

Energy Policy as a Pathway to Sustainable Development: Renewable Energy, Resource Governance, and the Algerian Experience

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Abstract

Purpose: This study examines the relationship between energy policy and sustainable development, with particular emphasis on Algeria's transition from dependence on exhaustible fossil-fuel resources toward a more diversified, efficient, and environmentally sustainable energy system. It explores the economic, social, environmental, and technological dimensions of sustainable development and evaluates the role of renewable energy, energy efficiency, and resource governance in protecting the interests of present and future generations.

Design/methodology/approach: The study adopts a descriptive-analytical and legal-institutional approach. It synthesizes the theoretical literature on sustainable development, energy policy, natural-resource management, and renewable energy while examining Algeria's principal energy legislation and policy instruments. Particular attention is given to Law No. 99-09 on energy management, Law No. 02-01 on electricity and the public distribution of natural gas, and Law No. 04-09 on the promotion of renewable energy within the framework of sustainable development. The analysis also considers the potential contribution of solar, wind, and hydropower to national energy diversification.

Findings: The findings indicate that sustainable development cannot be achieved through continued dependence on hydrocarbons alone. An effective energy policy requires the rational use of fossil-fuel resources, enforceable energy-efficiency standards, periodic energy audits, investment in clean technologies, supportive financing mechanisms, and greater public awareness. Algeria possesses substantial renewable-energy potential, particularly in solar energy, but the realization of this potential depends on stronger institutional coordination, regulatory implementation, technological capacity, and long-term investment. The analysis further shows that aligning energy policy with environmental protection can reduce pollution, preserve hydrocarbon reserves, improve energy security, and safeguard natural-resource availability for future generations.

Research limitations/implications: The study is primarily conceptual and based on legal documents and secondary sources; it does not provide an econometric assessment of the effects of renewable-energy investment or energy-efficiency measures on Algeria's economic and environmental performance. Future studies should employ longitudinal data and comparative models to evaluate the effectiveness of individual policy instruments and quantify their contribution to emissions reduction, energy diversification, and sustainable growth.

Practical implications: Policymakers should accelerate the implementation of renewable-energy programs, strengthen enforcement of energy-efficiency regulations, expand incentives for clean-energy investment, and improve coordination among public institutions, energy producers, research centers, and private investors. Energy

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policy should also incorporate measurable sustainability targets, transparent monitoring mechanisms, and technology-transfer initiatives suited to Algeria's economic and environmental conditions.

Originality/value: This study offers an integrated assessment of sustainable development and energy policy by connecting resource conservation, renewable-energy deployment, environmental protection, legal regulation, and intergenerational equity. Its value lies in applying this multidimensional framework to Algeria, where hydrocarbon dependence and considerable renewable-energy potential create both significant policy constraints and strategic opportunities.

Keywords: Algeria; energy efficiency; energy policy; energy transition; intergenerational equity; natural-resource governance; renewable energy; sustainable development.

JEL Classification: O13; Q28; Q42; Q48; Q56.

Introduction

Modern societies experience developments in the level and quality of goods and services desired by individuals and the community. These desires are met by utilizing natural resources by producing institutions, often resulting in manufacturing processes that require significant energy consumption and cause environmental pollution.

Sustainable development is a goal of economic policies in every country worldwide. The use of natural resources for energy production has a clear impact on the environment and the future of human development in general.

Focusing on sustainable development requires devising a policy that enables the appropriate use of natural resources for producing raw materials or energy. This necessitates considering nature and the environment as vital components of the economic cycle and in formulating various economic policies that nations undertake.

The concept of sustainable development aimed at by economic policy is linked to social welfare and improving living standards. This is achieved by enhancing the level and quality of human basic and secondary needs in the long term. To realize economic development in its modern sense, it is essential to overcome many obstacles and challenges, especially when it concerns the depletion of natural resources and the difficulty of accessing them, thus making it necessary to adopt alternative solutions.

Study Problem

Based on the foregoing, the following question can be posed:

How effective is the energy policy in achieving sustainable development?

Study Hypotheses

- Meeting energy needs solely through natural resources such as petroleum and gas is not always possible.
- Finding alternatives to traditional energy has become a necessity due to the depletion of natural resources like petroleum or their diminishing returns.
- Relying on renewable energies achieves greater effectiveness in protecting the environment and ensuring sustainable development.
- Relying on modern and renewable energies ensures effective sustainable development.

