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Towards reducing energy consumption in Algeria to ensure energy security: an econometric study for the period 2006-2025

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Abstract:
This research paper aims to highlight the role of an energy consumption reduction policy in ensuring energy security in Algeria. Specifically, it seeks to identify the key factors contributing to increased energy consumption and consequently affecting energy security in Algeria as a whole. Adopting an analytical descriptive approach, the study examines the impact of several significant variables on energy consumption in Algeria. The study also focuses on the econometric methods used to construct a model that explains the effect of these variables on Algeria's energy consumption between 2006 and 2025.
The study's findings suggest that two key variables — population size and the national vehicle fleet have a statistically significant positive impact on energy consumption. In contrast, the variable related to the national housing stock has a statistically significant negative effect on energy consumption. These results imply an associated impact on Algeria's energy security status. Accordingly, the research concludes that reducing energy consumption to ensure energy security in Algeria hinges on controlling the aforementioned variables.
Keywords: energy, energy consumption, energy security, ensuring energy security.

1. Introduction

Energy is a key focus for researchers and key state actors (L. Obanor, Nisoshili, Goodness & Oluwafikunolami, 2026, p. 2). This is due to the prominent position of energy resources, particularly oil and natural gas, within the global economy, international relations and global markets. Furthermore, rapid transformations in this area are being driven by developments in contemporary technology, military capabilities and biology (Nynke, Daniel, Giovanni, Roman and Lorenzo, 2026, p. 1). These changes have also influenced states' energy policies in terms of both production and consumption.
In light of these transformations affecting the global energy sector, all impacted countries—whether energy producers or consumers—seek to adopt an energy-based economic approach to protect themselves from external energy shocks and disturbances relating to prices or supplies (Ivanovski & Bernard, 2026, p. 26). Energy-consuming countries implement such a strategy to ensure the continuity of energy imports from abroad. Conversely, energy-producing

countries aim to secure the ongoing provision of these resources to external markets at prices that align with their strategic objectives while ensuring energy consumption within their domestic economy.

Against this backdrop, where both energy-producing and energy-consuming countries are pursuing their respective goals, the concept of energy security has emerged as a central issue, encompassing all these considerations.

As a country with substantial underground reserves of oil and natural gas and a leading energy producer, Algeria must focus its economic attention on the priorities of energy-producing countries. Accordingly, it must adjust its energy policy to ensure the continuity of external supplies of these resources at compatible prices, and to guarantee coverage of internal consumption.

This is particularly important given that Algeria's energy consumption levels are currently experiencing a difficult period, driven by record indicators observed during the first two decades of the third millennium. Such growth threatens the future achievement of energy security in Algeria.

In light of this key issue, a policy has emerged that aims to contribute to ensuring energy security in Algeria in the coming period. This policy is energy consumption reduction. Therefore, this study seeks to address the following research problem:

Research problem (research question): To what extent can reducing energy consumption contribute to ensuring energy security in Algeria?

Subject/topical scope

This research paper is concerned with energy security, approached through the lens of reducing energy consumption in Algeria.

The study examines the relationship between several variables related to energy consumption in Algeria over the period from 2006 to 2025.

The paper addresses energy consumption and energy security in Algeria, a country that produces conventional energy resources.

Research methodology and tools

In this study, we adopted a descriptive approach, as this aligns with the nature of the research and the presentation of fundamental energy-related concepts. We also used the analytical approach to interpret the impact of certain variables on energy consumption.

Furthermore, standard econometric modelling methods were employed using the statistical software package EViews 12 in an attempt to develop a model capable of explaining the impact of selected variables on energy consumption. Energy consumption is an important component of energy security in Algeria.

2. Literature Review: The Energy Sector

Energy is a fundamental element of economic development and social progress, particularly given its vital role in meeting individuals' insatiable needs (L. Obanor, Nisoshili, Goodness & Oluwafikunolami, 2026, p. 1).

Additionally, energy is the lifeblood of the global economy and the key driver of all productive and developmental activities in the modern era. No economic sector — whether industrial, agricultural or service-based — can operate or grow without a continuous and sustainable supply of energy. For this reason, energy is regarded as an indicator of countries' advancement and a key factor in global financial policy (Nynke, Daniel, Giovanni, Roman and Lorenzo, 2026, p. 2).

