. The energy audit checklist was used to obtain technical information about energy sources, equipment efficiency, energy consumption levels, operational practices, and areas of potential energy loss within the industrial facilities. The structured questionnaire was designed to gather information from industrial personnel regarding energy management practices, efficiency strategies, and perceived opportunities for energy savings.

The validity of the research instruments was ensured through expert review by specialists in energy management and industrial engineering who assessed the relevance, clarity, and adequacy of the items in relation to the objectives of the study. Reliability of the questionnaire was determined using the Cronbach alpha method to test the internal consistency of the instrument.

Data collected from the study were analyzed using both descriptive and analytical techniques. Descriptive statistics such as frequencies, percentages, mean scores, and standard deviation were used to summarize energy consumption patterns and efficiency levels across the selected industries. In addition, energy efficiency indicators such as energy intensity ratios and equipment efficiency levels were calculated to evaluate the performance of industrial operations. The findings were

presented using tables and charts to clearly illustrate patterns of energy consumption and potential opportunities for energy savings within the industrial sector.

RESULT

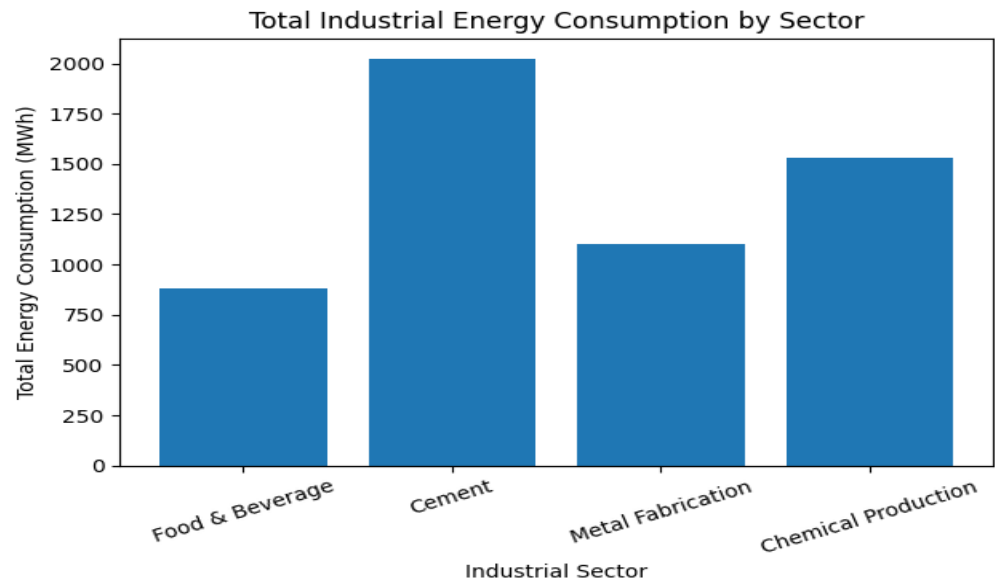


Table 1: Energy Consumption Pattern Across Selected Industrial Sectors in Nigeria

Industrial Sector	Electricity (MWh)	Diesel Equivalent (MWh Natural Gas Equivalent)	Gas (MWh)
Food and Beverage	420	310	150
Cement	860	540	620
Metal Fabrication	510	380	210
Chemical Production	640	420	470

The results show significant variations in energy consumption across the industrial sectors studied. The cement industry recorded the highest level of energy consumption across all energy sources, particularly electricity (860 MWh) and natural gas (620 MWh), indicating that cement production is highly energy intensive. Chemical production also demonstrated substantial energy use, particularly in electricity and natural gas consumption. Metal fabrication and food processing sectors recorded comparatively lower energy consumption levels, although diesel usage remained relatively high due to reliance on backup power generation. The findings highlight the strong dependence of Nigerian industries on multiple energy sources, especially diesel generators, reflecting persistent electricity supply challenges within the industrial environment.

Table 2: Energy Efficiency Levels of Major Industrial Equipment

Equipment Type	Average Efficiency (%)	Benchmark Efficiency (%)
Industrial Boilers	72	85
Electric Motors	81	90
Compressors	69	80
Production Furnaces	75	88

The table reveals noticeable gaps between the current efficiency levels of industrial equipment and recommended benchmark standards. Electric motors recorded the highest operational efficiency at 81%, though this still falls below the benchmark value of 90%. Compressors exhibited the lowest efficiency level at 69%, indicating significant energy losses during operation. Similarly, boilers and production furnaces recorded efficiency levels of 72% and 75% respectively, which are below optimal performance standards. These results suggest that many industrial facilities operate with outdated or poorly maintained equipment, resulting in unnecessary energy consumption and increased operational costs.