Study Importance

The importance of this research lies in highlighting the efficacy of energy policy in conserving as much as possible of depleting natural resources and how to effectively utilize renewable natural resources. Addressing sustainable development and its relationship with energy policy contributes to finding the best ways to provide basic needs at the lowest cost, on one hand, and ensuring the rights of future generations to these resources, on the other hand.

Study Objectives

The research aims to:

- Understand the conceptual framework of sustainable development and its dimensions.
- Explore the legal framework of the energy policy adopted in Algeria.
- Find solutions to some of the challenges in providing new energy alternatives.

1. Sustainable Development and Its Dimensions

With the increasing and diversifying risks associated with negative environmental impacts due to industrial development that consumes energy resources increasingly amid depleting natural resources, sustainable development has become a necessity. International interest in the environment peaked at the Earth Summit held in Rio de Janeiro in 1992, where the agenda 21 was established, outlining the guidelines for economic and social development areas.

1.1 The Concept of Sustainable Development

There are several definitions of sustainable development, among them:

Some economic definitions focus on the optimal management of natural resources, emphasizing maximizing the benefits of economic development while preserving the services and quality of natural resources (Bouaziz, 2012, p. 12).

Sustainable development is defined as "the development that achieves a balance between the ecological, economic, and social systems and contributes to the maximum growth that ensures meeting human needs without negatively affecting the ecological system and the base of natural resources. It encompasses three main dimensions: economic efficiency, social justice, and environmental protection" (Hamid, 2014, p. 57). Sustainable development is also defined as "continuous, fair, balanced, and integrated development that considers the environmental dimension in all its projects, ensuring that the fruits are not reaped by the current generation at the expense of future generations" (Nasr, 2017, p. 82).

Furthermore, sustainable development is described as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Al-Azzawi, 2015, p. 56).

1.2 Dimensions of Sustainable Development

Sustainable development aims to achieve four dimensions

1.2.1 Economic Dimension of Sustainable Development

The economic dimension of sustainable development relies on the principle of balance in using natural, human, and financial resources to meet the needs of the population without negatively impacting future generations. The economic dimension consists of several factors, which can be summarized as follows (Hamid, 2014, p. 61):

- Individual Consumption Share of Natural Resources: It is observed that the population in developed countries uses several times the per capita share of natural resources compared to that of developing countries. For example, energy consumption derived from oil, gas, and coal in the United States is 33 times higher than in India and 10 times higher on average than in developing countries combined as per the Organization for Economic Co-operation and Development (OECD).
- Stopping the Dissipation of Natural Resources: For wealthy countries, sustainable development involves ongoing reductions in the wasteful consumption of energy and natural resources, achieved through improved efficiency and changes in lifestyle.
- Responsibility of Developed Countries for Pollution and Its Management: Industrialized countries bear significant responsibility, especially in leading sustainable development because their large and increasing consumption of natural resources, such as fossil fuels, contributes disproportionately to global pollution problems compared to developing countries.
- Sustainable Development in Poor Countries: For poor countries, sustainable development means dedicating the use of natural resources to continuously improve living standards, with rapid improvement being crucial in alleviating the burden of poverty.

1.2.2 Social Dimension of Sustainable Development

The social dimension of sustainable development encompasses the following aspects (Rachid, 2006, p. 108):

- This dimension includes considering human happiness by improving the quality of life, providing job opportunities, and upholding the values of justice and equality among the population, with a general focus on disadvantaged or marginalized groups. Additionally, there is a need to focus on directing efforts towards investing in human capital, especially in developing countries where investment in health, education, and nutrition can increase human knowledge and skills to help improve their work and production performance.

- Working towards significant progress in stabilizing population growth so that increases do not hinder development efforts, along with paying attention to population distribution by establishing new cities and promoting active rural development to slow migration to urban areas. The social dimension also involves the full utilization of human resources by combating hunger, enhancing service levels, reallocating resources to ensure the fulfillment of basic human needs, and protecting cultural diversity.

1.2.3 Environmental Dimension of Sustainable Development

Sustainable development, with its emphasis on the principle of human needs, presents the issue of industrial peace, which refers to the needs that the economic system must meet. However, nature sets boundaries that must be identified and respected in manufacturing processes. The goal behind this is the better management and utilization of natural capital instead of squandering it.

1.2.4 Technological or Technical Dimension

This dimension encourages the use of clean technology that produces minimal or no waste and the use of environmentally friendly technologies, focusing on the utilization of clean energy sources such as solar power, wind, and natural gas, especially in industries and homes. It also implies the necessity of enforcing legal texts that impose penalties on users of polluting technologies to prevent further environmental degradation.

