

Algeria and the transition to renewable energy: the path to achieving energy security

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Abstract:

Within the framework of the dynamics of energy transition, Algeria, like many other countries in the world, seeks to use renewable energy sources to enhance its energy security by diversifying its energy mix and reducing its dependence on fossil fuels. The country enjoys great potential for renewable energy, especially solar and wind energy, due to abundant sunlight and strong winds in certain areas.

The aim of this study, after providing theoretical concepts about energy transition, energy security, and renewable energies, is to highlight the potential of renewable energy in Algeria by shedding light on current renewable energy projects in the country, as well as its future strategies and ambitious plans in this field.

Keywords: Energy transition, Energy security, Renewable energy in Algeria, Future strategies.

JEL Classification Codes : Q2, Q4.

Résumé:

Dans le cadre de la transition énergétique dynamique, l'Algérie cherche, comme de nombreux autres pays dans le monde, à utiliser des sources d'énergie renouvelable pour renforcer sa sécurité énergétique en diversifiant son mix énergétique et en réduisant sa dépendance aux combustibles fossiles. Le pays dispose de grandes potentialités en énergie renouvelable, notamment en énergie solaire et en énergie éolienne, en raison de l'abondance de soleil et de vents forts dans certaines régions.

Cette étude vise, après avoir présenté des concepts théoriques sur la transition énergétique, la sécurité énergétique et les énergies renouvelables, à mettre en évidence les potentialités de l'énergie renouvelable en Algérie en mettant en lumière les projets d'énergie renouvelable en cours dans le pays, ainsi que ses stratégies futures et ses ambitieux plans dans ce domaine.

Mots-clés: transition énergétique, sécurité énergétique, énergie renouvelable en Algérie, stratégies futures.

Jel Classification Codes: Q2, Q4.

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I. Introduction

Algeria is a North African country with a rich history and diverse culture. It is the largest country on the continent and the tenth largest in the world. Algeria is also one of the largest producers and exporters of oil and natural gas in Africa, making it a major player in the global energy market. However, like many other countries, Algeria faces challenges in meeting its energy needs while also addressing the environmental impacts of traditional energy sources.

Transitioning to renewable energy is seen as a key path to achieving energy security in Algeria. The country has vast solar and wind resources that can be harnessed to produce clean energy. In recent years, Algeria has taken steps to develop its renewable energy sector, with a goal of increasing the share of renewables in its energy mix to 27 % by 2030.

One of the main challenges facing Algeria in its transition to renewable energy is the need for investment and technology transfer. The government has recognized the importance of attracting foreign investment to support the development of renewable energy projects, and has implemented policies and incentives to encourage investment. In addition, Algeria has partnered with international organizations and countries to facilitate technology transfer and knowledge sharing.

Another challenge is the need to develop a regulatory framework and infrastructure to support the growth of renewable energy. This includes establishing clear policies and regulations to govern the sector, as well as investing in grid infrastructure to support the integration of renewable energy into the national grid.

Despite these challenges, Algeria has made significant progress in its transition to renewable energy in which it is characterized by a great diversity in its sources. The country has already developed several solar and wind projects, and has launched initiatives to promote energy efficiency and conservation. With continued investment and policy support, Algeria has the potential to become a leader in renewable energy and achieve energy security while also addressing the challenges of climate change.

Based on the above, we tried to formulate the main problematic of this study as follows:

- **What are the opportunities and challenges of transitioning to renewable energy sources in Algeria? And how can the country effectively harness its renewable energy potential to achieve sustainable economic growth?**

- **Objectives of the study**

The main objective of this study is to shed light on the promising potentials of renewable energies in Algeria, and the feasibility of developing and exploiting these resources within the framework of Algeria's energy transformation; and for drawing a theoretical framework for renewable energies and the reality of the energy transition.

- **The importance of studying**

The transition to renewable energy for achieving energy security lies in the fact that traditional energy sources such as fossil fuels are finite and can lead to environmental degradation and political instability. Renewable energy sources, on the other hand, are abundant and sustainable, and can provide a reliable and affordable source of energy for the long term. By studying the transition to renewable energy, we can better understand the potential benefits and challenges associated with this shift, and develop strategies and policies to facilitate a smooth and successful transition to a more sustainable energy.

- **Study contents**

In order to understand the aspects of the subject and answer its problems, we tried to divide the study into the following axes: The first axis: a conceptual introduction to energy transfer and renewable energies and energies; The second axis: the components and reality of renewable energies in Algeria.