Table 3: Potential Opportunities for Energy Savings Identified Through Energy Audit

Energy Saving Measure	Estimated Energy Savings (%)	Estimated Cost Reduction (%)
Replacement of inefficient motors	12	10
Waste heat recovery systems	18	16
Improved insulation of steam lines	9	7
Adoption of energy monitoring systems	14	12

The energy audit revealed several opportunities for improving energy efficiency within the studied industries. Waste heat recovery systems presented the highest potential for energy savings, with an estimated reduction of 18% in energy consumption and 16% in operational costs. The adoption of energy monitoring and management systems also demonstrated considerable benefits, with potential savings of 14%. Replacement of inefficient electric motors could reduce energy consumption by approximately 12%, while improving insulation in steam distribution systems could reduce energy losses by about 9%. These findings suggest that implementing relatively practical energy management measures could substantially reduce energy consumption and operating expenses in Nigerian industries.

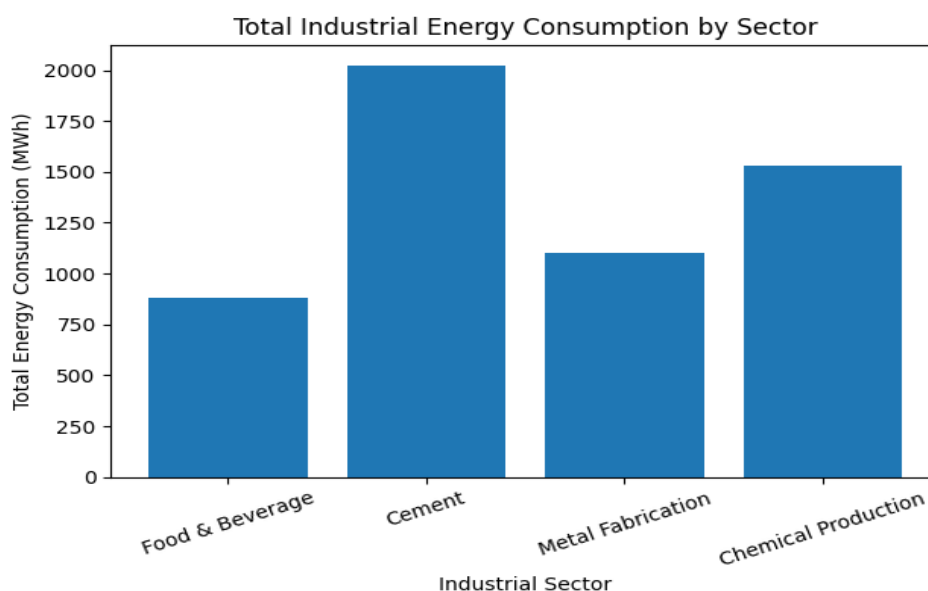
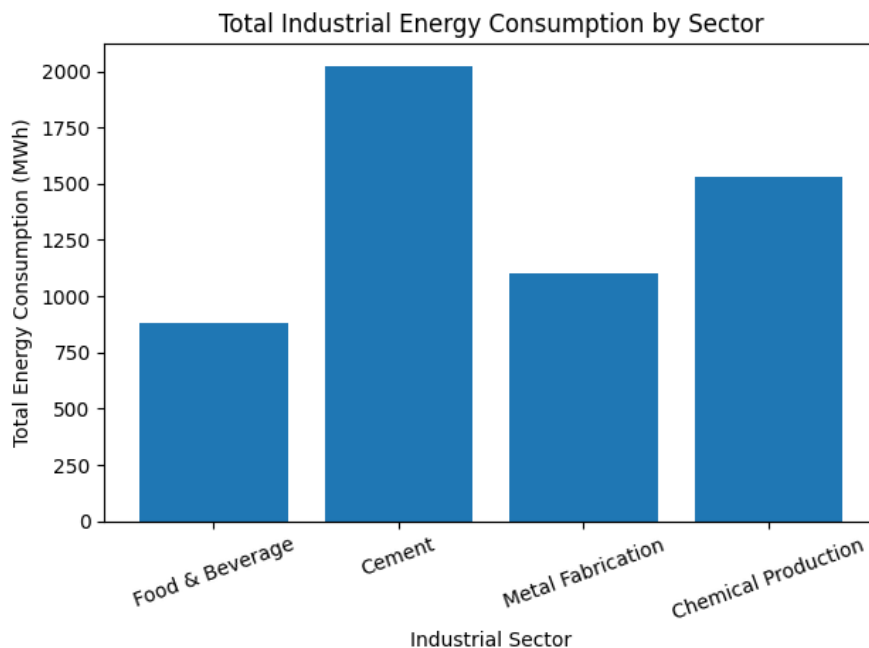


Chart: Total Industrial Energy Consumption by Sector



The chart illustrates the total energy consumption across the four industrial sectors examined in the study. The cement industry recorded the highest total energy consumption, exceeding 2000 MWh, confirming that cement production is the most energy intensive among the sectors analyzed. This high energy demand is mainly due to processes such as clinker production, grinding operations, and continuous kiln operation.

Chemical production recorded the second highest energy consumption, followed by metal fabrication. These industries require substantial amounts of electricity and thermal energy for chemical processing, heating, and heavy mechanical operations. The food and beverage sector recorded the lowest overall energy consumption among the sectors studied, although it still demonstrates notable dependence on electricity and diesel-powered backup systems. The pattern suggests that heavy manufacturing industries dominate industrial energy demand in Nigeria, highlighting the importance of targeting these sectors when implementing national energy efficiency and energy conservation policies.