2.1 The concept of energy

Due to the substantial importance of the topic of energy, a number of definitions have been proposed to explain this term. The U.S. Energy Information Administration (EIA, 2026) defines energy as the capacity to do work. However, this definition does not provide a sufficiently comprehensive description of the concept of energy.

It has also been defined as the quantity that must be converted into matter in order to perform work, or as that which can generate heat (Hoffman, 2020, p. 192). This definition appears to offer a more comprehensive characterisation of energy, particularly when linking it to heat generation.

Additionally, energy has been defined as 'those residues that give rise to certain characteristics', fundamentally including 'vitality, motion, and change' (Daggett, The Birth of Energy: Fossil Fuels, Thermodynamics, and the Politics of Work, 2020, p. 268). Through this definition, the researcher links the concept of energy to fundamental dynamics.

Based on these definitions, energy can be defined as the extent to which materials, in their various forms and manifestations, have the ability to set matter in motion through their stored potential capability.

2.2 The importance of energy

Energy has clearly impacted human development across different eras. Every significant period of prosperity has featured energy as a key contributor to that growth. For instance, energy has played a pivotal role in the industrial and transportation sectors (Hamza & Omar, 2026, p. 14). Furthermore, as energy is central to promoting economic growth, maintaining social stability and strengthening environmental sustainability, it also plays a key role in national development (Wang, Hao & Jun, 2025, p. 2).

From early times, the importance of energy has been linked to its efficient and rational use. The greater a country's energy production, the greater its improvement in condition. There is no doubt that the future prospects of states are closely tied to their energy situation.

2.3 Different forms of energy

What is distinctive about energy is its variety of forms, which vary according to geographic regions and the rapid technological and human development of the modern era. Classifications of energy forms and sources therefore differ across studies. Yet the most prominent and clearly identifiable forms appear to be as follows:

2.3.1 Traditional energy

The terms 'traditional energy' and 'fossil energy' essentially have the same meaning. Here, they refer to energy resources extracted from beneath the Earth's surface, such as coal and oil. Most researchers agree that these resources will eventually become depleted, even if this process takes a long time (Wygrala, 2026, p. 9).

At this stage, we can distinguish between the different forms of traditional energy as follows:

Oil: Here, we distinguish between two main types of oil. The number of atoms in a molecule determines the final form of oil found in nature. It may exist in either a gaseous or liquid form. The gaseous form is known as natural gas, while the liquid form is petroleum (Daggett, The Birth of Energy: Fossil Fuels, Thermodynamics, and the Politics of Work*, 2020, p. 268).

Coal: is formed from the accumulation of plant matter, especially green vegetation, in marshes over an estimated period of millions of years beneath the earth's surface. Coal can be brown, black or grey in colour (Daggett, The Birth of Energy: Fossil Fuels, Thermodynamics, and the Politics of Work, 2020, p. 269).

Natural gas: Natural gas is a cleaner energy resource compared with other types of fossil fuel. It is also the most widely used traditional energy source (Manfred, Tagliapietra & De, 2020, p. 112).

2.3.2 Renewable energies

Although the transition from traditional fossil fuels to renewable energy is widely accepted as necessary for long-term environmental sustainability, a real shift towards this goal remains far from being achieved globally for several reasons. One of these reasons is perhaps related to climate and energy conditions, as well as certain minerals and costly materials used in these processes (Pata & Selin, 2025, p. 1).

Furthermore, the process of exploiting energy — particularly the transition from traditional energy sources, such as fossil fuels, to renewable energy sources — requires large-scale investment, which in turn demands substantial financial resources to fund these transformation processes (Wang, Hao & Jun, 2025, p. 8). Consequently, these investments themselves can impede the transition to renewable energies in many countries worldwide, particularly in those classified as poor but possessing natural resources capable of enabling clean energy production.