Additionally, this dimension includes the necessity to focus on the use of fossil fuels and the disposal of their waste into the environment, alongside implementing measures to reduce emissions such as carbon dioxide and using new technology to more efficiently use thermal energy.

2. Energy Policy

Searching for ways to economize on natural energy resources through the exploitation of new or alternative means to preserve the environment with minimal damage reflects an effective energy policy.

2.1 Energy Policy and Its Conditions

2.1.1 Concept of Energy Policy

Energy policy encompasses all measures and practical activities aimed at rationalizing the use of renewable energy and reducing the impact of the energy system on the environment.

Energy policy can also be defined as "the prudent use of energy, which is the optimal utilization of energy consumption at various levels of production, energy transformation, and final consumption in sectors such as industry, transportation, services, and also in household consumption" (Article 03 of Law 04-09, 2004, p. 05).

2.1.2 Conditions for the Effectiveness of Energy Policy

The implementation of the national energy control policy relies on the following necessary commitments and conditions:

- Introduction of Energy Efficiency Standards: This is done by establishing criteria for thermal insulation in new buildings.
- Monitoring Energy Efficiency: Energy efficiency monitoring applies particularly to:
- Devices used for electricity, gas, and refined petroleum products to ensure their compliance with efficiency standards.
- Vehicles and machinery with engines, which are periodically monitored to ensure they operate under suitable conditions.
- Mandatory and Periodic Energy Audits: These are conducted after setting energy consumption levels that determine the standards for subjecting facilities to audits and the methods of conducting these audits.
- National Energy Control Program
- Developmental Research
- Funding for Energy Management
- Incentive Measures
- Raising User Awareness: This involves educating users about the importance and benefits of energy efficiency and conservation.

2.2 The Concept of Renewable Energy and Its Sources:

2.2.1 Concept of Renewable Energy

There are various definitions of renewable energy, among them: Renewable energy is defined as "forms of electrical, kinetic, thermal, or gaseous energy obtained from the transformation of solar radiation, wind power, geothermal heat, organic waste, hydropower, and biomass utilization technologies" (Article 03 of Law 04-09, 2004, p. 10).

Renewable energy is also defined as energy whose sources are continuously renewed or are inexhaustible. It is the energy obtained through energy currents that occur naturally and cyclically in nature (Talem, 2019, p. 175).

These are energy sources that are consistently available, unlike energy produced from fossil fuel sources, which deplete over time due to continuous use. The term "renewable energy" also refers to electricity generated from the sun, wind, biomass, geothermal and hydropower sources, as well as biofuel and hydrogen used from renewable sources. Renewable energy is considered environmentally friendly, hence it is sometimes referred to as "green energy." Renewable energy exists in various forms, and its primary source is solar radiation, in addition to the earth's geothermal heat and the moon's gravity, which causes the phenomenon of tides (Talem, 2019, p. 176).

2.2.2 Energy Sources

There are several major energy sources, including:

A. Solar Energy

Solar energy, emitted from the sun, is one of the most important energy sources globally. Despite the significance of solar energy in power generation, its contribution remains modest among total renewable energies. The primary uses of solar energy include generating heat and electricity, with water heating being the most common use, while its use in electricity generation is increasingly growing.

B. Wind Energy

Wind energy is generated by converting the movement of the wind, i.e., its kinetic energy, into other forms of energy, most often electrical or mechanical energy, though to a lesser extent. Despite the many positives of wind energy, such as it being renewable, not producing any greenhouse gas emissions or waste, and not requiring any fuel (and it can be connected to the national power grid), it has some downsides. These include the scarcity of locations with sufficient wind, the high costs of generating energy compared to fossil fuel costs, the need for vast areas which may not be available in many countries, and the noise produced by wind turbines, especially older models.

C. Hydropower

Hydropower is one of the most important sources of renewable energy used today, derived from the continuous movement of water, which is inexhaustible.

3. Sustainable Development and Its Relationship with Energy in Algeria

Algeria has adopted energy policies and programs targeting all economic sectors, focusing on rationalizing energy use, promoting renewable energies, and increasing their contribution to national consumption. This approach aims to preserve national savings from hydrocarbons and meet the domestic consumption requirements of energy resources without neglecting the rights of future generations to these resources.

The Algerian state is working to embody the desired goals by finding comprehensive and permanent solutions to environmental challenges through establishing policies, programs, and enacting laws for their implementation.

