The energy transition in Algeria and the role of solar energy in achieving environmental sustainability - the case of solar energy projects in the south -

Imane Khiati [1], Ali Talem [2]

[1] Faculty of Economic, Commercial and Management Sciences, Development of Algerian economic enterprise Laboratory, University of Tiaret, Algeria, imane.khiati@univ-tiaret.dz

[2] Faculty of Economic, Commercial and Management Sciences, University of Tiaret, Algeria, ali.talem@univ-tiaret.dz

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Abstract:

This study is dedicated to emphasizing the significance of the energy transition process and the integration of renewable energy sources within energy initiatives. It underscores the pivotal role of solar energy projects in southern Algeria in fostering environmental sustainability and mitigating the emission of harmful gases. Employing a descriptive analytical approach, our study thoroughly examines the centrality of the energy transition and its multifaceted implications. Solar energy emerges as a distinct renewable energy source in its capacity to promote environmental cleanliness.

Keywords: energy transition, renewable energies, solar energy, environment.

JEL Classifications Codes: Q2, Q560, O550

1. INTRODUCTION

The ongoing global energy transition is a critical endeavor geared towards sustainable development and enhanced energy security to safeguard future energy provisions. This transformative shift stands as an integral component of veering away from fossil fuel dependencies towards harnessing clean and sustainable renewable energy sources. Aligned with expert consensus on the challenges associated with fossil fuel availability, market dynamics, and price volatility, this transition assumes paramount importance.

Algeria boasts substantial potential in conventional energy reserves like oil, gas, and coal, ranking amongst the foremost producers of premium-grade crude oil. The national economy heavily relies on these conventional sources. Nevertheless, in light of policies aimed at curbing global warming, there exists a pressing need to curtail the consumption of traditional energy sources. Consequently, akin to other nations, Algeria is embarking on the energy transition journey and tapping into renewable energy outlets to uphold environmental equilibrium.

Strategically situated with abundant resources in renewable energies, particularly solar energy, and blessed with ample sunshine hours, southern Algeria emerges as a pivotal alternative energy source capable of bolstering energy security, enhancing energy efficiency, slashing gaseous emissions from fossil fuels, and catalyzing advancements in renewable energy investments to foster nascent industries and uplift the national energy infrastructure.

Hence, the energy transition in Algeria necessitates cohesive collaboration between the public and private sectors, alongside incentivizing research and development investments in the realms of renewable energy and streamlining the energy sector's transition towards a green and sustainable trajectory.

Problem Statement: Given the foregoing, we pose the following research questions: To what extent has the energy transition progressed in Algeria? What role does solar energy play in advancing environmental sustainability?

To address these queries, we propose the following hypotheses:

Hypothesis 1: Algeria's renewable energy potential positions it favorably for the energy transition,

Hypothesis 2: Solar energy in southern Algeria serves as a catalyst for energy diversification and environmental sustainability.

Study Objectives: The study aims to:

- Illuminate the national and international significance of the energy transition and its imperative in fulfilling future energy demands,
- Elucidate Algeria's solar energy potential and its prominence among renewable energy sources,
- Emphasize the significance of environmental security and ecological integrity in the energy transition process,
- Highlight the role of solar energy in southern Algeria in bolstering environmental sustainability.

Importance of the Study: This study enriches the educational discourse on the energy transition, climate change, and renewable energy landscape in Algeria, shedding light on solar energy's environmental impact as an added value to energy initiatives in the Greater South.

Methodology: Our study adopts a descriptive and analytical framework, encompassing a theoretical exposition on renewable energies and the energy transition in Algeria, alongside an examination of the environmental dimensions and the influence of renewable energies. The analytical facet delves into Algeria's renewable energy potential and the nexus between the energy transition and the environment, with a specific focus on solar energy in southern Algeria.

2. Renewable Energies as a Strategy for Energy Transition

The transition towards renewable energies requires well-defined strategies by the state to ensure future energy security and to meet the current generation's energy supply.

