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EVALUATION OF ENERGY DEMAND IN NIGER'S CONSTRUCTION SECTOR: A PROJECTION TO 2035

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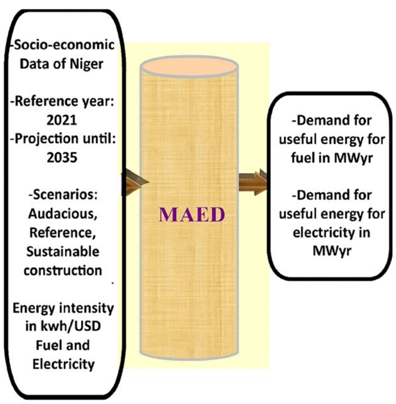
Graphical abstract



Abstract

The construction sector in Niger faces significant energy and environmental challenges. Sustained population growth (3.9% in 2021) and rapid urbanization (4.5% in 2021) have led to a substantial increase in the demand for residential, administrative, and commercial buildings. This trend, expected to continue, is driven by the expansion of mining activities (notably crude oil and uranium exports), the strengthening of agricultural infrastructure (hydro-agricultural developments), and the implementation of large-scale construction and road projects. These dynamics have resulted in growing energy consumption, mainly associated with the use of motorized equipment. However, construction practices remain largely traditional and insufficiently integrate the principles of energy efficiency and sustainability. The absence of a systemic approach to energy performance limits the sector's ability to address climate challenges and meet sustainable development goals. The central objective of this study is to identify mechanisms to promote a sustainable and energy-efficient construction model in Niger one that reconciles the reduction of future energy demand with the increasing need for housing and infrastructure. Specifically, the study aims to: (i) assess the energy demand (fuel and electricity) of the construction sector by 2035, in line with the Sustainable Development and Inclusive Growth Strategy – Niger 2035; and (ii) identify the scenario that achieves the greatest potential energy savings. The methodology is based on the MAED (Model for Analysis of Energy Demand) tool, a forward-looking modeling framework grounded in a techno-economic approach. Three scenarios have been developed: Reference scenario extending current trends; Audacious scenario combining strong economic growth with no energy efficiency measures; and Sustainable construction scenario combining sustained growth with the adoption of high-performance technologies. The main parameters considered include GDP growth, energy intensity, sectoral productivity, and equipment efficiency. Simulation results for 2035 indicate a total energy demand of 69 MWyr under the reference scenario (66.75 MWyr of fuel and 2.24 MWyr of electricity), 163.67 MWyr under the audacious scenario (158.33 MWyr of fuel and 5.34 MWyr of electricity), and 94.53 MWyr under the sustainable construction scenario (91.38 MWyr of fuel and 3.15 MWyr of electricity). The sustainable construction scenario would thus enable substantial energy savings, provided that concrete measures are implemented such as the adoption of high-efficiency equipment, the use of low-energy lighting, and the widespread application of sustainable construction practices, particularly in rural areas.

Keywords: energy intensity, energy planning energy saving, sustainable construction

1.0 INTRODUCTION

The construction sector plays a strategic role in Niger's economic development. It is a key driver of job creation, infrastructure modernization, and improvements in living conditions. Construction activity has grown at a relatively higher rate than other branches of the secondary sector, with an increase of 8.9% in 2021 compared to 3.2% in 2020 [1]. The added value of the construction sector accounted for around 5% of GDP in 2021 [1]. However, this expansion is accompanied by high energy consumption mainly fuel and electricity required for the operation of construction equipment, the production of building materials, and the domestic and tertiary uses of completed structures. Strong population growth (3.9% in 2021 [2]) and rapid urbanization (4.5% in 2021 [3]) are further increasing energy demand, particularly for fuel and electricity in construction activities.

In a national context characterized by limited energy supply, almost total dependence on petroleum products, and low integration of renewable energies, this growing energy demand in the construction sector raises several concerns. On one hand, it exerts additional pressure on national energy resources and public finances; on the other hand, it risks exacerbating greenhouse gas emissions and undermining the energy efficiency and sustainability goals set out in the Sustainable Development and Inclusive Growth Strategy (SDDCI–Niger 2035) [4].