Discussion of Findings

The findings of this study revealed that the cement industry recorded the highest level of energy consumption among the industrial sectors examined, followed by the chemical production sector, while the food and beverage industry consumed relatively lower energy. This result reflects the energy-intensive nature of heavy manufacturing industries such as cement production, which require continuous thermal and mechanical processes including clinker production, grinding, and kiln operations. The dominance of the cement sector in industrial energy consumption supports earlier findings that heavy industrial processes are the major drivers of industrial energy demand in developing economies. This finding is consistent with the work of Adeniran and Sanyaolu (2021) who reported that cement and chemical manufacturing industries in Nigeria account for a large proportion of industrial electricity demand due to their reliance on high-temperature processing and continuous production cycles. Similarly, IEA (2023) observed that energy-intensive industries such as cement and chemicals are responsible for a significant share of industrial energy use in emerging economies because of their high thermal energy requirements.

The study also found that many industrial facilities operate with equipment efficiency levels below recommended benchmark standards. Compressors, boilers, and industrial furnaces recorded efficiency levels significantly lower than global benchmark values, indicating substantial energy losses within production systems. This suggests that many Nigerian industries still rely on outdated equipment or poorly maintained machinery, which contributes to inefficient energy utilization and increased operational costs. This finding agrees with the study of Lawal (2024) which reported that inefficient industrial equipment and poor maintenance culture are major causes of energy wastage in Nigerian manufacturing industries. Similarly, Oyedepo (2019) observed that energy inefficiency in Nigeria's industrial sector is largely attributable to aging equipment, lack of energy management practices, and limited adoption of modern energy-efficient technologies.

Another important finding of the study is that significant opportunities exist for energy savings within Nigerian industries through measures such as waste heat recovery, replacement of inefficient motors, improved insulation of steam systems, and the adoption of energy monitoring technologies. Among these measures, waste heat recovery systems showed the highest potential for energy savings. This result demonstrates that substantial energy reductions can be achieved through relatively practical efficiency improvements without necessarily expanding energy supply. The finding supports the argument of International Energy Agency (2023) that industrial energy efficiency improvements can reduce energy consumption by 15–30% in many developing countries when modern energy management practices are implemented. In addition, Energy Commission of Nigeria (2022) emphasized that energy auditing and monitoring systems are effective tools for identifying inefficiencies and improving energy performance within industrial facilities.

Furthermore, the study revealed that industries still rely heavily on multiple energy sources, including diesel generators, to sustain production due to unstable electricity supply. This dependence increases energy costs and reduces overall energy efficiency within industrial operations. The finding aligns with the study of Olanrewaju, Jimoh, and Kolo (2020) who reported that unreliable public electricity supply forces many Nigerian industries to depend on self-generated power, thereby increasing production costs and reducing industrial competitiveness. In the same vein, Akinwale and Ogundari (2017) earlier noted that inconsistent electricity supply remains one of the major challenges affecting industrial productivity and energy efficiency in Nigeria.

CONCLUSION

This study examined energy consumption patterns and efficiency levels across selected industrial sectors in Nigeria with the aim of identifying opportunities for energy savings through energy audit practices. The findings revealed that energy consumption varies significantly across industrial sectors, with heavy industries such as cement and chemical production accounting for the largest share of industrial energy demand. These sectors require substantial electrical and thermal energy due to the nature of their production processes. The analysis further showed that many industries rely on multiple energy sources, including diesel-powered generators, as a response to unstable electricity supply. This dependence contributes to higher production costs and inefficient energy utilization within industrial operations.

The study also revealed that the efficiency levels of major industrial equipment such as compressors, boilers, and furnaces remain below internationally recommended benchmarks, indicating the presence of considerable energy losses within production systems. However, the energy audit identified several practical opportunities for improving industrial energy efficiency, including waste heat recovery, replacement of inefficient motors, improved insulation of steam systems, and the adoption of energy monitoring technologies. The results demonstrate that significant energy savings can be achieved in Nigerian industries through improved energy management practices and modernization of industrial equipment. Improving energy efficiency in the industrial sector will not

only reduce operational costs but also enhance industrial productivity and contribute to sustainable economic development in Nigeria.

RECOMMENDATIONS

1. The Federal Government of Nigeria through the Energy Commission of Nigeria and the Ministry of Power should strengthen national policies that promote industrial energy efficiency.
2. Industrial organizations should prioritize the modernization and replacement of inefficient equipment such as outdated motors, compressors, and boilers.
3. Government agencies responsible for industrial development should provide financial incentives such as tax credits, energy efficiency grants, and low interest financing to support industries in adopting energy saving technologies and implementing energy audit recommendations.
4. Industrial firms should adopt structured energy management practices including continuous monitoring of energy consumption, routine maintenance of energy systems, and training of technical personnel on energy efficiency practices.

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