2.1 Renewable Energies, Their Characteristics, and Sources

Clean energies, as defined by the International Energy Agency IEA, are energies sourced from nature that are continuously renewed by natural processes. These include solar energy, wind energy, and hydropower (EIA, 2023)

According to the definition by the Intergovernmental Panel on Climate Change (IPCC), renewable energies are sourced geophysical or biologically, with a production rate exceeding their consumption rate. They are generated from continuous streams in nature, such as solar energy, geothermal energy, water movement, tidal energy, and wind energy, utilizing technologies that allow energy production from these sources (Abdellah, 2018)

Renewable energies, also known as clean energies or new energies due to their novelty in production and the use of technology in their production processes, are natural sources found in all regions of the world without exception. These include solar energy, wind energy, hydropower, thermal energy, and biomass energy, along with artificial sources like energy produced from recycling household, industrial, and forest waste.

These energies are primary alternatives to traditional energy sources and have been adopted to produce electricity as replacements for oil, natural gas, and coal due to their distinctive features:

- Renewable energies are the main alternative to depleting traditional energies,
- They are sustainable energies ensuring energy supply for future generations (Nour Elhouda, 2020, p. 39),
- Renewable energies contribute to energy security and the spread of energy efficiency,
- They play a role in developing industrial growth that attracts major long-term investments and competitiveness in the global market (Asmahan, 2018),
- It is impossible to determine their reserves, such as (the sun, the wind),

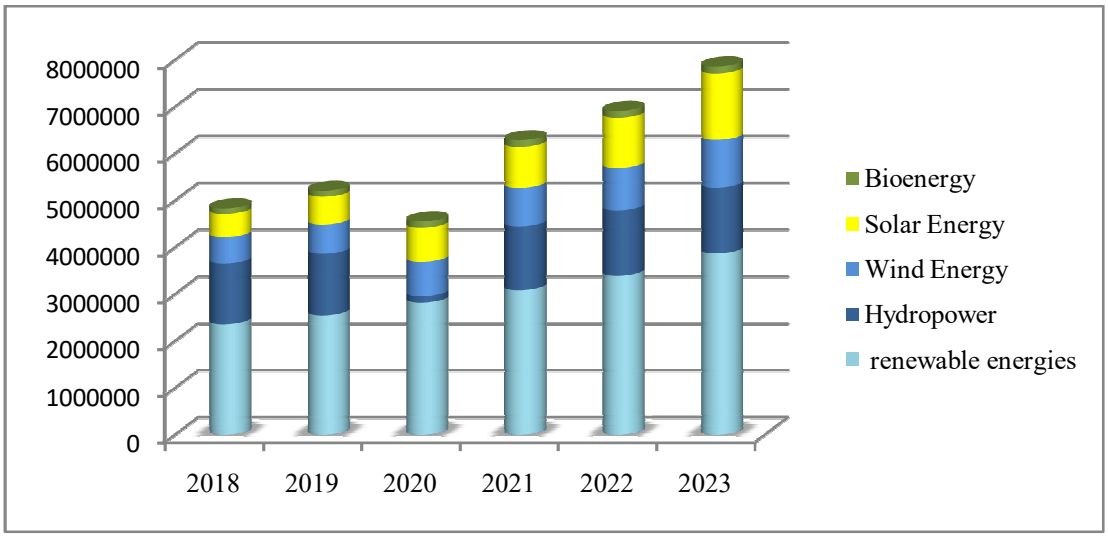
Moreover, they are characterized by their inexhaustibility and their positive effects on the environment and climate, which qualifies them to be an alternative energy source to traditional depleting energies, the primary cause of climate change and global warming.

In summary, renewable energies are clean in the production process and do not emit greenhouse gases, serving as alternative sources to traditional energy sources.