The central issue addressed in this study is therefore how to manage future energy demand in the construction sector amid sustained economic and demographic growth. This challenge can be summarized by the following question: How can Niger plan and anticipate changes in energy demand in its construction sector by 2035, while promoting sustainable development and improved energy efficiency? To answer this question, it is essential to identify the main determinants of energy consumption such as population growth, urbanization, public investment, technological innovation, and construction standards and to assess their impacts through various scenarios.

The use of the MAED (Model for Analysis of Energy Demand) model is particularly relevant in this context, as it enables the simulation of energy demand based on socio-economic and technological parameters, while evaluating the effects of alternative energy policies.

This study is justified by the need to provide public decision-makers and construction sector stakeholders with a robust analytical framework for energy planning, the promotion of energy-efficient technologies, and the implementation of sustainable construction strategies. It also contributes to the scientific literature on energy forecasting in Sahelian countries, where long-term data and analyses remain scarce.

The overall objective of this study is to assess the future energy demand of Niger's construction sector by 2035, taking into account socio-economic dynamics, public policies, and the development orientations defined within the SDDCI–Niger 2035 framework. Specifically, the study aims to: (i) quantify energy consumption in the construction sector during building activities; (ii) develop and simulate different future scenarios (reference, audacious, and sustainable construction) using the MAED model to anticipate possible trends in fuel and electricity demand; (iii) compare the results of these scenarios to identify the one that best promotes energy demand management and minimizes excessive consumption; and (iv) propose technical and policy measures to enhance energy efficiency in the construction sector while supporting economic growth and environmental sustainability.

The originality of this study lies in the fact that it represents one of the first in-depth prospective analyses of energy demand in Niger's construction sector. While most existing research focuses on the residential, industrial, or transport sectors, the construction sector remains relatively underexplored, despite its growing role in the country's economic development and urbanization.

Several approaches have been explored to estimate future fuel consumption and energy demand in the construction sector. For instance, [5] highlights the difficulties faced by researchers in estimating fuel consumption for construction vehicles due to data limitations and differing assumptions regarding energy use. [6] proposes a method for estimating fuel consumption and energy resources on low-rise building construction sites. [7] presents an innovative predictive model for estimating, from the planning stage, fuel consumption and CO_2 emissions associated with earthworks in residential construction projects based on technical documentation. [8] analyzes the drivers of high energy consumption in China's construction sector using economic analysis methods and chronological input-output tables. [9] proposes a method for estimating energy consumption throughout a building's life cycle, incorporating operational energy (heating, cooling, ventilation, lighting, equipment), embodied energy (production and maintenance), and demolition energy (deconstruction and material transport). [10] discusses energy-saving measures in building construction, emphasizing the use of modern equipment and mechanized techniques. Similarly, [11] advocates for the development of sustainable, energy-efficient, and low-carbon buildings, encouraging the use of local materials.

The forward-looking approach developed in this study provides an integrated perspective on the interactions between economic growth, technological choices, and energy consumption in the construction sector.

From a scientific perspective, this research contributes to the literature on energy modeling and planning in Sahelian countries, where long-term data and prospective analyses remain limited. It underscores the importance of integrating parameters related to energy efficiency, building sustainability, and the energy transition into national development policies.

From a practical perspective, the results of this study offer a valuable decision-making tool for policymakers, energy planners, and construction stakeholders. They help identify the most effective technological and policy options for managing future energy demand growth, reducing construction site operating costs, and promoting sustainable buildings suited to Niger's climatic conditions.

In summary, this study fills both a scientific and strategic gap by providing a solid analytical foundation for energy planning in the construction sector and for the formulation of energy efficiency policies for 2035.

The methodology used is detailed in the second part of the article, the results and their analysis are presented in the third part, and the conclusion is outlined in the fourth part.

2.0 METHODOLOGY

2.1 Conceptual Framework and Approach

The assessment is based on a forward-looking analysis of energy demand in the construction sector using the MAED (Model for Analysis of Energy Demand) framework. This model establishes a systematic relationship between the energy required for the production of goods and services and the social, economic, and technological factors influencing this demand. Energy demand is disaggregated into numerous end-use categories, each corresponding to a specific service or the production of a particular good. The level and nature of this demand depend on several determining factors, including population growth, average household size, the number and types of electrical appliances, population mobility and transport preferences, national industrial and sectoral development priorities, changes in equipment efficiency, and the penetration of new technologies or energy sources in the market. The total energy demand from each end-use category is then aggregated into four major consuming sectors: Industry (including agriculture, construction, mining, and manufacturing), Transport, Households, and Services. The MAED model thus enables the quantification of the impact of changes in economic or social parameters such as lifestyle evolution or technological development—on overall energy demand [12].