Despite the difficulty of addressing all renewable energy sources developed by modern science, numerous studies have identified the following forms of renewable energy:

Solar energy

Solar energy originates from the Sun and appears in the form of ultra-fast thermal or optical waves. These waves can be converted into electrical energy using modern technological methods (Bridge, 2015, p. 4).

Wind energy is an important form of renewable energy that is harnessed using large turbines to convert wind motion into electrical energy (Maria-Floriana, 2014, p. 6).

Hydropower is perhaps the most widely used type of renewable, clean energy in the world after solar and wind energy. It is produced by harnessing the water in dams constructed by humans and using the movement of this water (Bridge, 2015, p. 5).

Geothermal energy is the process of extracting electrical energy by converting the enormous thermal energy generated within the Earth, typically in the form of superheated water.

3. The Literary Dimension of the Topic of Energy Security

Global economic activity has been linked to the issue of energy security, particularly with regard to energy prices, supply disruptions, and geopolitical tensions (Ivanovski & Bernard, 2026, p. 26). Consequently, energy security exerts effects on multiple sectors at local, regional and international levels. Furthermore, given the ongoing and persistent increase in demand for fossil fuels, there is a need to transition towards alternative energy sources in various forms to replace conventional energy sources (Iyke & Sin-Yu, 2026, p. 1).

3.1 The Concept of Energy Security

Energy security refers to a state in which energy is easily accessible and affordable (Iyke & Sin-Yu, 2026, p. 1). It also denotes the continuous availability of energy materials at an affordable cost. Furthermore, it encompasses international strategic efforts to mitigate fluctuations in market conditions and diversify supply chains for these vital resources (Obanor, L., Nisoshi, L., Goodness, E. & Oluwafikunolami, O., 2026, p. 4).

3.2 The importance of energy security

Energy security has several dimensions that are directly linked to the economies of states. The first of these is the direct reliance of some countries on external energy supplies, with no local energy production. This makes them dependent on the stability of the prices of these imported commodities (Dunyoh, Adiku & Teye, 2026, p. 2).

As the objectives of sustainable development are tied to ensuring the availability of safe and reliable energy supplies, the importance of energy security has grown for many economies (Yasmeen & Rui, 2026, p. 1). Furthermore, as many countries rely on fossil fuels that they do not possess and must therefore import from other states, whether neighbouring or more distant, the importance of adopting policies to secure energy supplies has increased (Svazas, Valentinas, Raimondas, Yuriy & Shahzad, 2026, p. 1).

3.3 Energy security from an international perspective

The International Energy Agency (IEA), established in 1974, is regarded as the fundamental cornerstone of international efforts to regulate and ensure three essential elements: the supply of energy materials at reasonable prices and the continuity of their provision (Amritanshu & Sharma, 2020, p. 398). The 1972 Stockholm conference on energy and the environment also addressed international views on energy security (Amritanshu & Sharma, 2020, p. 399).

Furthermore, researchers and academics in the field of energy security argue that energy security does not depend solely on the prices and availability of energy commodities in global energy markets, nor on their reliability. Rather, the concept has expanded to encompass other global issues, such as globalisation and climate change, as well as certain international matters (Svazas et al., 2026, p. 3).

Successive oil shocks beginning in 1973, then in 1979, 1986, 1990, 1998, 2008 and finally in 2014 have prompted most energy-consuming and energy-producing countries to reconsider, reinforce and renew their approach to energy security.

4. Econometric Study of Energy Security in Algeria

This section of the research paper will present the econometric model of the study, which addresses the issue of energy security in Algeria. While this topic may encompass various components, the study will concentrate on one aspect: energy consumption in Algeria. This will be examined through a set of variables that affect it and, consequently, energy security in general.

Econometric techniques will be employed to investigate the impact of the considered variables on energy consumption in Algeria from 2006 to 2025. This will provide an important insight into the topic of energy security in Algeria.

4.1 Formulation of the econometric model

In this study, energy consumption in Algeria will be treated as a dependent variable determined by a set of independent variables:

The first independent variable is the population of Algeria between 2006 and 2025.

- Second independent variable: the national vehicle fleet in Algeria over the period 2006–2025;
- Third independent variable: the national housing stock in Algeria over the period 2006–2025.