Sources of Renewable Energies

The sources of renewable energies are diverse, including solar energy, wind energy, in addition to hydropower and biomass energy. Below is an explanation of these:

Figure Number 01: Installed Capacity of Renewable Energies Worldwide (2018-2023):



Source: Compiled by researchers based on data from IRENA: (IRENA, 2024, pp. 2-30)

Renewable energies are continually growing, as seen in the figure, confirming that most countries are moving towards using renewable energies and exploring their sources. In 2023, the global capacity of renewable energies reached 3,869,705 megawatts, marking an increase of 1507165 megawatts since 2018, distributed into 1418969 megawatts from solar energy, 1407754 megawatts from hydropower, 1017199 megawatts from wind energy, and 150261 megawatts from bioenergy energy. This rise is due to the global health crisis of COVID-19 in 2020, where the production and distribution of traditional energies decreased, leading non-oil-producing countries to utilize renewable energies for electricity production, The continuous rise is also attributed to environmental factors, as the world experiences unprecedented global warming in recent years, explaining the increased interest in renewable energies, It is noted that bioenergy has the lowest share among renewable energy elements, due to most countries not utilizing such energies because of the lack of production means and the difficulty of their use.

From the figure, we conclude that renewable energies have several forms, such as:

1. Solar Energy: Considered a primary source of renewable energy as it is available throughout the year and directly falls on the Earth's surface. Tropical and equatorial regions are more exposed to solar energy, receiving about 2500 kilowatts/m² per hour annually. Regions in Africa, the Arabian Peninsula, and Latin America are most exposed to solar radiation (Ahlam, 2013)

The term solar energy refers to the consumption of electric energy produced from solar rays, which travel through electromagnetic waves at a speed of 200,000 km/second, and are divided into (Asmahan, 2018):

- Ultraviolet rays: Representing 6% to 7% of solar radiation, with wavelengths ranging from 10 to 400 nanometers,
- Visible light rays: Including violet, yellow, green,blue, orange, and red rays, with wavelengths ranging from 400 to 700 nanometers,
- Infrared rays: Their role includes heating the atmosphere and the Earth's surface, evaporating water, and controlling wind movement, with wavelengths reaching 700 nanometers.

Key elements of solar energy include:

Concentrated Solar Power (CSP): Uses the heat from sunlight to generate electric power from

conventional steam-driven turbines, using lenses or mirrors and tracking systems to concentrate a large area of sunlight into a small beam (Energy, 2018). It is about 25% more expensive than photovoltaic solar energy but is non-competitive with gas-powered energy production (the future of solar energy, 2015),

Photovoltaic Solar Energy: Captures sunlight using photovoltaic cells, representing technologies that directly convert solar rays into electrical energy based on the photovoltaic effect. French physicist Henri Becquerel was one of its early discoverers (Adlof & Vollcer, 2005).

2. Wind Energy: A renewable energy source that has been utilized by farmers in regions of Australia and North America to generate power and supply their homes with electricity. It involves large blades that rotate according to the direction of the wind and are connected to generators responsible for electricity production. This form of energy indirectly originates from solar energy due to the effect of infrared rays in moving the wind (as discussed in types of solar radiation). Studies have shown that about 2% of infrared rays are converted into wind energy, representing 30 million terawatt-hours per year, which is 350 times the global energy consumption (Nizar, 2015, p. 220),

3. Hydropower: Refers to the energy produced from water movement, derived from tidal energy, sea wave motion, and hydropower (Ahmed & Ziad, 2022, pp. 200-201),

4. Hydrogen Energy: Hydrogen is a versatile energy carrier and not an energy source as some researchers define it according to the International Energy Agency. It is one of the oldest chemical elements, and hydrogen energy is produced from natural gas, coal, oil, and water electrolysis as follows (Omar & Ahmed, 2010):

- Steam Reforming: This method is the most widespread due to its economic costs, using steam and high heat to break down the methane element found in natural gas,

- Electrolysis: This method is more sustainable only if the electricity used is produced from renewable energy sources. Water (H_2O) is decomposed into two elements (oxygen O_2 and hydrogen H_2) using an electric current in an aqueous solution,

- Basalt Dissolution: Basalt is a radioactive material found in the Earth's crust, decomposed using special technologies to produce hydrogen energy,

- Biological Splitting: Refers to the use of algae and bacteria in water to produce hydrogen using sunlight or chemical energy.

