

Energy Subsidies and Energy Efficiency in Algeria: Toward an Approach for Achieving the Environmental Dimension of Sustainable Development

Dr. Nadjat Harnane²

Dr. Nawal Sabeg³

Abstract:

This research paper examined the relationship between energy subsidies, energy efficiency, and the environmental dimension of sustainable development in Algeria by gathering data and literature and conducting a logical analysis to achieve the desired findings. The results of this study concluded that the excessive consumption of these energy products entails adverse environmental consequences, as it exacerbates the scale of environmental pollution through greenhouse gas emissions. Furthermore, the study highlighted that advancing the energy efficiency program toward the 2030 horizon constitutes a fundamental mechanism for reforming and rationalizing energy product consumption.

Keywords: Fuel and Electricity Subsidies, Energy Efficiency, Sustainable Development, Environmental Dimension

Introduction:

Energy represents one of the most critical pillars of economic and social development in Algeria; developing its resources and optimizing their management are among the core strategies for sustainable development. Fuel and electricity constitute the primary sources for diverse energy uses globally, which creates a gap that must be bridged due to the subsidies allocated to these commodities. Moreover, the extensive reliance on this policy has led to an escalating scale of environmental pollution resulting from greenhouse gas emissions and subsequent climate change, alongside a substantial economic cost that has burdened the state budget as a consequence of this support.

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² Abbes Laghrour University – Khenchela, nadjat.har@gmail.com

³ Larbi Ben M'hidi University – Oum El Bouaghi, snawal1987@gmail.com

These challenges prompted Algeria to develop its energy efficiency program and formulate strategic visions that ensure sustainable development anchored in renewable energy, while striving to preserve resources for future generations.

Problem Statement:

Through this research paper, we address the following central problem: How do energy subsidies affect the environmental dimension of sustainable development? And what are the mechanisms for rationalizing them?

Study Hypothesis:

To address the research problem, we formulated the following hypothesis: The development of Algeria's energy efficiency program serves as a mechanism to rationalize energy product subsidies, which in turn contributes to mitigating the impacts of environmental pollution in Algeria.

Significance and Objectives of the Study:

The significance of this study lies in addressing a topic of prominent and distinguished importance in the economies of various countries worldwide today, particularly amid energy commodity price volatility and increasing greenhouse gas emissions detrimental to the environment, whereas energy efficiency programs contribute to subsidy reform and enhance the efficacy of sustainable development in its environmental dimension.

Methodology:

This study adopted the descriptive-analytical approach, collecting literature and data and analyzing them logically to achieve the required findings.

Regarding the research instruments, the study relied on various relevant scientific articles, reports from international organizations and institutions such as the International Monetary Fund and the World Bank, as well as selected academic books and theses.

Structure of the Study:

To address the aforementioned framework, the study examines the following themes:

- ❖ **First:** Theoretical Framework of Energy Subsidies, Sustainable Development, and Energy Efficiency
- ❖ **Second:** Impacts of Energy Subsidies on the Environmental Dimension of Sustainable Development
- ❖ **Third:** Energy Efficiency as a Mechanism for Rationalizing Petroleum Product and Electricity Subsidies

1. Theoretical Framework of Energy Subsidies, Sustainable Development, and Energy Efficiency

1.1. Definition of Energy Subsidies (Fuel and Electricity) and Their Various Forms

Economic perspectives on defining subsidies and support have diverged across past decades. This is attributable, on one hand, to the multiplicity of their forms and mechanisms, and on the other, to the variation in the objectives sought to be achieved. These divergences can be observed across several orientations as follows:

Richard Stone addressed subsidies as a financial burden borne by the government intended to enable individuals and enterprises to purchase goods, services, or factors of production at a price lower than what would be obtained without support in free markets¹.

Kenneth E. Boulding regards subsidies or support as an indirect negative tax², an orientation that prevails in economic literature across the writings of numerous scholars, such as Musgrave. This implies that eliminating them could produce effects equivalent to the imposition of direct taxes of equal value on the subsidized commodities—a view that is widespread within the economies of certain nations, particularly advanced economies³.