The following table presents these variables in detail, as well as justifying their selection:

Table of variables related to the study model

Nature of the variable	Assigned code	Variable	Unit of measurement	Study period	Justification for selecting the variable
Dependent variable	CEN	Energy consumption	ktoe (kilotons of oil equivalent)	2025-2006	/
Independent variable	NH	Population count	million persons		Human needs for various energy materials
Independent variable	PAUTO	National vehicle fleet	million vehicles		Energy materials are a main driver of vehicle operation
Independent variable	PLGT	National housing stock	million housing units		State-built housing units are connected

		(housing units constructed by the state only)			to electricity and gas networks

Source: prepared by the researchers based on the study variables.

4.2 Estimation of the model parameters

First, the data related to the study variables was collected over the specified period from 2006 to 2025 inclusive, in order to estimate the parameters of the model. Next, we determined the mathematical form of the study. Finally, we estimated the parameters of the study model. These steps are as follows:

4.2.1 Collection of study data

The data for the dependent and independent variables over the aforementioned period are presented in the following table:

Table of data for the dependent and independent variables for the period 2006–2025.

Year	CEN	NH	PAUTO	PLGT
2006	37461	33,64	3,40	1,12
2007	39393	34,17	3,60	1,28
2008	41090	34,73	3,98	1,49
2009	41855	35,33	4,17	1,69
2010	43362	35,98	4,31	1,88
2011	46096	36,66	4,51	2,09
2012	50866	37,38	5,01	2,44
2013	53268	38,14	5,52	2,45
2014	55882	38,92	5,94	2,81
2015	58265	39,73	5,96	2,82
2016	58341	40,55	5,99	3,03
2017	59582	41,39	6,01	3,04
2018	64964	42,23	6,15	3,48
2019	66902	43,25	6,58	4,01
2020	67111	44,15	6,60	4,04
2021	68180	45,06	6,75	4,05
2022	69152	45,97	6,91	4,90
2023	70182	46,96	7,19	5,52
2024	71200	47,81	7,42	5,99
2025	72899	48,92	7,7	7,81

Source: Prepared by the researchers based on:
The annual reports of the Algerian Ministry of Energy for the period 2006–2025, available at: (bit.ly/3tdtZ9b), accessed on 06/06/2026.

- World Bank data on population for the period 2006–2025, available on the website: (bit.ly/2Skpm0J), accessed on 05/05/2026.
- Annual reports of the Bank of Algeria for the period 2006–2025, available at: (bit.ly/35P2c5C), accessed on 05/06/2026.

The annual reports of the National Office of Statistics for the period 2006–2025 are available on the website: (bit.ly/35HHhSh), accessed on 07/05/2026.

Housing statistics from the Algerian Ministry of Housing for the period 2006–2025 are available on the website: bit.ly/3j3CQsJ, accessed on 08/05/2026.

4.3 Determining the mathematical form

This econometric model relies on choosing between two types of functional specification: linear and logarithmic equations. To this end, the first differences of the dependent variable — that is, energy consumption in Algeria during the aforementioned study period — must be calculated. The first differences obtained are as follows:

Table showing the first differences of the dependent variable for the period 2006–2025.

Year	CN	BCN	Year	CN	BCN
2006	37461	-	2016	58341	76
2007	39393	1932	2017	59582	1241
2008	41090	1697	2018	64964	5382
2009	41855	765	2019	66902	1938
2010	43362	1507	2020	67111	209
2011	46096	2734	2021	68180	1069
2012	50866	4770	2022	69152	972
2013	53268	2402	2023	70182	1028
2014	55882	2614	2024	71200	1020
2015	58265	2383	2025	72899	1699

Source: prepared by the researchers based on dependent variable data.

The table above shows that the first differences in energy consumption, which represents the dependent variable in this study, are not constant. This suggests a non-linear relationship between the variables in the study. It also suggests the existence of a logarithmic relationship between these variables, which can be expressed by the following equation:

$$ln(CEN) = ln(NH) + ln(PAUT) + ln(PLGT)$$

Estimation of the parameters of the logarithmic model

Using econometric software (EViews), the values of all the variables will be transformed into logarithmic values. Accordingly, the variable symbols will become as follows:

- The dependent variable energy consumption (LCEN);
- The independent variable population (LNH);
- The independent variable national vehicle fleet (LPAUTO);
- The independent variable national housing stock (LPLGT).