5. Biomass: The use of biomass for energy generation is considered a sustainable alternative to fossil fuels. Its production is part of environmental sustainability, continually renewed through intensified tree planting and vegetation growth. This contributes to environmental cleanliness and sustainability. Additionally, its production process represents the natural carbon cycle: plants absorb carbon dioxide during growth and release it during combustion, known as the carbon cycle (Omar & Ahmed, 2010)

2.2 Energy Transition

Today, the world faces several energy-related issues, including decreasing energy supplies and increasingenergy consumption (energy security problem), global warming, and climate change (environmental security problem).

Therefore, it is essential to explore solutions and accelerate the transition to sustainable renewable energies.

A. Definition of Energy Transition:

The energy transition is defined as the shift from traditional, depleting, non-renewable energies to clean and sustainable renewable energies,

According to the Paris Agreement: An international agreement among more than 180 countries, agreed upon transitioning to clean, sustainable energy due to climate change. This agreement aims to limit the increase in global temperatures to less than two degrees Celsius and to encourage the use of low-carbon energy to reduce greenhouse gas emissions (Nicole, 2020, p. 4),

Definition by the International Renewable Energy Agency: The energy transition is defined as an act that will not happen by itself but through public policy interventions to steer the current energy system towards clean and renewable energy (IRENA, 2018),

It is also known as the shift from traditional energies to the production of renewable energy, preserving the environment and ensuring energy supply for future generations (Malki & Mouaden, 2020, p. 223),

Thus, the energy transition involves moving from a domain reliant on traditional energies (oil, natural gas, coal) to one reliant on renewable energies, driven by nature and cost-effective, in addition to being sustainable and clean (sun, wind, water).

B. Efficiency of the Energy Transition

To achieve an effective and efficient energy transition in a region, it requires mechanisms and prerequisites, including:

- Strong commitment adopting policies and strategies that enhance the use of renewable energy,
- Establishment of projects and installation of renewable energy stations, attracting investments, and developing innovative financing mechanisms,
- Development of the necessary technologies for the generation and storage of renewable energy efficiently and sustainably,
- Changes in the economic models of the region and creating alternative economic opportunities to ensure sustainable development.

In short, the success of the transition towards renewable energies requires cooperation in various fields to enhance the exchange of expertise and knowledge.

C. Objectives of the Energy Transition

Today, the world is shifting towards renewable energies for several reasons (IRENA, 2018):

- Reducing Carbon Emissions: Relying on the clean, nearly carbon-free renewable energy sector for electricity production, this is expected to rise from 25% in 2017 to 85% by 2050,
- Costs of Renewable Energy:While the reliance on renewable energies will increase their costs—expected to reach $1.7 trillion by 2050—this will positively impact the economy and communities, with savings estimated at $6 trillion by 2050,
- Economic Growth and Personal Income:Renewable energies are expected to generate profits estimated at $54 trillion by 2050, creating about 19 million jobs by 2050 in the context of technological advancement,

Looking at the anticipated scenarios, we notice a well-planned strategy in developing renewable energies from environmental, economic, and social perspectives, demonstrating the seriousness of

countries in ensuring future generations are supplied with clean energy.

3. Justifications for the Energy Transition in Algeria

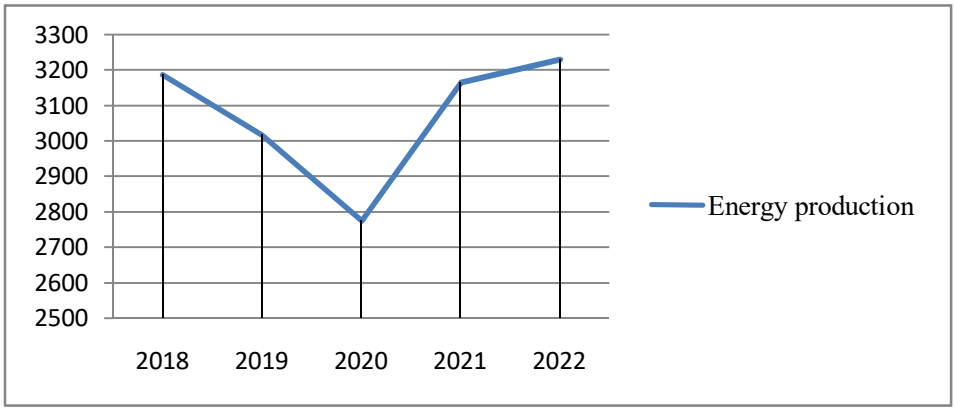
In recent years, Algeria has focused on the idea of energy transition, shifting from an economy dependent on traditional energies (oil, natural gas, coal) to a diversified economy that incorporates renewable energies (solar, wind, and hydropower) in the production, generation, and consumption of electricity and energy in general.