Regarding energy products, there is no universally agreed-upon definition of subsidies provided for them. This policy varies among organizations active in this field due to differences in measurement methods and estimation approaches. Furthermore, economists' perspectives diverge according to their alignment with different economic schools regarding their stance on energy product pricing.

In this context, the United Nations Environment Programme (UNEP) adopts a narrow yet more common concept of energy subsidies, defining them as direct cash payments made by the government to consumers or producers of energy commodities in order to incentivize them to increase production or encourage the use of a specific source⁴.

Conversely, broad-based definitions seek to encompass other forms of government interventions that directly or indirectly influence prices and costs. The Organisation for Economic Co-operation and Development (OECD) has contributed a more comprehensive concept of subsidies, as they aim to maintain consumer prices below market levels, keep producer prices above market levels, or reduce consumer and producer costs through the provision of direct and indirect support or subsidies⁵.

Additionally, the International Energy Agency (IEA) has specifically focused on energy subsidies, characterizing them as any government measure primarily related to the energy sector that lowers the cost of energy production, raises the price received by energy producers, or lowers the price paid by energy consumers⁶.

From this definition, it can be inferred that a subsidy exists when domestic energy prices are lower than international market prices, adjusted for the costs of bringing these commodities to market; this is known as the price-gap approach⁷.

Table (01) illustrates the main forms of energy subsidies based on the definition of the International Energy Agency.

Government Intervention	Forms of Subsidy Mechanism	Reducing Production Costs	Increasing Production Costs	Reducing Prices for Consumers

Direct Financial Support	Grants to producers	×		
	Grants to consumers			×
	Low-interest or preferential loans	×		
Preferential Tax Treatment	Reductions or exemptions from royalties, sales taxes, producer levies, and customs tariffs	×		
	Tax credits	×		×
	Accelerated depreciation allowances for energy supply equipment	×		
Trade Restrictions	Quotas, technical restrictions, and trade embargoes		×	
Energy-Related Services Provided Directly by Government Below Full Cost	Direct investment in energy infrastructure	×		
	Public research and development	×		
	Liability insurance and facility decommissioning costs	×		

Energy Sector Regulation	Demand guarantees and mandated deployment rates	×	×	×
	Price controls		×	
	Market entry restrictions		×	

Source: MORGAN, Trevor. "Reforming energy subsidies: opportunities to contribute to the climate change agenda". United Nations Publications, 2008. P 12.

Based on the table above, energy subsidies, under the broader definition of the International Energy Agency, take various forms. The impact may be direct on prices and costs, such as grants and tax exemptions, or indirect, such as regulations and rules designed to guide the market toward the use of a specific fuel. The mechanism through which support is delivered depends on several factors, including the total cost of the program, the administrative transaction costs involved, and its potential impact across different social groups.

2.1. Mechanisms of Energy Subsidies for Fuel and Electricity in Algeria

1.2.1. Fuel Subsidy Mechanisms in Algeria

Petroleum products encompass all substances resulting from refining operations, such as gasoline, diesel, aviation fuels, and marine bunker fuels, in addition to products resulting from the fractionation of liquefied petroleum gases, such as butane, propane, and liquefied petroleum gas used as auto-fuel (LPG/C), alongside bituminous products and lubricants⁸.

The importation and marketing of these products constitute an open activity across the national territory, resulting in financial support whose burden is assumed by the State⁹. The requirements of the domestic market for locally refined or imported petroleum products are met through Sonatrach, with the government compensating for the differential between international prices and domestic administered prices—that is, the price paid by the final consumer, whether for household consumption, private enterprises, or public sector consumption, in addition to associated logistical and operational costs.

1.2.2. Electricity Subsidy Mechanisms in Algeria

Electricity is generated in power stations (conventional thermal, solar, hydroelectric, and wind power), supplying all consumers via an interconnected network of overhead and underground transmission and distribution lines. A defining physical characteristic of electrical energy is that it cannot be stored in large quantities within the grid¹⁰.