The use of the MAED model involves two main stages. The first consists of constructing the energy consumption structure for the base year, following the model's format. This step entails distributing energy consumption data by sector and by end use to obtain a balanced final energy balance for the reference year, thereby calibrating the model to the specific energy situation of the country. The second stage involves developing forward-looking scenarios adapted to the national context and development objectives. These scenarios are generally divided into two subcategories: the socio-economic sub-scenario, which describes the fundamental characteristics of national social and economic development; and the technological sub-scenario, which focuses on factors affecting energy demand, such as equipment efficiency, available technologies, and the market penetration of various energy sources. The projected energy demand generated by the MAED model directly reflects the assumptions adopted in each scenario. It is therefore essential to ensure the internal consistency of these assumptions particularly regarding social, economic, and technological dynamics in order to guarantee the plausibility and reliability of the results [12].

In this study, the analysis of energy demand in Niger's construction sector covers the period 2021–2035, with a five-year time step, and follows three main stages: Baseline development: collection and processing of historical data on construction activity (types of buildings, roads, and infrastructure).

Scenario formulation: definition of contrasting trajectories based on alternative energy and technology policies.

Simulation and analysis: estimation and interpretation of projected energy demand under each scenario.

2.2 Input Data and Parameters

The year 2021 was selected as the base year for running the MAED model, as it is relatively recent and was not marked by major disruptions in the energy or economic sectors. Moreover, complete statistical and energy balance data are available for this year. The projection years chosen for the prospective analysis are 2025, 2030, and 2035.

Energy data (from the 2021 national energy balance) were obtained from the Department of Energy. Additional energy, demographic, and economic data particularly the sectoral composition of GDP were collected from several institutions, including the National Institute of Statistics (INS), the World Bank, the International Monetary Fund (IMF), the Ministry of Economy and Finance, the Ministry of Planning, and other official and institutional sources.

The socio-economic data for the reference year are summarized in Table 1, based on sources [1], [13], and [14].

Table 1 Socio-economic data for the reference year (2021)

Object	Unity	2021
Population *	Million	23.59
Population growth rate *	%	-
Urban Population	%	16.80
Person/ urban Household	cap	7
Number of urban Households	Million	0.57
Rural Population	%	83.20
Person/ rural Household	cap	7.40
Number of rural Households	Million	2.65
Potential Labour Force	%	48.67
Participating Labour Force	%	73.86
Active Labour Force	Million	8.48
Population in cities with public transport	%	20
GDP	US$ Billion	13.85
GDP growth rate	% p.a.	-
per capita GDP	US$/Cap	587.23
Distribution by sector of GDP		
Agriculture	%	36.57
Construction	%	5
Mining	%	8
Manufacturing	%	8.4
Service	%	40.3
Energy	%	1.73
Total	%	100

Table 2 presents the final fuel consumption (in toe) by type of housing constructed in 2021, based on data from [1] and [13].

Table 2 Final Fuel Consumption in toe by Types of dwellings Constructed in 2021

Types of dwellings	Type-specific percentages %	Number of Units	Final Fuel Consumption (toe)
Villa - hard - semi-hard - bank	20	22,953	4,016.65
Apartments/Condominiums	15	17,215	5,000.27
Single-person housing	30	34,429	1,769.88

Table 3 presents the final fuel consumption (in toe) by type of road constructed in 2021, based on data from [1] and [13].

Table 3 Final Fuel Consumption in tons of oil equivalent (toe) by Road Type Constructed in 2021.

Road and Rehabilitation	Distance (km)	Final Fuel Consumption (toe)
Upgrading of unpaved roads	36,5	291,85
Linear length of rural roads constructed	293,97	3726,78
Linear length of paved roads constructed	145,95	1788,46
Length of rehabilitated paved roads.	122,7	536,52
Length of rehabilitated dirt roads	44,7	343,78
linear length of constructed urban roads	20,51	258,19

Table 4 presents the annual electricity consumption (in toe) by type of housing constructed in 2021, based on data from [1] and [13].