II. The concept of Energy transition

Energy transition as the "process of transforming the energy sector from one based on the extraction and combustion of fossil fuels to one based on renewable energy sources, energy efficiency, and the electrification of transportation" . (Diesendorf, 2019, p. 131). The energy transition is driven by environmental and economic imperatives, including the need to mitigate climate change, reduce air pollution, and achieve energy security. The technical and economic feasibility of. renewable energy sources such as solar, wind, and hydro, and notes that they are becoming increasingly competitive with fossil fuels. Hence, the energy transition involves a transformation of the entire energy system, including changes in energy production, distribution, and consumption patterns. A successful energy transition requires a combination of policies, technologies, and social change. (Diesendorf, 2019, p. 152)

III. The concept of energy security

Energy security refers to the uninterrupted availability of energy sources at an affordable price. It encompasses various dimensions, such as physical security, economic security, environmental security, and social security. Energy security is essential for the functioning of modern societies and economies, as it underpins a range of critical activities, including transportation, industrial production, and heating and cooling of buildings. (Dannreuther, 2018, p. 1)

III.1 The concept of energy security in the importing countries

III.1.1 The American concept of energy security

The United States concept of energy security has evolved over the past century in response to changing circumstances. Today, the United States relies heavily on oil for transportation, natural gas and coal for electricity, and nuclear power for baseload electricity. However, the U.S. energy system is facing a number of challenges, including increasing demand, aging infrastructure, climate change, and geopolitical risks. To address these challenges, the U.S. concept of energy security focuses on diversifying the country's energy mix, promoting energy efficiency and conservation, and developing alternative sources of energy such as renewables and nuclear power. The U.S. also seeks to reduce its dependence on foreign oil by increasing domestic production and expanding energy trade with friendly countries. Additionally, the U.S. works to protect energy infrastructure and critical assets from physical and cyber threats, and to maintain market stability and global energy security through multilateral cooperation and diplomacy. (Luft, 2011, pp. 15-16)

III.1.2 Chinese concept for energy security

The Chinese concept of energy security has undergone significant changes since the 1990s, reflecting both domestic and international factors. The country's primary energy sources are coal, oil, and natural gas, and it has become increasingly reliant on imports of these resources in recent years. This has raised concerns about supply security, price stability, and environmental sustainability. To address these challenges, the Chinese concept of energy security focuses on increasing domestic production, diversifying energy sources, promoting energy conservation and efficiency, and developing alternative sources of energy such as renewables and nuclear power. The government has also taken steps to secure energy supplies from abroad through strategic partnerships and investment in overseas oil and gas reserves. In addition, China has established energy reserves and emergency response mechanisms to mitigate the risks of supply disruptions. At the same time, the Chinese concept of energy security is closely linked to the country's broader strategic goals, including economic

development, social stability, and regional influence. China views energy security as an integral part of its national security strategy, and seeks to balance its domestic and international energy interests while avoiding dependence on any single country or region. (Lai, 2016, pp. 1-2)

III.2 The concept of energy security in exporting countries

III.2.1 Russian concept for energy security

Energy security is one of the central concepts in Russia's foreign policy. Its interpretation and implementation, however, has evolved considerably over time. During the 1990s, the focus was on the development of the energy sector and the expansion of exports. The need to ensure reliable supplies to domestic and foreign consumers was the main priority. In the 2000s, the focus shifted towards the protection of national interests in the energy sector, particularly in the context of Russia's strained relations with the West. The concept of energy security became closely linked to national security and the country's strategic goals. The emphasis was on the need to prevent external interference in Russia's energy affairs, particularly by the United States and its allies. Since then, the concept of energy security has become more multifaceted, reflecting the growing complexity of the global energy landscape. Russia's approach to energy security now involves a combination of market-oriented policies and state intervention, with the goal of balancing economic, political, and social considerations. The key components of Russia's concept of energy security include the development of domestic energy resources, the expansion of export markets, the establishment of long-term partnerships with other energy-producing countries, and the diversification of energy supplies and transportation routes. In addition, Russia has sought to promote cooperation with other countries on energy-related issues, particularly within the framework of international organizations such as the G20 and the International Energy Agency. Overall, the Russian concept of energy security reflects the country's desire to maintain its status as a major energy producer and exporter, while balancing economic, political, and social considerations at home and abroad. (Kozhanov, 2016, pp. 1-2)