Electricity is also regarded as a public commodity widely consumed across all segments of society and across all economic activities, compelling the State to subsidize its tariffs and provide it at rates below its actual production cost. Electricity subsidy systems are governed by a set of foundational principles¹¹:

- ❖ **Targeting:** Subsidies should be restricted to intended beneficiary groups who genuinely qualify for support.
- ❖ **Clarity:** The electricity subsidy structure should be clearly designed to allow for adjustments, as well as the rigorous measurement of its resultant costs and returns.
- ❖ **Transparency:** The public should be kept informed regarding the aggregate cost and the actual socio-economic benefits derived from the electricity subsidies provided.
- ❖ **Time Limitation:** The subsidy timeframe should be bound by defined temporal limits rather than remaining open-ended, preventing public expenditures from exceeding budgetary control.
- ❖ **Economic Rationality:** Market distortions generated by electricity price subsidies must be addressed and managed rationally.
- ❖ **Cost Efficiency:** Program objectives should be achieved while keeping the administrative overhead of the subsidy mechanism to a minimum.

Electricity subsidy policy in Algeria reflects the social role of the State through supporting all segments of the population. Electricity subsidies in Algeria take two forms: direct subsidies and indirect subsidies.

A. Direct Electricity Price Subsidies

Direct subsidies take the form of reductions in electricity bills to support residents of southern Algeria who consume low- and medium-voltage electricity in the following provinces:

Southern Provinces: Adrar, Laghouat, Ghardaïa, Ouargla, Tamanrasset, Béchar, Tindouf, Illizi, El Oued, and Biskra. Here, two levels of support have been established¹²:

- ❖ **First Level: Financing a 65% reduction on electricity bills:**

- For households utilizing low-voltage electricity up to an annual consumption ceiling of 12,000 kWh.
- For farmers utilizing low- and medium-voltage electricity up to an annual consumption ceiling of 12,000 kWh.

If the consumed quantity exceeds 12,000 kWh per year for either households or farmers, the surplus is billed according to the standard applicable tariff.

- ❖ **Second Level: Financing a 25% reduction on electricity bills:**

- For non-agricultural economic activities utilizing low- and medium-voltage electricity up to an annual consumption ceiling of 200,000 kWh. If consumption exceeds this volume, the excess is billed according to the standard applicable tariff.

High Plateaus Provinces: Djelfa, El Bayadh, and Naâma:

Financing a 10% reduction on electricity bills for customers utilizing low- and medium-voltage electricity, pursuant to Interministerial Instruction No. 02 of August 7, 2001, concerning the reduction of electricity bills in southern provinces.

B. Indirect Electricity Price Subsidies

Indirect electricity subsidies take the form of compensating for the differential between the real cost-reflective price of electricity (encompassing all operating and capital costs) and its domestic market tariff in favor of the national electricity and gas company (Sonelgaz). This mechanism aims to

maintain electricity bills at an accessible level for designated segments of citizens on the one hand, and to ensure the financial equilibrium of the utility or reduce its structural deficit on the other¹³.

1.3. Theoretical Concepts of Sustainable Development

In light of the scarcity and uneven spatial distribution of natural, human, and capital resources, coupled with the increasing demand for them to achieve socio-economic development—and alongside the growing consciousness among nations, organizations, institutions, and individuals regarding environmental and societal challenges—a new paradigm of development emerged, known as sustainable development¹⁴. This concept was formally introduced in the Report of the World Commission on Environment and Development, titled *Our Common Future* and published in 1987¹⁵. Definitions and conceptualizations surrounding development and sustainability have since proliferated; the World Commission on Sustainable Development defined sustainable development as: "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

Furthermore, sustainable development was defined during the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil, in 1992, as: "the imperative to fulfill the right to development so as to equitably meet developmental and environmental needs of present and future generations."¹⁶

Synthesizing these definitions, sustainable development fundamentally aims to realize holistic progress across economic, social, and cultural domains without jeopardizing the right of future generations to benefit from natural assets and potential, while preserving the ecosystem and harnessing environmentally sound renewable energy sources.