3.1 The Oil Market

- Oil Production:

A statement from the Ministry of Energy highlighted the need to reduce daily barrel production to ensure the balance of the oil market and the fear of reaching peak production. According to Hubert's Peak Theory, if production reaches its peak, an oil crisis will occur, leading to a decrease in the rate of energy supply followed by economic contraction (Ali & Farida, 2019, p. 183). "In the context of joint efforts led by OPEC+ countries and in support of additional cuts announced by Saudi Arabia and Russia to support the stability and balance of oil markets, Algeria decided to implement an additional reduction of its production by 20,000 barrels per day from the first to the thirty-first of August 2023" (SERVICE, 2023). This reduction explains the production decrease, which reached 48,000 barrels in April of the previous year, with production expected to reach 940,000 barrels per day by the end of August 2023, according to the Ministry of Energy (SERVICE, 2023).

Figure Number 02: Energy Production in Algeria within OAPEC (2018-2022)



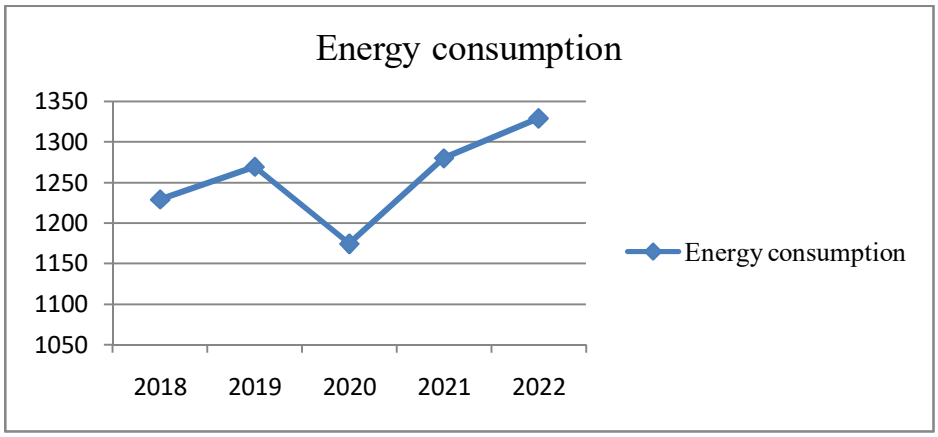
Source: Compiled by researchers based on data from (OAPEC, 2023).

Algeria recorded in 2022 the highest level of energy production estimated at 3229 thousand barrels/day, after recording the lowest production rate since 2018 in 2020, estimated at 2775 thousand barrels/day. This increase is explained by the rise in domestic.

- Consumption:

National consumption of oil products is continuously increasing. In 2022, the total consumption reached 1329,6 thousand barrels/day, an increase of 449 thousand barrels/day compared to 2020, when consumption was 1174,4 thousand barrels/day, the lowest rate since 2018.

Figure Number 03: Energy Consumption in Algeria within OAPEC (2018-2022)



Source: Compiled by researchers based on data from (OAPEC, 2023)