III.2.2 Saudi concept for energy security

Saudi Arabia's energy security strategy is a multifaceted approach that aims to ensure reliable and sustainable energy supplies to meet the country's growing demand while also diversifying its energy mix and reducing its reliance on oil exports. One of the key components of this strategy is the Saudi Vision 2030, which includes a range of initiatives to promote energy efficiency, renewable energy development, and technological innovation. Additionally, the country has established several entities to oversee its energy security policies, including the Ministry of Energy, the Saudi

Arabian Oil Company (Saudi Aramco), and the King Abdullah City for Atomic and Renewable Energy (K.A.CARE). These entities work together to implement the government's energy policies, monitor energy production and consumption, and promote research and development in the energy sector. Moreover, Saudi Arabia has also been actively involved in global energy governance initiatives, such as the G20 Energy Ministerial Meetings, to promote cooperation and collaboration with other countries on energy issues. Saudi Arabia is also a member of the Organization of the Petroleum Exporting Countries (OPEC), which enables it to coordinate with other oil-producing nations to stabilize global oil markets. (Saudi Arabia's Energy Security, 2019)

III.3 The trends of energy security

Encompass several areas and concepts that evolve with changes in economic, political, technological, and environmental conditions. Among these trends are:

- The global economy's shift towards reliance on clean and renewable energy sources such as solar, wind, hydrogen, and safe nuclear energy; (Net Zero by 2050, 2021)
- The trend towards diversifying energy sources and improving their efficiency, which helps reduce reliance on fossil fuels that are unsustainable and environmentally polluting; (Net Zero by 2050 : A Roadmap for the Global Energy Sector, 2021)
- The improvement of energy production, storage, and distribution technology, encouraging innovation in these areas, and utilizing digital and artificial intelligence technologies to improve energy management; (Energy Technology Perspectives : Catalysing Energy Technology Transformations, 2019)
- Strengthening international cooperation and strategic partnerships to achieve energy security, exchanging experiences, technologies, and information in this field; (Energy Security, 2021)
- Providing energy at reasonable prices for consumers, improving energy consumption management, and controlling excess consumption; (Energy Efficiency : Analysis and Outlooks to 2040, 2019)
- Confronting security, economic, and environmental challenges related to energy sources, such as terrorist attacks, geopolitical conflicts, environmental pollution, and climate change. (Energy Security, 2021)

IV. Concept of renewable energy

Renewable energy refers to energy that is generated from renewable resources that are naturally replenished, such as sunlight, wind, rain, tides, and geothermal heat. Unlike non-renewable energy sources such as coal, oil, and natural gas, which are

finite and can be depleted, renewable energy sources are virtually unlimited and can provide energy for an indefinite period of time. Renewable energy technologies include solar photovoltaic, solar thermal, wind power, hydroelectric power, geothermal energy, and bioenergy. These technologies have made significant progress in recent years, and have become increasingly competitive with traditional fossil fuel-based energy sources. the increased deployment of renewable energy is essential for achieving a sustainable and low-carbon energy system, and for addressing the challenges of climate change, energy security, and access to energy. The authors highlight the importance of policies and incentives that support the deployment of renewable energy, and stress the need for collaboration between different stakeholders, including governments, businesses, and civil society. (Boyle, 2012, p. 71)

IV.1 Definition of renewable energies at the internal level

The Algerian legislator focused in his definition of renewable energy on identifying its sources:

- The Algerian legislator defined it in Article 03 of Law N° 04-09 as "forms of electrical, kinetic, thermal, or gaseous energy obtained from the conversion of solar radiation, wind power, geothermal energy, organic waste, hydropower and techniques for using biomass";
- The set of methods that allow significant energy by savings. These can be done by resorting to techniques of bioclimatic engineering in the construction process.

The definition provided by Executive Decree 17-98, which specifies in Article 02 the procedure for requesting bids for the production of renewable energy is "all energy derived from hydraulic sources, solar energy, thermal energy, wind energy, geothermal energy, solar energy, biomass, as well as waste recovery." (Article 2 Executive Decree No. 17-98, 2017)

The renewable energy sources can be listed in the following elements:

- **Solar energy:** Solar energy is a type of renewable energy that comes from the sun. It is the conversion of the sun's energy into electricity or heat. The sun's energy is harnessed through the use of solar panels or collectors that absorb sunlight and convert it into usable energy. Solar energy is a clean, sustainable, and abundant source of energy that has the potential to reduce our dependence on fossil fuels and mitigate climate change. (Bührke, 2013, p. 78)
- **Wind power :** Wind power is a form of renewable energy that converts the energy of the wind into electricity. The kinetic energy of the wind is harnessed by wind turbines, which are large structures with blades that rotate when the wind blows. The rotation of the blades drives a generator that produces electricity. Wind power is a clean, sustainable, and abundant source of energy

that has the potential to reduce our dependence on fossil fuels and mitigate climate change. (Boyle, 2012, p. 71)