1.3.1. Dimensions of Sustainable Development

Sustainable development rests upon three foundational pillars: the economic dimension, the social dimension, and the environmental dimension, summarized as follows:

A. The Economic Dimension:

The economic dimension of sustainable development aims to enhance economic growth rates by raising national and per capita income, fostering economic welfare to elevate living standards, and eradicating poverty.

B. The Social Dimension:

The social dimension centers on individuals as the core of development by striving to achieve social equity, alleviate poverty, and deliver essential social services, alongside consolidating democratic principles through transparent civic engagement in public decision-making¹⁷.

C. The Environmental Dimension:

The environmental dimension is grounded in preserving ecosystem integrity and safeguarding it against degradation, pollution, and resource depletion through regulatory and deterrent legal frameworks that ensure the optimal exploitation of natural endowments without disrupting ecological balance.

1.4. The Energy Efficiency Development Program in Algeria

Energy efficiency occupies a prominent position on the public policy agendas of numerous countries worldwide. It fundamentally signifies the reduction of energy waste, which yields commercial and industrial benefits, enhances energy security, and delivers environmental gains such as the mitigation of carbon dioxide emissions¹⁸.

The energy efficiency program in Algeria aims to produce the same level of goods and services using the least amount of energy possible, while safeguarding resources for future generations. This program encompasses all sectors, particularly the building, industrial, and transport sectors.

In this regard, Algeria has outlined an action plan to achieve primary energy savings amounting to 63 million tonnes of oil equivalent (Mtoe) by the 2030 horizon, distributed as follows:

Table (02): The Energy Efficiency Program Targeted by the 2030 Horizon

Sector	Program to be Promoted	Plan by the 2030 Horizon
Buildings (Residential and Tertiary Sectors)	Thermal insulation of buildings	Saving 7 million tonnes of oil equivalent (Mtoe) of energy
	Low-consumption light bulbs	Saving more than 20 million tonnes of oil equivalent (Mtoe) of energy
	Solar water heaters	Saving 02 million tonnes of oil equivalent (Mtoe) of energy
	Energy performance in public lighting	Saving 7 million tonnes of oil equivalent (Mtoe) of energy
Transport Sector	Liquefied petroleum gas as fuel (LPG/C) and natural gas as fuel (CNG)	Saving 16 million tonnes of oil equivalent (Mtoe) of energy
Industry Sector	Energy efficiency in the industrial sector	Saving 30 million tonnes of oil equivalent (Mtoe) of energy

Source: Compiled by the author based on the official website of the Algerian Ministry of Energy: <https://www.energy.gov.dz/?rubrique=energies-nouvelles-renouvelables-et-maitrise-de-lenergie> (Accessed on March 22, 2020)