3.1 The Legal Framework

Algeria has enacted laws to implement its energy policy, including:

- Law No. 09-99 dated 28/07/1999 on Energy Control: The purpose of this law is to define the national policy for energy control.
- Law No. 02-01 dated 05/02/2002 on Electricity and Public Distribution of Natural Gas via Pipelines: This law sets procedures to promote electricity production from renewable energies. The regulatory texts issued to implement this law include Executive Decree No. 04-92 dated 25/03/2004, which relates to the costs of diversifying electricity production and includes granting financial and tax incentives under certain conditions to electricity producers, especially from solar thermal energy resources.

- Law No. 04-09 dated 14/08/2004 on Promoting Renewable Energies in the Context of Sustainable Development: Among the goals of this law is to protect the environment by encouraging the use of non-polluting energy sources. Also, Executive Decree No. 05-16 dated 11/01/2005 was issued, which sets the specific rules for energy efficiency applied to devices operating on electricity, gases, and petroleum products.

3.2 The Relationship Between Sustainable Development and Energy Policy

The relationship can be analyzed from the following aspects:

3.2.1 Environmental Aspect

The environmental aspect of sustainable development can be analyzed through the study of:

- The Impact of Oil and Gas Production Activities on the Environment: The production activities for oil generate environmental impacts including mud pollution and water contamination used in the extraction of hydrocarbons, as well as air pollution resulting from combustion processes. In terms of mud, the national company Sonatrach, as part of integrating social and environmental dimensions into its strategies, has addressed this issue and achieved positive outcomes. Recycling this mud has allowed the recovery of significant quantities of trapped oil, resulting in substantial financial gains. Regarding used water, the company has managed to reduce the amount of water used to 80 million cubic meters. Most of these quantities are treated and reinjected into oil and gas fields. For air pollution, Sonatrach has implemented several projects for capturing and storing carbon dioxide, the most significant of which is the joint project with BP of the UK and Statoil of Norway (Hussein, 2014, pp. 16-17).
- The Impact of Consuming Oil and Gas Outputs on the Environment: Algeria relies on a policy of valorizing available energy resources, focusing on the use of natural gas and reducing petroleum consumption, directing surplus quantities for export. This is evident from the ratio of energy consumed in Algeria, 60% of which comes from natural gas. This approach aligns with the objectives of reducing environmental impact and promoting sustainable energy usage within the national energy policy framework.

3.2.2 Economic Aspect

The reality of the energy policy in Algeria and its impact on the economic aspect, especially regarding the importation of diesel and gasoline from 2005 to 2017, can be analyzed through the following statistics.

Table (1): Shows the import of diesel and gasoline in million dollars

Year	Diesel (Million \$)	Gasoline (Million \$)	Year	Diesel (Million \$)	Gasoline (Million \$)
2005	0.04	-	2012	988	413
2006	-	-	2013	2248	1284
2007	0.01	-	2014	1132	772
2008	0.001	-	2015	870	886
2009	27	-	2016	445	797
2010	196	-	2017	700	798
2011	218	-			

Source: Prepared by the researcher based on statistics from the National Agency for the Promotion of Foreign Trade.

The statistics shown in the table above indicate that the state began importing diesel in 2009 and started importing gasoline in 2012, although the Algerian state had previously met its needs through national production. With the rise in global oil prices, which exceeded \$100 per barrel during the period from 2011 to 2014, the cost of importing these two materials was very high. The total financial value of the imports for these two substances in 2013 exceeded \$3.5 billion, which posed a burden on the trade balance from an economic perspective.

3.2.3 The Technical and Technological Aspect

With the increasing excessive consumption of energy in Algeria, the state imposed some taxes and fees on devices, machinery, and vehicles that consume energy. This includes the tax introduced in 2017, known as the energy

efficiency fee, which applies to devices operating on electricity, gas, and petroleum products that are considered excessive in consumption. This fee is imposed on products produced locally or imported at rates ranging from 5% to 35%, depending on the energy category of the product, which can be A, B, C, D, E, or F, as defined according to the provisions of Article 07 of Executive Decree No. 05-16 dated 11/01/2005, which specifies the rules for energy efficiency. The import is permitted only for energy categories A, B, and C, and 10% of the revenue obtained from this tax is allocated to the National Fund for Energy Control, Renewable Energies, and Combined Power Generation (Articles 70 to 74 of Finance Law, 2017, pp. 31-35).