Table 4 Annual Electricity Consumption by Types of dwellings

Types of dwellings	Type-specific percentages %	Number of Units	Annual Electricity Consumption (toe)
Villa – hard – semi-hard – bank	20	22,953	357.22
Apartments/ Condominiums	15	17,215	270.88

Figure 1 presents the evolution of value added in the construction sector relative to GDP, based on data from [1].

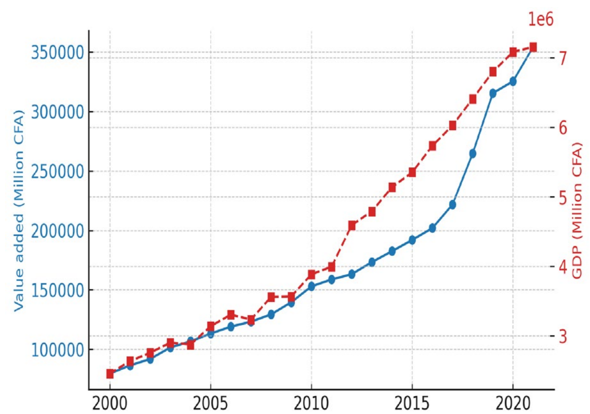


Figure 1 Change in the value added of the construction sector relative to GDP

In 2021, the value added of the construction sector accounted for 5% of GDP, compared with 3.9% in 2010 and 3.2% in 2000. Between 2000 and 2021, national GDP increased by 190.6%**,** while the value added of the construction sector rose by 344%. These trends reflect the dynamism and sustained growth of the sector, which has become one of the key drivers of economic development in Niger.

2.3 Construction of Scenarios

Three prospective scenarios have been developed for the period 2021–2035, each based on different assumptions regarding economic, demographic, and technological growth.

Table 5 presents the study's assumptions for demographic and economic growth, based on data from [4], [15], [16], and [17].

Table 5 Assumptions Regarding Demographic and Economic Growth

Scenarios		Year		
		2021-2025	2025-2030	2030-2035
Reference (%)	Demographics	3.9	4	4.1
	Economy	5.9	6	6.2
Ambitious (%)	Demographics	3.7	3.5	3.2
	Economy	7.7	7.7	7.8
Sustainable Construction (%)	Demographics	3.7	3.5	3.2
	Economy	7.7	7.7	7.8

2.3.1 Reference Scenario (RS)

Assumption: Continuation of current socio-economic trends. Population growth: 3.9% in 2021 → 4.1% in 2035. Economic growth: Approximately 6% per year.

Characteristics: Continuation of existing policies, strong pressure on natural resources, predominance of the rural sector.

Objective: To provide a realistic baseline for comparison [4], [16], [17].

2.3.2 Audacious Scenario (AS)

Assumption: Accelerated economic growth driven by PDES-related investments.
Population growth: 3.7% in 2021 → 3.2% in 2035. Economic growth: Average annual rate of 7.7%. Characteristics: Increased industrialization, rapid expansion of the construction sector, absence of energy efficiency measures.

Objective: To illustrate a trajectory of high energy demand [4], [16], [17].

2.3.3 Sustainable Construction Scenario (SCS)

Assumption: Identical demographic and economic growth as in the Audacious Scenario, but with the implementation of energy efficiency policies. Integrated measures: Progressive reduction of the sector's energy intensity, mandatory high-performance building standards for public and commercial facilities, systematic use of low-energy lighting, replacement of obsolete equipment with high-efficiency devices, and nationwide awareness campaigns for households. Objective: To assess the potential for energy savings in the construction sector [4], [15], [16], [17].

2.3.4 Assumptions and Justification

Assumptions regarding population and economic growth are based on projections by the National Institute of Statistics (INS) [1], [13], derived from the Sustainable Development Strategy for Inclusive Growth (SDDCI 2035) [4], the Economic and Social Development Plan (PDES 2022–2026) [16], the International Monetary Fund (IMF) [17], and the World Bank [14]. Energy yields and equipment load factors were estimated from the South Coast Air Quality Management District (1993) [5] and the MAED-IAEA database [12].

These parameters ensure consistency with national conditions, comparability with regional studies, and scientific reproducibility of the modelling approach.