- **Bioenergy** : Bioenergy is a form of renewable energy that comes from biomass, which is any organic material that comes from plants or animals. Bioenergy is produced by converting biomass into heat, electricity, or biofuels such as ethanol and biodiesel. Bioenergy is a clean and sustainable source of energy that has the potential to reduce our dependence on fossil fuels and mitigate climate change. (Dahiya, 2013, p. 3)

V. Elements of the transition to renewable energies in Algeria

V.1 Solar capacities

Algeria has important solar capacities distributed as follows:

Table (01): potential of solar energy in Algeria

Areas	Coastal area	Plateaus	Desert area
Area (%)	4	10	86
"Average duration of sunrise (hours/year)"	2650	3000	3500
"The rate of energy obtained (kWh/m ² /year)"	1700	1900	2650

Source: Ministry of Energy and Mines, Renewable Energies Guide 2007, Algeria, 2007, p. 39

Through the presented table, we can say that the Algerian desert is a large reservoir of solar energy, as its vast desert region receives over 2600 annual hours of sunshine (collection a significant amount of solar energy). The amount of energy extracted daily on a horizontal area of 1 square meter can be calculated to be around 5 kilowatt-hours. In general, the amount of solar energy extracted in most parts of the Algerian territory ranges from approximately 1700 kilowatt-hours per square meter per year in the north to 2263 kilowatt-hours per square meter per year in the south.

Table (02): The updated National Renewable Energy and Energy Efficiency Program 2015-2030.

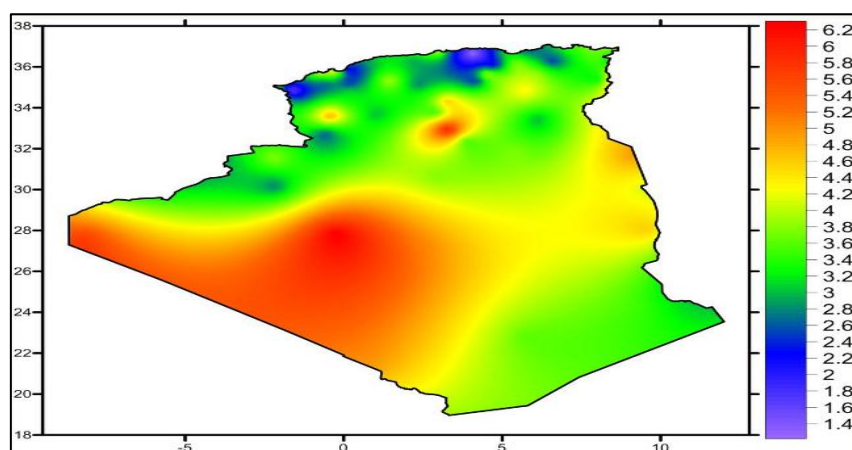
	Phase One 2015-2020	Phase Two 2021	Total
Solar cells	3000	10575	13575
Wind	1010	4000	5010
Solar thermal	-	2000	2000
Cogeneration	190	250	440
Biomass	360	640	1000
Geothermal	05	10	15
Total	4525	17475	22000

Source: CEREFÉ, Energy Transition in Algeria, 2020, p. 50.

V.2 Wind power capabilities

Wind energy resources in Algeria vary by region, with wind speeds increasing particularly in the southwest, where they exceed 4 m/s. In 2017, the Renewable Energy Development Center published a new wind Atlas based on a database containing hourly and three-hourly wind speeds recorded for 10 consecutive years from 2004 to 2014 at 74 weather stations in the National Meteorological Observatory, in addition to 21 additional stations in neighboring countries. This is illustrated in the following figure:

Fig (01): Atlas of wind speed in Algeria at a height of 10 meters on earth (m/sec)



Source: Renewable Energy Development Center, 07/03/2023,
<https://www.cder.dz/spip.php?article3584>

Due to the almost uniform geographical distribution between the north and south, the new Algerian wind Atlas reflects estimated changes in wind sources compared to the previous Atlas, especially in desert areas, at a height of 10 meters above ground level. Among the sites listed in the Atlas, the Ain Salah site shows an average speed of 4.6 meters per second near Adrar, which recorded 3.6 meters per second. The Illizi province, which contains numerous stations, shows speeds exceeding 5 meters per second, while the average wind speed in HassiR'mel site is 5.6 meters per second. It is important to note that some sites such as Ksar Chellala, Bousaada, and Tébessa show negligible values (less than 50 percent), which greatly reduces their potential for wind energy utilization.