2. Impacts of Fuel and Electricity Subsidies on the Environmental Dimension of Sustainable Development

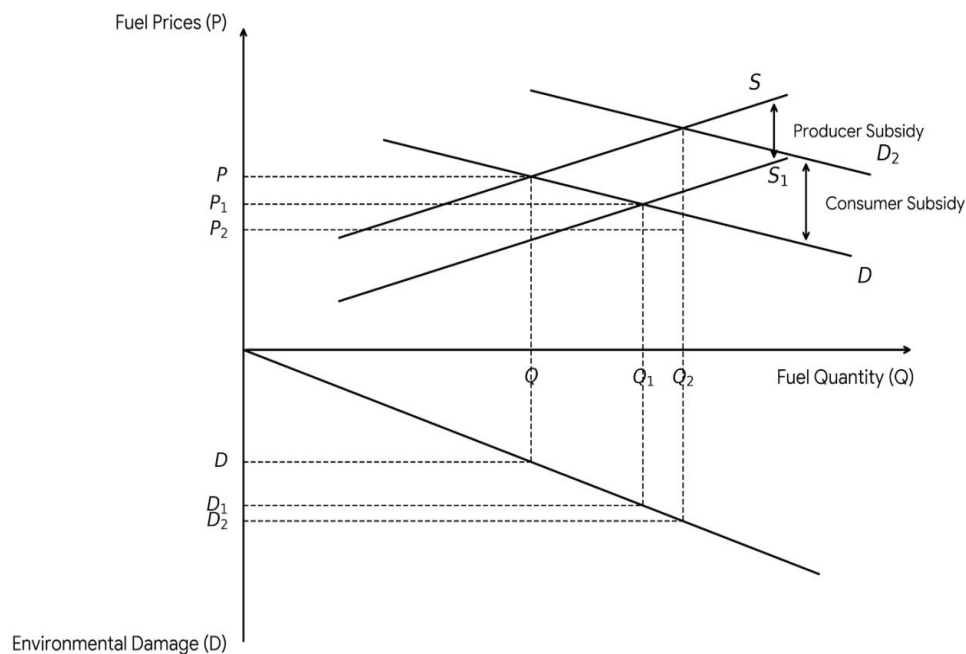
Despite the positive effects of energy subsidy policies, such as poverty alleviation, the achievement of social equity, and income redistribution in favor of low-income strata, the excessive consumption of subsidized energy commodities entails negative environmental ramifications.

– Energy commodity subsidies contribute to climate change by depressing fossil fuel prices, which incentivizes higher levels of production and consumption, and consequently amplifies emissions. In a study published in 2018 by a research team led by the International Institute for Applied Systems Analysis (IIASA), it was indicated that phasing out fossil fuel subsidies could reduce global greenhouse gas emissions by up to 5% through 2030; it would likewise contribute to mitigating climate change impacts and unlock investments in renewable energy¹⁹.

- Fuel subsidies can also impede the development of clean and renewable energy technologies—such as solar and wind power—which face difficulties in competing with subsidized fossil fuels²⁰.
- Furthermore, negative externalities arise from increased traffic volumes driven by subsidized fuel, manifesting in traffic congestion, elevated accident rates, and premature road infrastructure wear²¹.

The following diagram illustrates the environmental impacts of subsidies directed to producers and consumers:

Figure (01): The Impact of Fuel Subsidies on Environmental Pollution



Source: MORGAN, Trevor. "Reforming energy subsidies: opportunities to contribute to the climate change agenda". United Nations Publications, 2008. P19.

- **S:** Producer Subsidy Curve

- **D:** Consumer Subsidy Curve
- **Q:** Fuel Quantity
- **P:** Fuel Prices
- **D:** Environmental Damage

The diagram above illustrates how reducing energy costs for end consumers can lead to increased fuel combustion and consequently higher emissions, assuming that fuel utilization generates air pollution and greenhouse gas emissions that drive climate change.

Providing a per-unit production subsidy for fuel shifts the supply curve from S to S_1 , causing the price to fall to P_1 and the quantity of fuel sold to rise to Q_1 , which contributes to an increase in environmental damage from D to D_1 . Similarly, a per-unit consumption subsidy shifts the demand curve from D to D_2 , leading to a reduction in the price paid by the consumer to P_2 and an increase in the quantity of fuel consumed to Q_2 , thereby exacerbating environmental damage to D_2 ²².

To curb wasteful consumption that adversely affects the environment, numerous countries have adopted various measures based on deploying renewable technologies, procuring energy-efficient equipment, and investing in research and development within the clean energy sector²³. Furthermore, reforming energy subsidies requires²⁴:

- Identifying both intended and unintended beneficiaries of subsidies (for example, middle- and high-income households rather than low-income households);
- Identifying potential unintended consequences of inefficient energy use, which typically stem from market distortions and negative environmental impacts (for instance, subsidizing coal for power generation can act as a barrier to the transition toward renewable energy sources and generate additional greenhouse gas emissions).