Oil refineries in Algeria have undergone several expansion and development projects over the past two decades, aiming to improve compliance with environmental regulations, enhance thermal integration, and implement energy consumption rationalization measures, yet these have not been sufficient. The average energy efficiency index stands at 420%, a value that indicates very low energy efficiency compared to standard refineries. The reasons for this poor energy efficiency include the low refining capacity of the refineries, outdated equipment, and delays in implementing the development project for existing refineries.

Currently, a project to develop oil refineries in Algeria is underway, along with the construction of three new refineries in Biskra, Ghardaïa, and Hassi Messaoud, each with a capacity of 100,000 barrels per day.

The plan to establish new refineries and develop existing ones, along with the application of modern technologies, is expected to enhance the energy efficiency of Algerian refineries. Consequently, the average energy consumption could decrease from 296 to 138 British thermal units per refined barrel. Total savings are expected to reach 33.64 trillion British thermal units per year, which is equivalent to 53.11% of the total current energy consumption in all operating refineries. The energy efficiency index is expected to improve from 420% to 194%, which is considered a good indicator (Imad, 2020, p. 156).

Figure (1) shown below illustrates the evolution of energy consumption in Algeria during the period from 1980 to 2017.

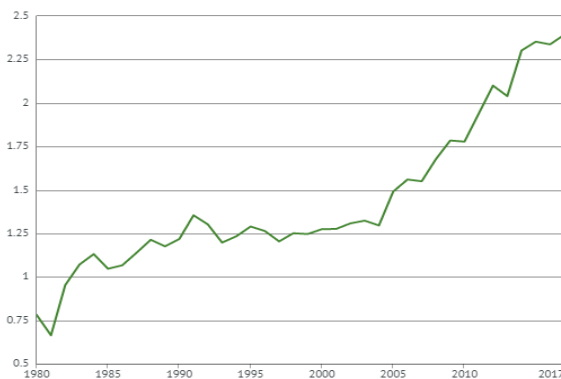


Figure (1): Demonstrates the total energy consumption in Algeria

Source: (International-Energy, 2020).

According to the figure, it is evident that the peak in total energy consumption was reached in 2017, which was double the total consumption in 2005. This compelled the state to adopt an energy policy in 2017 by imposing fees on energy-consuming devices to enforce consumer rationalization of their energy usage. Additionally, fees were imposed on new cars, whether imported or locally manufactured, with exemptions from this fee amounting to 20,000 DZD for cars

powered by liquefied natural gas as fuel.

CONCLUSION

Algeria possesses both depleting natural resources and renewable ones. Despite this, the country still imports some energy materials at high costs, which hinders the achievement of sustainable development aspired to by current and future generations.

This study has shown that Algeria relies on crude oil to generate its financial resources, a significant portion of which is allocated to importing oil-derived energy materials. Moreover, oil remains the primary source for meeting energy needs in Algeria and satisfying consumer demands.

Algeria possesses a significant reserve of natural gas, which is more environmentally friendly and has the potential to replace some imported materials like gasoline. Therefore, adopting an energy policy that directs consumers, whether they are industrialists or private individuals, to convert their diesel and gasoline-powered machinery and vehicles to those that can operate on gas is feasible. Utilizing this resource does not impact the rights of future generations.

Despite the availability of legal texts that encourage the rationalization of energy consumption for individuals and families, this policy remains ineffective, and household energy consumption continues to increase because these goods have become necessities that are indispensable and meet their desire for advanced services and high-quality goods.

Furthermore, although Algeria has been a producer of oil and gas for decades, it still suffers from inefficiency in its refining industry, which currently consumes a significant amount of energy for refining petroleum.

Through this research, the hypotheses have been confirmed:

- Meeting energy needs solely through natural resources such as petroleum and gas is not always possible.
- Finding alternatives to traditional energy has become a necessity due to the depletion of natural resources like petroleum or their diminishing returns.
- Relying on renewable energies achieves greater effectiveness in protecting the environment and ensuring sustainable development.

Based on the above, we conclude that achieving sustainable development requires an effective and implementable energy policy to ensure the current consumer needs are met and the rights of future generations to natural resources are preserved.

Based on this research, we recommend the following:

- Enable economic operators to invest in renewable energy by providing them with appropriate incentives.
- Encourage the use of liquefied natural gas as fuel for machinery and vehicles that can operate on this fuel.
- Establish modern and sufficient refineries to process petroleum and produce energy materials locally to cover the national market.

Impose additional fees on imported petroleum products that can be produced locally and allocate a portion of the collected amounts to support the local oil refining industry.

Declarations

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