2.3.5 Validation and Reliability

The results generated by the MAED model were compared with national statistics from *SIE-Niger* (2010–2021) and regional energy balances from *UEMOA*, in order to verify their internal consistency and plausibility for the 2035 horizon.

2.4. Estimation of Energy Consumption

This study evaluates energy consumption in Niger's construction sector by considering two main energy forms:

Fuel: Calculated based on the annual consumption of motorized equipment (excavators, loaders, compactors, graders, pump trucks, etc.) used in housing and road construction or rehabilitation.

Electricity: Estimated from the annual consumption of electrical construction equipment (lighting, jackhammers, metal fabrication tools, etc.) primarily used in building works.

2.4.1 Estimation of Fuel Consumption

The annual fuel consumption of construction equipment is calculated using Equation (1), according to the method proposed in [5]:

$$E = \sum(Q \times HP \times H \times LF \times FCR)$$
$$E = \sum(Q \times HP \times H \times LF \times FCR) \quad (1)$$

With:

Quantity of equipment (Q): total number of units used for the specific task;

Power (HP): nominal power of the equipment (*1 hp = 0.746 kW*);

Operating hours (H): total annual hours of operation;

Load factor (LF): average proportion of nominal power actually used;

Fuel consumption rate (FCR): quantity of fuel consumed per vehicle, per horsepower, and per hour of operation.

For diesel-powered equipment, an average FCR value of 0.05 gallons per vehicle-horsepower-hour is adopted, as recommended by the *South Coast Air Quality Management District (1993)* [5].

2.4.2 Estimation of Electricity Consumption

The annual electricity consumption is calculated using Equation (2), following the approach proposed in [18]:

$$Ec = \frac{(P \times T \times N)}{1000} \quad (2)$$

With:

Ec: annual electricity consumption (kWh);

P: electrical power of the equipment (W);

T: total number of operating hours per day (h);

N: total number of operating days per year [18].

2.4.3 Energy Intensity Analysis

Figures 2 and 3 present the projected energy intensity for motive power (fuel) and specific electricity uses, respectively, under the three scenarios considered (Reference, Audacious, and Sustainable Construction) over the period 2021–2035.

This analysis allows for a comparative assessment of the efficiency of energy use in the construction sector and highlights the potential impacts of different policy and technological measures on future energy consumption patterns.

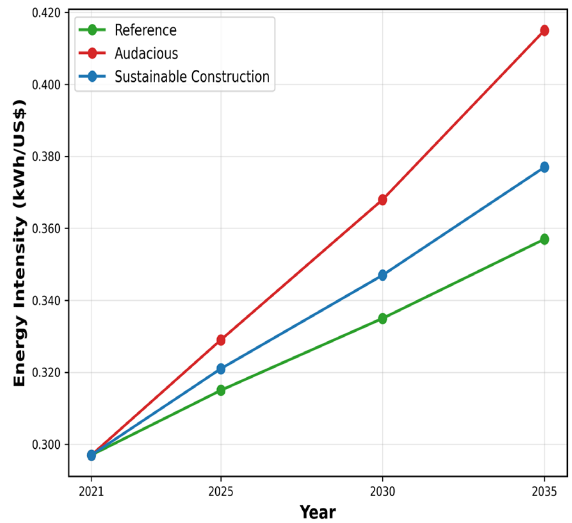


Figure 2 Fuel Energy Intensity for the Three Scenarios

The analysis of fuel energy intensity reveals contrasting dynamics across the three scenarios.

In the Reference Scenario, energy intensity rises from 0.297 to 0.357 kWh/US$, representing an increase of 20% over the period 2021–2035. This change reflects an increase in energy consumption per unit of economic output, indicating a moderate improvement in the sector's energy efficiency. Energy demand is therefore growing faster than the value added produced.

In the Audacious Scenario, fuel energy intensity increases more sharply, from 0.297 to 0.415 kWh/US$, or +40% over the same period. This rapid rise reflects uncontrolled energy growth, with consumption increasing faster than economic output. Characterized by accelerated industrialization and rapid urbanization, this scenario is more energy-intensive in the short and medium term, before gradually stabilizing in the long term.