3. Energy Efficiency as a Mechanism for Rationalizing Subsidies on Petroleum Products and Electricity

3.1. Thermal Insulation of Buildings

The building sector in Algeria accounts for 37% of final energy consumption. On the one hand, the expanding building stock and the growth of the service sector are driving up energy consumption; on the other hand, given its arid and semi-arid climate, Algeria remains vulnerable to climate change. This necessitates the implementation of building insulation to reduce cooling and heating energy demand. Consequently, controlling energy consumption in buildings represents a major challenge for the coming decades—an objective pursued by the National Building Thermal Insulation Program through²⁵:

- Insulating roofs and building envelopes, as well as installing high-performance joinery;
 - Training a qualified workforce;
 - Establishing a competitive market for materials and equipment dedicated to thermal insulation;
 - Mobilizing construction sector stakeholders regarding the importance of thermal insulation.
- This program benefits from technical support provided by the National Agency for the Promotion and Rationalization of Energy Use through the development of technical specifications aligned with energy efficiency measures, comprehensive oversight of project implementation, and the rollout of dedicated public awareness campaigns.

Additionally, the program receives financial support covering up to 80% of the additional capital expenditures associated with integrating thermal insulation, funded by the National Fund for Energy Management, Renewable Energies, and Cogeneration.

3.2. Development of Solar Water Heating

Regarding individual and collective domestic hot water usage, this program aims to substitute gas water heating with solar thermal systems by²⁶:

- Disseminating and deploying solar water heaters, particularly in individual dwellings and service sector facilities such as schools, mosques, public health centers, restaurants, etc.;
- Promoting local manufacturing industries for solar water heaters;
- Fostering sustainable markets for solar water heating technologies;
- Reducing the consumption of natural gas and liquefied petroleum gas (LPG) used for water and space heating.

This program receives technical assistance from the National Agency for the Promotion and Rationalization of Energy Use (APRUE) through the preparation of technical specifications meeting standard requirements for solar water heater quality, installation guidelines, maintenance protocols, and after-sales service, along with comprehensive project monitoring and targeted public awareness campaigns.

In addition, the program benefits from financial co-financing provided by the National Fund for Energy Management, Renewable Energies, and Cogeneration (FNMEERC).

3.3. Widespread Adoption of Energy-Efficient Lighting

Residential lighting accounts for 32% of total household electricity consumption in Algeria. This program seeks to replace all incandescent lamps with energy-efficient lamps in order to²⁷:

- Reduce electricity bills;
- Lower national energy consumption and mitigate greenhouse gas emissions;
- Foster the emergence of domestic markets for low-consumption lighting products.

The program is supported technically by the National Agency for the Promotion and Rationalization of Energy Use (APRUE) through the elaboration of technical specifications governing the quality standards of lighting equipment, as well as guidelines for installation, maintenance, and after-sales service, accompanied by overall monitoring of project implementation. It also receives co-financing from the National Fund for Energy Management, Renewable Energies, and Cogeneration.

Under the initial phase, the import of incandescent lamps will be banned, followed by a ban on their commercial distribution in the subsequent phase. Concurrently, domestic production of energy-efficient LED lamps will be promoted. Cumulative energy savings are estimated to reach approximately 20 million tonnes of oil equivalent (Mtoe) by 2030.

3.4. Integrating Energy Performance into Public Street Lighting

The energy efficiency program tailored for local municipalities aims to replace all energy-intensive mercury-vapor lamps with more energy-efficient lighting fixtures. This measure reduces municipal electricity expenditures and is projected to save approximately 1 million tonnes of oil equivalent (Mtoe) by 2030²⁸.

3.5. Promoting Energy Efficiency in the Industrial Sector

The industrial sector represents 16% of total final energy consumption in Algeria²⁹. The industrial energy efficiency program aims to incentivize manufacturing enterprises toward more rational energy consumption, addressing the challenge posed by increasing industrial energy demand. In this regard, the targeted energy savings are set at 30 million tonnes of oil equivalent (Mtoe) by the 2030 horizon. Under this program, key initiatives include:

- Generalizing industrial energy audits and optimizing manufacturing processes to identify significant energy-saving potential and establish corrective action plans;
- Curtailing excessive energy consumption across industrial processes through State-backed incentives and co-financing mechanisms.