V.3 Hydropower: The electricity production capacity from irrigation in Algeria is 286 megawatts, which represents 5% of the total electricity production. Despite the existence of some water sites, the production capacity from this source is weak due to the insufficient number of irrigation sites and the non-utilization of available sites. The hydropower station at Bermaia in the Jijel province was rehabilitated with a capacity of 100 megawatts in 2005. The figure below illustrates the hydropower production in Algeria during the period of 2007-2018.

Table (03): Hydropower Production in Algeria for the period 2007-2018
Unit: Gigawatt-hour (GWh)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Production	226	283	342	173	378	389	98	193	145	72	56	117

Source: IRENA (2018, 2019, 2020), Renewable Energy Statistics, The International Renewable Energy Agency, Abu Dhabi.P: 26. Availableon: www.irena.org.

The table shows an increase in hydroelectric power production from 226 Gigawatts in 2007 to 389 Gigawatts in 2012, where production peaked. However, production declined thereafter, reaching its lowest level in 2017 at 56 Gigawatts and subsequently, hydroelectric power production increased to 117 Gigawatts in 2018.

V.4 Biomass capabilities: Algeria possesses significant potential for biomass energy, with its forests having a capacity of 37 million tons of oil equivalents and urban waste having a capacity of 30 million tons. Although the Maritime Pine and Calotropis represent only 5% of Algeria's forests, they are crucial for energy usage. Additionally, agricultural waste, such as olive and date products, is an essential source of biomass energy in the country.

V.5 Geothermal Energy: There are more than 200 geothermal sources located in the north of Algeria, with temperatures exceeding 45 degrees Celsius in one-third of them and reaching 118 degrees Celsius in Biskra.

VI. Energy Transition in Algeria and the Role of Renewable Energy in Achieving It

The Algerian Government considers energy transition an inevitable necessity imposed by the situation of the traditional fuel production sector, which is witnessing a slowdown in production. In addition, the level of energy consumption within Algeria is increasing as a result of adopting an energy pricing policy that encourages excessive consumption of electricity and all forms of energy in general. This leads to a reduction in Algeria's exports of fuels or even resorting to imports.

VI.1 Conditions for the energy transition in Algeria

Achieving energy transition and improving energy efficiency in Algeria depends on meeting a set of conditions, including the following:

- Providing a clear and comprehensive legal and regulatory framework for renewable energy and energy efficiency;
- Promoting and encouraging private sector investment in renewable energy projects and energy efficiency initiatives;
- Enhancing the capacity of national institutions to design, implement, and monitor renewable energy and energy efficiency policies and programs;

- Raising awareness and educating the public about the benefits of renewable energy and energy efficiency, and promoting behavioral changes to reduce energy consumption;
- Strengthening research and development activities to support the development and deployment of new renewable energy technologies and energy efficiency measures;
- Ensuring the availability of adequate financing mechanisms and incentives to support renewable energy and energy efficiency projects;
- Developing and implementing energy efficiency standards and labeling programs for appliances and buildings;
- Improving the integration of renewable energy into the national electricity grid and developing a robust and flexible electricity system that can accommodate a high share of renewable energy;
- Fostering international cooperation and partnerships to share best practices and experiences in renewable energy and energy efficiency.

VI.2 Key factors that could help Algeria achieve an energy transition:

-Political Will: One of the most important factors for achieving energy transition is political will. The government must be committed to implementing the necessary policies, regulations, and incentives to drive the transition towards renewable energy sources.

- **Investment:** Algeria will need to invest in renewable energy infrastructure, including wind, solar, and hydropower. This investment will require both public and private funding;
- **Regulatory Framework:** A supportive regulatory framework that encourages renewable energy development, energy efficiency measures and reduction of carbon emissions should be in place;
- **Technological Advancement:** Developing and adopting new and advanced technologies that improve energy efficiency and reduce carbon emissions is a key element for achieving an energy transition;
- **Public Awareness:** Public awareness and education is important to raise awareness of the benefits of renewable energy, energy efficiency, and the importance of reducing carbon emissions. This can help drive support for policies and investment in renewable energy;
- **International Cooperation:** Algeria can benefit from international cooperation in terms of technical assistance, knowledge sharing, and access to international markets for renewable energy technologies. Overall, achieving an energy transition in Algeria will require a multi-faceted approach that includes a combination of policies, investments, and public awareness.