The program generated the following results:

Table of the estimation results of the logarithmic model for the period 2006–2025.

Equation: UNTITLED Workfile: UNTITLED::U...

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: LCEN
Method: Least Squares
Date: 06/25/26 Time: 11:42
Sample: 2006 2025
Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNH	1.049648	0.275144	3.814902	0.0015
LPAUTO	0.781379	0.096512	8.096208	0.0000
LPLGT	-0.184830	0.073849	-2.502810	0.0235
C	1.072458	2.213164	0.484581	0.6345

R-squared	0.989989	Mean dependent var	10.92481
Adjusted R-squared	0.988112	S.D. dependent var	0.221788
S.E. of regression	0.024182	Akaike info criterion	-4.429548
Sum squared resid	0.009356	Schwarz criterion	-4.230401
Log likelihood	48.29548	Hannan-Quinn criter.	-4.390672
F-statistic	527.4124	Durbin-Watson stat	1.380228
Prob(F-statistic)	0.000000		

Source: Based on the outputs of EViews 12.

The figure above shows that the F-statistic value is statistically significant at 527.4124.

The same figure also shows that the estimated coefficients of the independent variables are statistically significant because their p-values are below 5%. These coefficients are presented as follows:

- The coefficient of the independent variable 'population (LNH)' is equal to 0.0015.
- The coefficient of the independent variable 'national vehicle fleet' (LPAUTO) is equal to 0.0000.
- The coefficient of the independent variable 'national housing stock (LPLGT)' is equal to 0.0235.

Furthermore, the independent variables above explain 98.99% of the variation in energy consumption, as indicated by the R-squared value in the above figure.

Additionally, the value of the Durbin–Watson statistic, which is 1.38 and is included in the study results, indicates that there is no linear autocorrelation among the random errors.

Discussion of the study results

Based on the results obtained through the econometric software EViews 12, as shown in the previous figure, the independent variables were found to be statistically significant, specifically:

- Population (LNH): the positive sign of the estimated coefficient of the independent variable population indicates a positive effect of population growth in Algeria on energy consumption. This can be explained by the fact that the Algerian population represents the primary driver of energy consumption due to the multitude of daily practices and activities that require energy, particularly electricity, for each individual.

- National vehicle fleet (LPAUTO): the impact of changes in the national vehicle fleet on energy consumption in Algeria is clearly reflected in the positive sign of this variable's coefficient. This suggests that an increase in the size of Algeria's vehicle fleet leads to higher energy consumption because oil-derived products are essential for the operation and movement of the fleet's components.

- National housing stock (LPLGT): The statistical significance of the independent variable national housing stock, indicated by a negative coefficient, points to an inverse relationship between this variable and energy consumption in Algeria during the study period. This can be explained by the relatively regular household energy consumption patterns in Algeria associated with state-built housing projects, as opposed to the more random and heterogeneous energy consumption patterns observed in privately built housing.

5. Ways to Review Energy Consumption in Algeria to Ensure Energy Security

In addition to energy production, energy consumption is an important dimension of the energy security issue. Once the balance between these two components is achieved, energy security is fulfilled. Conversely, if energy consumption exceeds production, energy security will inevitably be characterised by a deficit — an outcome that Algeria, like many other countries, seeks to avoid in the present and future. Conversely, if the quantities of energy produced exceed consumption quantities, the energy balance is in surplus and energy security is realised.

The results of this study, which examined certain variables affecting energy consumption in Algeria from 2006 to 2025 based on standardised consumption figures, reveal alarming trends for Algeria. The findings also suggest an inability of energy production to keep pace with consumption, which reached more than 72,000 k ton of oil equivalent in 2025. This implies a movement towards an energy security deficit in the future due to exceptionally high consumption levels.