3.6. Promotion of Liquefied Petroleum Gas and Natural Gas as Motor Fuels

The transport sector represents one of the largest energy-consuming sectors in Algeria, accounting for 41% of final energy consumption and relying primarily on liquid fuels. However, the use of liquefied petroleum gas as a motor fuel (autogas / LPG-c) does not exceed 5% of vehicle fuel consumption, while the growing consumption of other fuel types entails negative economic and environmental impacts.

The PROP-AIR program, targeted at private vehicle owners and taxi drivers, aims to convert over 1.1 million vehicles to autogas (LPG-c) by the 2030 horizon, including an intermediate target of 500,000 vehicles by 2021. This program aims to³⁰:

- Offset the domestic market fuel deficit and reduce the import bill that has been rising for years;
- Create employment opportunities through the vehicle LPG conversion sector;
- Provide cost-effective, environmentally friendly alternative energy sources.

This program benefits from technical support provided by the National Agency for the Promotion and Rationalization of Energy Use (APRUE) through the preparation of technical specifications meeting quality standards for LPG fuel conversion systems, in addition to regulations governing installation, maintenance, and after-sales service, along with comprehensive monitoring of program implementation. The program also benefits from financial support covering the installation costs of LPG vehicle kits, provided by the National Fund for Energy Management, Renewable Energies, and Cogeneration.

3.7. Algeria's Current Standing in Energy Efficiency According to the Arab Future Energy Index

The Arab Future Energy Index (AFEX) is an assessment tool designed to evaluate the development of renewable energy and energy efficiency across 20 Arab countries based on four evaluation pillars: energy pricing, institutional capacity, policy framework, and electricity utilities. Under these pillars, countries are evaluated according to 9 factors comprising more than 30 indicators³¹. Algeria ranked eighth in the Arab world in the overall Energy Efficiency Index for 2017, possessing a more comprehensive regulatory and legal framework in the field of energy efficiency compared to other Arab countries. Over the long term, it aims to implement a national program in renewable energies and energy efficiency by the 2030 horizon; however, subsidized fuel, electricity, and gas prices in Algeria represent a major challenge to the implementation of this program³²

4. Conclusion:

The objectives of energy subsidies in Algeria do not fundamentally differ from those of other countries; in addition to assisting low-income populations in accessing both fuel and electricity at affordable prices, they contribute to promoting certain emerging industries. However, the over-reliance on this policy has generated adverse environmental impacts resulting from the excessive consumption of fossil fuels.

Study Findings: The present study leads to the following findings:

Regarding the central research question, which focused on: To what extent do fuel and electricity subsidies impact sustainable development in its environmental dimension, and what are the mechanisms for their rationalization?

In Algeria, fuel products and electricity are provided at low costs due to the granted subsidies. This has contributed to excessive consumption, resulting in environmental challenges and greenhouse gas emissions. Consequently, this spurred the adoption of the National Energy Efficiency Program toward the 2030 horizon to reduce greenhouse gas emissions and mitigate the effects of global warming.

In light of the findings reached in this research paper, the key policy recommendations are as follows:

- Encouraging investment in alternative energy sources;
- Providing subsidies and support for biofuels to achieve sustainable development;
- Leveraging the successful experiences of leading countries in the circular economy;
- Gradually phasing out subsidies on fossil fuel consumption, thereby raising their relative cost and driving the transition toward clean alternative energy sources.

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Participants Information Form

Information Field	Participant 1	Participant 2
Surname	Harnane	Sabeg
First Name	Nadjet	Nawal
Country	Algeria	Algeria
Nationality	Algerian	Algerian
Position	Adjunct Lecturer	Adjunct Lecturer
Affiliation / Institution	University of khenchela	University of Oum El Bouaghi
Academic Rank	Adjunct Lecturer	Adjunct Lecturer
Highest Qualification	Magister	Master's Degree
Phone Number	0551347546	0673840900

Email Address	Nadjet.har@gmail.com	snawal1987@gmail.com
Track / Axis Number	Third Track	Third Track