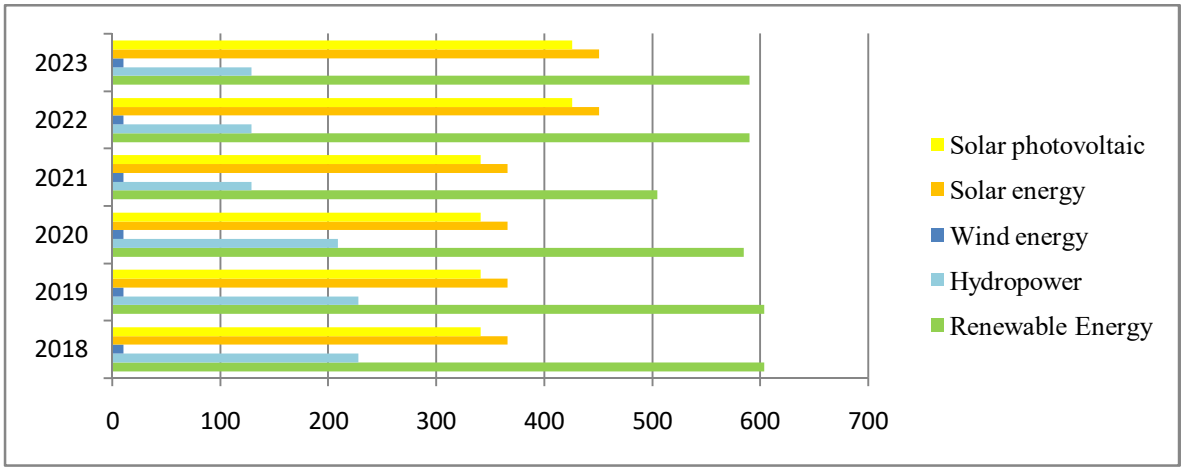
According to statistics on daily oil production and consumption, the transition to renewable energies has become a priority for the national economy to maintain future energy security and ensure energy supplies, and to avoid oil crises.

3.2 Renewable Energies and the Issue of Energy Security

- **Algeria's Renewable Energy Potential:**

Algeria possesses significant potential from renewable energy sources, qualifying it to lead in the new energy sector and attract international investments to enhance the exploitation of renewable energies and expand their use.

Figure Number 04: Distribution of Installed Capacity from Renewable Energies in Algeria by Source Type



Source: Compiled by researchers based on data from IRENA: (IRENA, 2024)

Wind Energy Potential: Wind energy is among the available energies in Algeria, following solar energy, as confirmed by the Center for Renewable Energy Development. The average wind speed is 5 m/s in the regions of Tindouf, Tiaret, and Oran, reaching more than 6 m/s in Adrar, Timimoun, and Ain Salah. These fields are suitable for establishing wind farms for producing and generating electrical energy. The French company "Siglac" completed and installed equipment for an electricity production field within 37 months, installing 165 electrical generators over an area estimated at 50 hectares and establishing 12 stations for low and medium pressure (Asmahan,

2018, p. 246),

Hydropower Potential: The rainfall in Algeria is estimated at about 65 billion cubic meters, but only about 5% is exploited, due to high evaporation and concentration on limited areas. Also, there is a lack of efficiency in producing energy from water sources. The surface water resources in Algeria vary from north to south, currently estimated at about 25 billion m^3, 2/3 of which are surface resources. The share of electricity production from hydropower in the national park is 1%, i.e., 286 megawatts, due to the limited number of dams where 103 dam sites have been identified, of which 50 are in the construction phase (Akila, 2009, pp. 232-233),

Geothermal Energy Potential: Algeria has more than 200 hot springs, known as the Alpine aquifer, surveyed in the northeast and northwest of the country, extending to the Tunisian border. The average water temperature is 57°C, representing a capacity of more than 700 megawatts (Akila, 2009, pp. 230-231), High-temperature springs are found in Guelma at Hammam Debagh reaching up to 98°C, and in Ain Oulmene where Alpine water temperatures reach 118°C. The hottest are in Biskra, reaching 119°C (Akila, 2009),

Biomass Energy Potential: Divided into two types:

- Forest Resources: Cover 10% of the country's area, with forests around 18 million hectares. Maritime pine and eucalyptus are used for energy production, representing only 5% of the plants in Algerian forests (CDER, 2016),

- Energy Resources from Urban and Agricultural Waste: The total waste is estimated at 8.64 million tons of oil equivalent/year, with 2.26 from household waste and 6.38 from agricultural waste, representing a field capable of handling 1.33 million tons of oil equivalents per year (CDER, 2016),

Solar Energy Potential: Algeria, with approximately 86% of its area covered by the desert, features long durations of solar radiation most of the year and high temperatures especially in summer, allowing for the exploitation of solar energy and rays in generating electricity and supplying remote and rural areas lacking electricity due to their distance from cities or power generation centers.