In light of the impact of the study's independent variables (population size, the national vehicle fleet and the national housing stock) on the dependent variable (energy consumption), which generated concern regarding the country's overall energy situation in relation to energy security, a set of urgent remedial strategies has been put forward to curb this exceptional rise in energy consumption levels. These strategies are reflected in the following points:

5.1 Strategy to Control the National Vehicle Fleet

Based on the impact of the national vehicle fleet in Algeria on energy consumption, as indicated by the standardised results presented earlier, and as a consequence of the rapid increase in the total number of vehicles in the national fleet — where this figure doubled during the study period, rising from approximately 3.4 million vehicles to around 7.7 million vehicles — several measures have emerged. These measures aim to limit the ongoing and concerning growth in the number of vehicles, and to curb the continuous rise in energy consumption, specifically as follows:

- Imposing controls on automotive marketing activities: These controls have been deemed necessary to address a significant set of undesirable effects primarily affecting the national

economy through its energy consumption, as well as the environmental impact (Meknni, 2015, p. 79).
- Moving towards developing the automotive industries according to the global automobile industry value chain: This shift allows for improvements in the automotive sector, particularly with respect to producing each vehicle component according to international standards. This improves the energy consumption efficiency of vehicles manufactured within this value chain (Djedidi, 2019, p. 156).

5.2 Strategy to Control the National Housing Stock

In line with the unprecedented increase in Algeria's national housing stock, as reflected in the different housing forms hosted by the Algerian state and recorded in the above study, this increase has negatively affected energy consumption. Specifically, the study establishes an inverse relationship between the national housing stock and energy consumption, which contributed to Algeria's rising energy consumption during the investigated period (2006 to 2025). Consequently, a set of measures has emerged to control or limit the growing energy consumption attributable to the housing sector. The most prominent of these measures are:
- Adopting household energy systems based on solar energy, particularly in rural housing, since the majority of these dwellings are located in remote areas far from the national electricity and gas grid (Ben Ziane, 2019, p. 150).
- Restricting housing categories fully financed and allocated by the state to households with middle incomes, according to the social rental housing scheme introduced under Law No. 334-04 in 2004, together with efforts to increase state assistance to high-income individuals. This measure is intended to curb the continuous increase in energy consumption stemming from the housing sector (Bettaher, 2019, p. 204).

5.3 Strategy for Rationalising and Reducing Individual Energy Consumption

In Algeria, this strategy has been implemented through the National Energy Conservation Programme, as set out in Executive Decree No. 04-149, issued in 2004. The main aim of this decree is to: (Kaawane, 2019, p. 63).

- Emphasise the importance of controlling energy use for individual energy consumers.
- Train and qualify human resources working in institutions related to the energy sector to improve awareness of energy consumption.
- Ensure the development and implementation of programmes aimed at rationalising energy consumption.
- Provide training in energy saving to individuals.

6. Conclusion:

Given the prominent position of the energy sector worldwide and in Algeria in particular, energy security has emerged as an economic necessity that accompanies the activities and general policies of any state. In light of the findings of our study, which examined reducing energy consumption as a means of ensuring energy security in Algeria, it became clear that energy consumption in Algeria has reached record levels. This was demonstrated by showing

the effect of several variables, most notably population size, followed by the national vehicle fleet and the national housing stock.

Furthermore, the study identified indicators suggesting that rising energy consumption levels may adversely affect energy security in Algeria in the future. Taking these influencing factors into account, the study concluded that the most significant strategies for reducing energy consumption in Algeria in future — thereby increasing the likelihood of ensuring energy security — centre on optimally managing these variables. In other words, this involves controlling the size of the national vehicle fleet and housing stock in accordance with relevant policies and adopting a strategy to rationalise energy consumption by Algerian individuals.

To further support these strategies, an important set of proposals and recommendations was presented to enhance the prospects of ensuring energy security in Algeria in the future.

The need to intensify cooperation among the various ministries and government agencies concerned, in order to identify the most important factors contributing to the increase in energy consumption in Algeria and subsequently control these factors.

- To accompany Algeria's energy consumption reduction policy with other mechanisms, most importantly an urgent shift towards exploiting renewable energies and consequently increasing energy production.
- To study leading international experiences in the energy sector and apply them to the Algerian context.

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