Conversely, in the Sustainable Construction Scenario, energy intensity rises only from 0.297 to 0.377 kWh/US$, or +27% over the study period. This moderate increase illustrates sustained growth with improved energy efficiency, due to the adoption of high-performance building standards, integration of sustainable materials, and deployment of energy-efficient technologies. This scenario demonstrates the potential to balance economic growth with energy efficiency, thereby supporting a more sustainable development pathway.

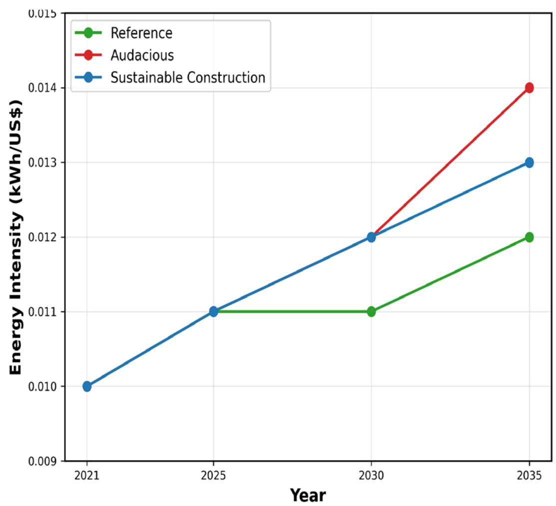


Figure 3 Energy Intensity for Specific Uses of Electricity

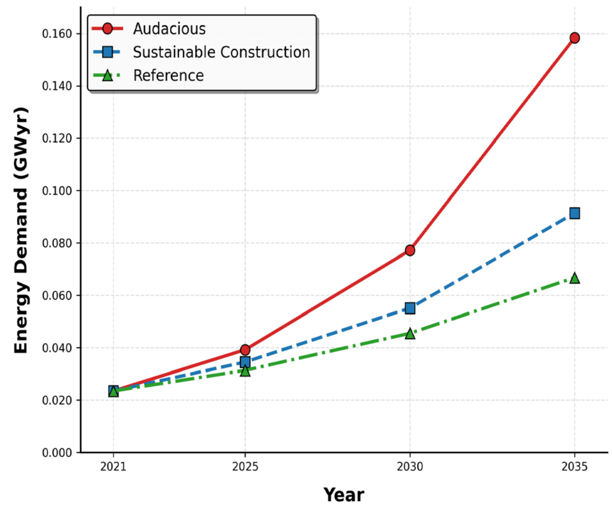


Figure 4 Useful Energy Demand for Motive Power

The evolution of energy intensity associated with specific electricity uses exhibits contrasting trends across the scenarios.

In the Reference Scenario, energy intensity increases from 0.010 to 0.012 kWh/US$, representing a 20% rise. This slow but steady growth indicates moderate increases in electricity consumption per unit of economic output, reflecting a conventional economic model with limited technological advancement and virtually stagnant energy efficiency.

In the Audacious Scenario, energy intensity rises more sharply, from 0.010 to 0.014 kWh/US$, or +40%, indicating that electricity consumption grows faster than economic output despite strong economic performance. This scenario represents an energy-intensive trajectory, driven by accelerated industrialization and urbanization.

Conversely, in the Sustainable Construction Scenario, energy intensity increases moderately from 0.010 to 0.013 kWh/US$, or +30%. This trend demonstrates the effect of sustainability and energy efficiency policies, where electricity consumption grows in a controlled manner while supporting economic growth.

3.0 RESULTS AND DISCUSSION

Analysis of the MAED simulation results for the three scenarios reveals contrasting implications for the development of the construction sector in Niger and highlights critical energy policy considerations.

Figures 4 and 5 illustrate the useful energy demand for motive power (fuel) and for specific electricity uses, respectively.

With regard to motive power (fuel), particularly high energy growth is observed in the Audacious Scenario. Energy demand rises from 23.5 MWyr in 2021 to 158.3 MWyr in 2035, representing an increase of 574%. The Sustainable Construction Scenario exhibits more moderate growth, with demand increasing from 23.5 MWyr to 91.4 MWyr, corresponding to an increase of 289%. Finally, the Reference Scenario shows the lowest growth, rising from 23.5 MWyr to 66.8 MWyr, an increase of 184%.