VII. The development Structures and outcome of the exploitation of renewable energies in Algeria:

VII.1 Policies supporting the National Renewable Energy Program in Algeria

National policies have been developed in Algeria to promote and enhance renewable energy as part of sustainable development. These policies rely on a group of economic entities and institutions, each responsible for developing renewable energy within its scope of expertise. In addition, other research centers have been established in Algeria to encourage research in this field, and each entity will be defined separately.

- **The National Agency for the Promotion and Rationalization of Energy Use (APRUE)**

It was established on August 25, 1985, with the role of implementing the state's policy in controlling energy consumption, promoting renewable energy, and implementing sectoral programs related to energy use, especially in industry, transportation and agriculture. (Makhlouf, 2020, p. 9)

- **The Solar Equipment Development Unit**

This unit was established on January 9, 1988, in Tipaza. It is responsible for developing solar equipment, producing experimental models related to solar equipment with thermal effects for domestic, industrial and agricultural use, as well as solar equipment with voltage lighting for domestic and agricultural use. It is also responsible for developing electrical, thermal and mechanical systems that contribute to the development of solar equipment. (Abd Erzzag Fawzi, 2014, p. 37)

- **Silicium Technology Development Unit**

This unit was established in 1988 and operates under the auspices of the Ministry of Higher Education and Scientific Research. Its mission is to conduct scientific research, innovation, evaluation, and training in the fields of material sciences and semiconductor devices for applications in several fields. It also collaborates with universities to develop knowledge and transform it into technological skills and necessary products for economic and social recovery. (Bouzeroura Lynda, 2019, p. 155)

- **Center for Development of New and Renewable Energies**

On March 28, 1998, the Ministry of Higher Education and Scientific Research founded the Center in Bouzareah. The center's primary goals are to conduct research programs focused on renewable energy, specifically solar energy, and to devise strategies to harness these sources of energy.

- **The Applied Research Unit for Renewable Energies (CDPER)**

(CDPER) is an Algerian research institution that was established in 1997. The center is committed to advancing sustainable development through the promotion of renewable energy solutions. CDPER collaborates with universities and research centers to conduct research and provide training on renewable energy in Algeria.

- **The Algerian Company for New Energies (CANE)**

(CANE) is a state-owned enterprise in Algeria that focuses on the development, implementation, and management of renewable energy projects. CANE's mission is to contribute to the country's energy transition by diversifying its energy sources and promoting sustainable development. The company is responsible for implementing various renewable energy projects in Algeria, including solar, wind, and hydroelectric power plants. CANE also collaborates with national and international partners to advance renewable energy research and development and to promote the use of renewable energy in Algeria. (Algerian Company for New Energies (CANE), s.d.)

- **Applied Research Unit in Renewable Energy in Desert Regions**

This unit was founded in 2004 and falls under the Renewable Energy Development Center. It participates in all scientific research activities and technology development carried out within the unit as part of the National Program for Research in Renewable Energies. It specializes in conducting research aimed at improving and enhancing the use of renewable energies in desert regions.

- **Electricity and Gas Research and Development Center (CREDEG)**

Its main responsibilities include providing consultations and technical support, certification in the field of industrial electricity and gas, approving electricity and gas devices used by local consumers, and testing electrical and gas tools and equipments. It also seeks to introduce new technologies and innovations through applied research and experiments, and to develop the use of renewable energies and improve them. Additionally, it manages, monitors, and distributes technical references.

- **Algerian Institute of Renewable Energy**

This institute primarily contributes to the training efforts carried out by the state in the field of renewable energy, as it offers training in areas such as engineering, security and safety, energy auditing and project management.

VII.2 The legal and legislative framework for renewable energy in Algeria

In this context, Algeria has developed several incentive mechanisms under legal frameworks to regulate and define the roles of various entities involved in the optimal

investment and exploitation of renewable natural resources. Some of the most important laws are:

- **The Decree dated 28/12/1988:** Related to the connection of solar equipment development units to the Renewable Energy Center;
- **Law N° 02-01 dated February 5, 2002:** Relates to electricity and the public distribution of gas. It is considered as the first legislative framework to address the marketing of electricity produced from renewable sources, promote the use of renewable energies, and integrate the environmental commitments defined by the regulations; (Nassima, 2019, p. 536)
- **Law N° 04-09 dated August 4, 2004:** Concerns the promotion of renewable energies within the framework of sustainable development. It provides for the formulation of a national program to promote renewable energies, as well as the encouragement and promotion of the development of renewable energies. The law also establishes a national observatory for renewable energies, which is responsible for their promotion and development; (Ilyas Hannache, 2017)
- **Presidential Decree N° 12-416, dated December 11, 2012:** Includes the ratification of the memorandum of understanding between the Government of Algeria and the Government of Tunisia in the fields of energy management and renewable energies. This includes cooperation and collaboration on controlling energy consumption and promoting the use of renewable energy sources in both countries;
- **Decree N° 17-89, dated February 26, 2017:** Which sets out the procedure for tendering renewable energy production. Or those emanating from joint production and the integration of the national system for electricity supply;
- **Executive Decree N° 20-322 of November 22, 2020:** Defines the powers of the Minister of Energy Transition and Renewable Energies; (Algerian Official Gazette, 2020, p. 3)
- **Executive Decree N° 20-323 dated November 22, 2020:** Which regulates the central administration of the Ministry of Energy Transition and Renewable Energies. (Algerian Official Gazette, 2020, p. 5)

VII.3 The Algerian Future Strategy for Renewable Energy 2011-2030

In 2011, a significant and promising program was launched in Algeria to develop and promote renewable energy. This program is set to continue for twenty years until 2030 and was adopted by the Algerian government on February 2, 2011, with the aim of developing and utilizing the available renewable energy sources in the country, such as solar and wind energy. The program also aims to achieve diversity in energy sources, extend the assumed lifespan of national fossil fuel reserves, achieve energy security for the country and meet environmental goals. As part of this program, a

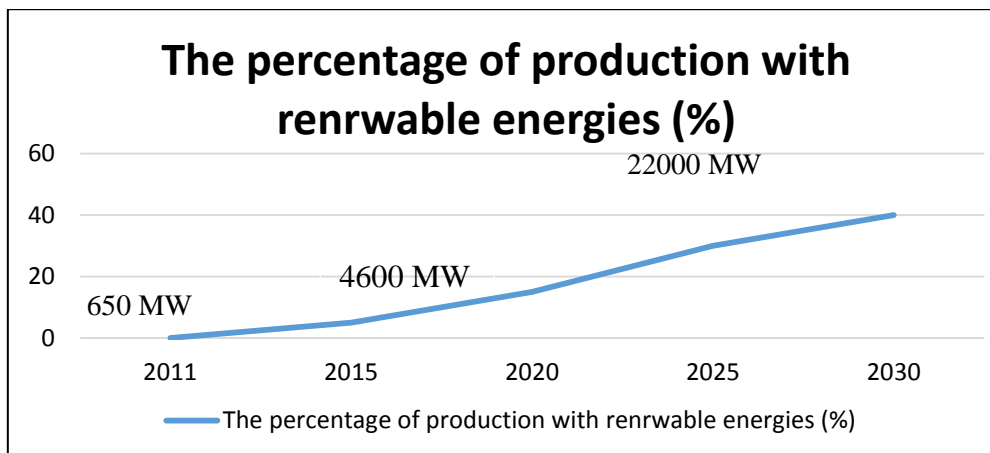
renewable energy fund was established under Executive Decree No. 11-423 in December 2011 to support and finance investment in the field of renewable energy. Three basic stages were outlined for the implementation of this program as follows: (Algerian Official Gazette, 2020, p. 53)

- **The first phase:** (2011-2013) focused on developing pioneering (model) projects to select various available technologies;
- **The second phase:** (2014-2015) characterized by the implementation of the program dissemination;
- **The third phase:** (2016-2030) is dedicated to the wide-scale implementation of the program.

During the period between 2011 and 2030, of which 12,000 megawatts are dedicated to covering the national demand for electricity and 10,000 megawatts for export. Around 40% of electricity production will be directed for domestic consumption from renewable sources, and solar energy is the main axis of the renewable energy program. It is expected to contribute 37% of the total national electricity production between 2011-2030. Wind energy is the second axis of development, with its share estimated to reach 3% of the total national electricity production in 2030. The program includes the construction of 60 stations between photovoltaic solar, concentrated solar, wind region and others. Achieving this program will allow reaching a share of renewable energies of 27% of the national electricity production by 2030. Producing 22,000 megawatts of renewable energy targeted by this program will save 300 billion cubic meters of natural gas, which is equivalent to 8 times the national consumption for one year (2014). (Algerian Official Gazette, 2020, p. 15)

The program will consist of installing up to 22,000 megawatts by 2030, which represents 40% of renewable energy generation capacity between 2011 and 2030. It is planned to use 12,000 megawatts of the project's energy to meet local electricity demand, while the remaining 10,000 megawatts will be directed for export over the next two decades.