For useful energy demand dedicated to specific electricity uses, the Audacious Scenario exhibits the highest growth, increasing from 0.79 MWyr in 2021 to 5.34 MWyr in 2035, corresponding to a 575% rise. The Sustainable Construction Scenario shows moderate growth, with demand rising from 0.79 MWyr to 3.15 MWyr, an increase of 298% over the period 2021–2035. Finally, the Reference Scenario shows the lowest growth, with demand increasing from 0.79 MWyr to 2.24 MWyr, representing a 184% increase between 2021 and 2035.

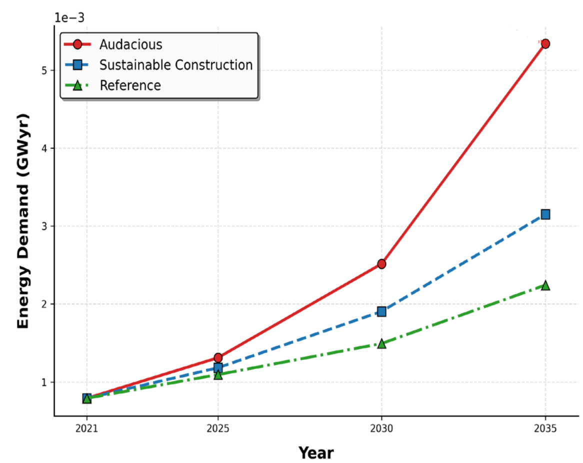


Figure 5 Useful Energy Demand for Specific Electricity Use

Figure 6 illustrate the Total Final Energy Demand in the Construction Sector. The results for total final energy demand in 2035 indicate the following:

In the Reference Scenario, total energy demand reaches 69 MWyr, of which 66.75 MWyr corresponds to fuels and 2.24 MWyr to electricity. This scenario reflects the continuation of the status quo, characterized by limited adoption of high-performance technologies and a lack of energy efficiency measures in construction. In this context, the construction sector lags in terms of innovation, productivity, and sustainability. Current infrastructure investment policies, although significant [3], [4], do not allow energy growth to be controlled or dependence on fossil fuels to be reduced. Without technological and regulatory reforms, the sector risks maintaining high energy intensity and placing increasing pressure on the national energy system.

In the Audacious Scenario, total energy demand rises sharply to 163.67 MWyr by 2035 (including 158.33 MWyr for fuels and 5.34 MWyr for electricity), compared with 24.27 MWyr in 2021. This rapid increase reflects accelerated construction activity driven by major investment projects, including the construction of the second refinery in Dosso [19], hydro-agricultural developments [20], road infrastructure, and residential and commercial buildings [21], [22], [23]. However, this scenario does not incorporate any energy-saving measures: equipment modernization remains limited, and the use of energy-efficient devices is marginal. As a result, economic expansion is accompanied by high energy intensity and increased emissions. In 2035, total energy demand in the Audacious Scenario is 137% higher than in the Reference Scenario, highlighting potential challenges for energy security and environmental sustainability, especially given fuel price volatility and growing reliance on energy imports.

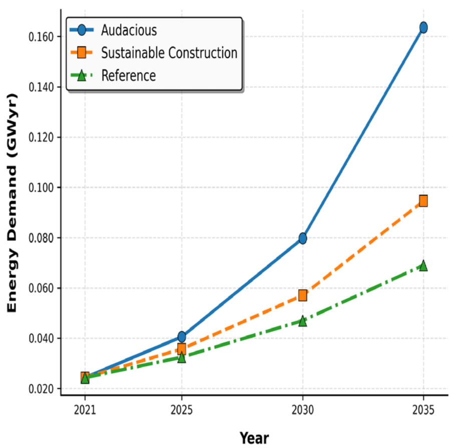


Figure 6 Total Absolute Final Energy Demand in Construction

The Sustainable Construction Scenario shows a significant reduction in energy demand, with a total of 94.53 MWyr, of which 91.38 MWyr is for fuels and 3.15 MWyr for electricity. Compared to the Audacious Scenario, this represents a final energy saving of approximately 41%. This performance results from the adoption of efficient technologies (high-efficiency motorized equipment, high-performance lighting systems) and energy efficiency measures in buildings (bioclimatic design standards, thermal insulation, use of low-energy lighting) [4], [15], [16]. These results are consistent with previous studies [10, 11], which demonstrate that modernizing construction processes can reduce energy demand by 30–45%.