Fig (02): Expected penetration rate of renewable energies in national production



Source: The Electricity and Gas Regulatory Commission (CREG), 2011-2030, March 2011, p.9.

The figure shows that Algeria's strategy for integrating renewable energy into the energy mix is done through stages without completely abandoning the use of fossil fuels. This explains the government's direction towards diversifying energy sources and gradually integrating renewable energy into the national energy and economic system as a whole.

The stages included in the renewable energy program are (The Commission for the Regulation of Electricity and Gas (CREG), 2011, p. 9)

- In 2013, a total capacity of 110 megawatts was installed, including 30 megawatts from the hybrid power station in Hassi R'mel;
- By 2015, it is expected that a total capacity of up to 650 megawatts will be installed;
- By the year 2020, an expected total capacity of around 2600 megawatts will be installed for local use, with the possibility of exporting up to 2000 megawatts;
- By the year 2030, an expected total capacity of around 12000 megawatts will be installed for local use, with the possibility of exporting up to 10000 megawatts. The Algerian Ministry of Energy and Mining expects that around 40% of the electricity generated from the project will be produced using renewable energy sources by 2030, with 37% coming from solar energy and 3% from wind energy.

The renewable energy development program included the implementation of around sixty solar power plants and wind energy areas by 2020. Renewable energy projects for electricity production for the domestic market will be implemented in two stages:

- Phase One 2015-2020: This phase will witness the completion of 4000 MW of energy from solar and wind sources, and 500 MW from biomass, cogeneration, and geothermal sources";
- Phase Two 2021-2030: The development of electrical interconnection between the north and the Sahara (Adrar) will enable the installation of large renewable energy stations in the regions of Ain Salah, Adrar, Timimoun and Bechar, and their integration into the national energy system.

The importance of the renewable energy program in achieving sustainable development in Algeria is highlighted, as it is expected to have positive effects on all economic and social sectors throughout the country. Among these effects, we can mention:

- Preserving natural resources and reducing the use of fossil fuels, which leads to a reduction of carbon dioxide emissions by 900 billion metric tons of CO₂ equivalent CO₂e";
- Developing a local industry for renewable energy equipment, with over 80% of it being integrated by Algerian institutions;
- In addition, a network of contracting companies is being established in the industry of necessary mixtures for the expected power plants;
- Technology transfer in the field of renewable and new energy, and improving the capabilities and experiences of Algerian experts, researchers, and engineers in this field, leading to achieving 100% of renewable energy projects by Algerian hands. This creates thousands of new job opportunities for Algerian youth and talents, and improves the quality of life for residents living in remote areas of the country.

Renewable Energy Investment Development Plan, Whereby the capacity of renewable energy will be installed according to the characteristics of each region as follows:

- Desert area: to hybridize existing centers and supply scattered sites based on the availability of space and the importance of capacities of solar and wind energy;
- Plateaus: According to its capacity for solar radiation and wind, with the possibility of acquiring land parcels;
- Coastal areas: according to the availability of real estate facilities and utilizing all spaces such as rooftops, balconies, buildings and other unused areas.

A national research program has been developed to accompany the strategy for renewable energy development. The scientific objectives of this program aim to evaluate renewable energy resources, control the process of converting and storing

these energies, and develop the necessary skills, from studying to completing the installation site.

VIII. Conclusion

While Algeria has faced challenges in its transition to renewable energy, including the need for investment and technology transfer, it has made, in turn, significant progress in recent years. It has implemented policies and incentives to attract and to encourage investment in renewable energy projects, but infrastructure development remains a critical challenge in addition to the necessity of establishing a clear regulatory framework for the renewable energy sector.

The article discusses the potential of Algeria to develop the above mentioned sector, particularly in solar and wind power given the abundance of both of those resources. Algeria can accelerate its transition to renewable energy by addressing the challenges and implementing the recommendations inferred which mainly consist of increasing investment in renewable energy projects, expanding its infrastructure, and fostering partnerships with international organizations and knowledge sharing in order to achieve its energy security goals.

Finally, it can be said that Algeria's transition to renewable energy represents a critical path towards achieving energy security, reducing greenhouse gas emissions, and meeting the country's growing energy demand. In general, Algeria has a significant potential to develop renewable energy projects that can help to reduce its reliance on fossil fuels and diversify its energy mix which can contribute to promote energy efficiency and its conservation.

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