A comparison with similar studies in the sub-region shows converging trends. For example, a study conducted in Nigeria [24] highlights the potential for energy savings in construction through measures such as the use of modern biomass for thermal fuels and solar energy for lighting, replacing firewood and diesel generators, thereby promoting sustainable construction practices.

Integrating sustainable construction principles in Niger would not only reduce energy consumption but also limit greenhouse gas emissions, improve climate resilience, and attract international green investment. The difference between the Audacious Scenario and the Sustainable Construction Scenario amounts to 37%, clearly demonstrating that the sector's energy future will depend heavily on technological and policy decisions made over the coming decade.

In the Audacious Scenario, rapid sector growth without energy management would increase economic vulnerability and pressure on fossil resources. In contrast, the Sustainable Construction Scenario offers a sustainable pathway, reconciling economic development, energy efficiency, and environmental sustainability.

A specific feature of the Nigerien context is the predominant role of fuel, which accounts for more than 90% of the sector's energy demand. This emphasizes the urgency of developing alternative solutions for heavy construction equipment, potentially through electrification or biofuels.

3.1 Policy Implications

The results underscore the strategic importance of the construction sector in Niger's national energy dynamics and the need to integrate energy efficiency measures into public policy.

Control of energy demand: Scenario analysis indicates that, without energy efficiency measures, demand in the construction sector could grow rapidly, increasing pressure on national energy resources and reinforcing dependence on fossil fuel imports. This justifies the introduction of sustainable construction standards and sector-specific energy regulations, including energy performance requirements for public, residential, and commercial buildings.

Adoption of efficient technologies: Implementing modern, energy-efficient technologies in construction can significantly reduce future energy demand. The government could support this transition via tax incentives, green financing mechanisms, and the promotion of local low-carbon materials.

Cross-sectoral planning: Strengthening coordination between ministries responsible for energy, construction, and the environment would ensure consistency between urbanization, land use planning, and energy transition policies.

Monitoring and capacity building: Enhancing technical and institutional capacity to monitor energy consumption in the construction sector is essential. Developing a national system for monitoring building energy indicators would support better policy evaluation and more sustainable investment planning.

These implications extend beyond analysis alone, providing a foundation for integrated energy policy that reconciles construction sector growth, national energy security, and Niger's sustainable development objectives for 2035.

3.2 Limitations of the Study

Despite providing relevant information for energy planning, several methodological limitations should be acknowledged:

Data availability and reliability: Statistical information on energy consumption specific to the construction sector remains fragmented and often aggregated with other sectors. This necessitated the use of estimates and extrapolations from secondary sources, which may affect accuracy.

Environmental and behavioral aspects: The study does not include a detailed analysis of environmental impacts, particularly greenhouse gas emissions, nor does it thoroughly examine behavioral factors influencing the adoption of energy-efficient technologies. These aspects warrant further investigation.

Time horizon: The analysis is limited to 2035, in line with the SDDCI-Niger 2035 framework. A longer-term projection would allow for a more accurate assessment of cumulative effects from energy efficiency policies and renewable energy adoption.

Despite these limitations, the results provide a solid analytical basis for energy planning and constitute a relevant starting point for further research incorporating more dynamic modeling and updated sectoral data.

4.0 CONCLUSION

This study assessed the energy demand of the construction sector in Niger for the period 2021–2035 using the MAED model, considering three scenarios: Reference, Audacious, and Sustainable Construction. The results for 2035 indicate the following: Reference Scenario: 69 MWyr (fuel + electricity); Audacious Scenario: 163.67 MWyr (158.33 MWyr of fuel and 5.34 MWyr of electricity); Sustainable Construction Scenario: 94.53 MWyr (91.38 MWyr of fuel and 3.15 MWyr of electricity). The Sustainable Construction Scenario demonstrates the potential to significantly reduce energy consumption while supporting sustained economic growth. Achieving this goal requires the promotion of sustainable and energy-efficient construction practices, the adoption of low-energy lighting, and an estimated investment of approximately US$16 million to support energy efficiency in buildings. Finally, future research could focus on the environmental impacts of energy consumption and evaluate the benefits of transitioning to more sustainable construction practices, particularly in terms of greenhouse gas emissions and climate resilience.

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Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper

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