3.3 The Role of Renewable Energies in Enhancing Energy Security and Efficiency

The problem of energy security emerged with statistics predicting the depletion of traditional energies and a decrease in reserves along with increasing consumption. The rising population density in Algeria corresponds with an increase in energy consumption, potentially leading to future crises that could cause a decline in energy supplies produced for electricity. This drives Algeria to transition to renewable energies, replacing traditional energies to secure energy supply and achieve energy efficiency,

Energy Security: One of the goals of transitioning to renewable energies is to achieve energy security and increase energy supplies for guaranteed consumption now and in the future. Considering the potential that Algeria possesses, it can provide 60 times the reserves of Western Europe. Statistics confirm that the Algerian desert is a reservoir for generating solar energy, with solar radiation in the region reaching 3,000 radiation hours/year, covering four times the global consumption and 5,000 times the national consumption. This means achieving self-sufficiency and exporting solar energy globally, which is one of the goals of renewable energy, it ensures local consumption and provides energy to the world (Fatiha, 2022, p. 19),

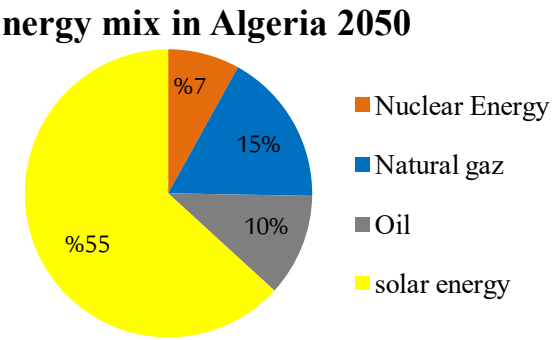
Algeria has developed a well-crafted strategy to ensure long-term energy security (by 2030) according to the "let it work" scenario and the "base scenario." This strategy includes: producing energy-efficient equipment like economical light bulbs and thermal insulation materials, water heaters, and setting up monitoring to track the effectiveness of renewable energies in Algeria, enacting laws and regulations to control energy and rationalize local energy consumption (Slimane & Al, 2019),

4 Strategies for the exploitation of solar energy in Algeria to promote environmental sustainability

First: Algeria has exploited its solar energy potential to deliver electricity to remote areas in the south, with the aim of facilitating the energy supply of the population and spreading renewable energies on a large scale, Algeria has approximately 169,440 terawatt hours / year and the equivalent of 500 times the national consumption of electricity, and 3,000 terawatt hours / year of Europe's consumption (Slimane & Al, 2019), these statistics indicate the solar potential in Algeria, which allows it to open the door to investment in solar energy and facilitate the process of Importing solar panels to expand the deployment of renewable energy throughout the country.

In light of the deployment of solar energy in Algeria, the Directorate of Energy and Mines of the wilaya of Ghardaia launched a tender related to the completion of a solar power plant with a capacity of 80 megawatts in the area called "El Qarara", and the area was chosen because of its proximity to the electrical transformer 60/30 that connects the areas of "Qarara" and "Berriane" with electricity, the area sits on an area of 200 hectares, in an area that has the conditions for the construction of the solar plant and is easy to access in addition to other technical conditions listed in the term sheet, 16 national companies participated This project falls within the implementation of the National Energy Transition Program and the Renewable Energy Development Program, which aim to produce 15,000 MW in 2035,

Figure 05: Algeria's energy mix (scenario 2050)



Source (Hosni & Al, 2021, p. 18)

According to future projections, Algeria relies heavily on solar energy by 55% to ensure future energy supply and provide the country with electricity produced from clean carbon-free energy and preserve the environment,

Mechanisms for the exploitation of solar energy in Algeria: Algeria has confirmed its leadership in the field of solar energy and renewable energies as a whole by setting a program for the

development of renewable energies in 2011, which extends to 2030, divided into three phases as follows:

The first phase 2011-2015: This phase is considered as a starting stage Several important projects have been completed in solar energy to connect remote areas to electricity, and the focus was on the southern regions for their abundance on the basics of solar electricity generation, which is heat throughout the year and vast areas that facilitate the installation of solar panels, and the launch was the largest national-foreign investment project (Hassi Ramel hybrid plant) The project was launched in 2011 with a production capacity of 25 MW, and it is the first project that combines renewable energies Fossil energies (solar + gas) were created jointly with a Spanish company (ABENER) within the framework of the expansion of the deployment of solar energy (Ministry of Energy and Mining),

the second phase 2015-2020: In this phase, which is considered a stage to achieve self-sufficiency, according to experts, it was planned, according to scenarios, to produce 4,000 megawatts as a combination between wind and solar energy, and plants have already been employed in several states, including:

Table 01: Projects realized in the second phase

Year/Project	Station	Installed capacity (MW)
	Raqan	05 MW
	Zawya of Kentah	06 MW
2016	Djelfa	20 MW
	Neama	20 MW
	Seaida	30 MW
2017	SSP in Neama State	70 MW
2018	SSP station in Hassi Ramel	70 MW

Source: (Ministry of Energy and Mining, 2023)

the third phase 2020-2030: It is planned to be the export phase, the electrical interconnection between the southern regions and the connection to the north, and the installation of major solar stations in the southern regions... Several foreign investment projects have been signed that benefit the export of solar energy to the world, (Moussa & Mesoudi, 2022, p. 318).

In 2023, a project with a total capacity of about 300 kW of solar photovoltaic plants was completed, completed by Sonatrach and SOMIZ, these projects included hybrid installations (solar energy and natural gas) and the installation of solar panels on roofs and parking lots, the capacity of the projects ranged between 35 kW and 120 kW, aiming to contribute to the creation of a more sustainable and environmentally friendly economy (CDER, 2023, p. 140),

Some projects were also signed that aim at exploiting solar energy, achieving environmental sustainability and connecting electricity, especially in isolated areas, these projects were completed in 2023 under the leadership of Sonelgaz, the Center for Research in Renewable Energies and other institutions interested in the energy, maintenance and production operations sector, represented in (CDER, 2023, pp. 88-90):

- National Lithium Battery Development Project: This project aims to improve energy storage technologies, not completed and is under study, in partnership with manufacturing and battery improvement and design enterprises, and this project also contributes to technological innovation

and energy sustainability,

- Project to develop a smart fault detection system at the photovoltaic power plant at Oran International Airport: The objective of this project is to provide the photovoltaic power station with a dedicated monitoring and maintenance tool for meteorological determination, radiation and electrical measurement for the airport management to avoid any malfunction during service,
- Development of a hybrid controller for power plants in isolated areas: This project is a combination of solar energy and natural gas in order to provide electricity and energy in the wilayas of Tamanrasset and Djanet, aims to ensure economic and environmental profitability in the two regions by exploiting solar energy in electricity production and ensuring energy supply at all times and availability of quality, while developing methods to improve distribution and energy management.

Second: The impact of solar energy on the environment

The increasing exploitation of traditional energies has led to higher temperatures in the earth and has caused the ozone layer to be pierced and acid rain harmful to living organisms (Nizar, 2015)

From this standpoint, countries affirmed their desire to reduce greenhouse gas emissions, it was agreed at the Kyoto Conference in 1997 held in Japan to reduce CO2 emissions to avoid the environmental crisis and climate pollution resulting from the generation of electricity from traditional energies (Nizar, 2015),

In the same context, the National Climate Commission established in 2015 the CNC, which ratified the Paris Agreement, which provides for reducing greenhouse gas emissions and preserving the climate, where the reduction of emissions by 7% of carbon was approved, and in 2016 the Ministry of Environment, in cooperation with 18 ministries, launched a national plan for climate development in Algeria, which was divided into for four phases (Ministry of Environment and Renewable Energy, 2023):

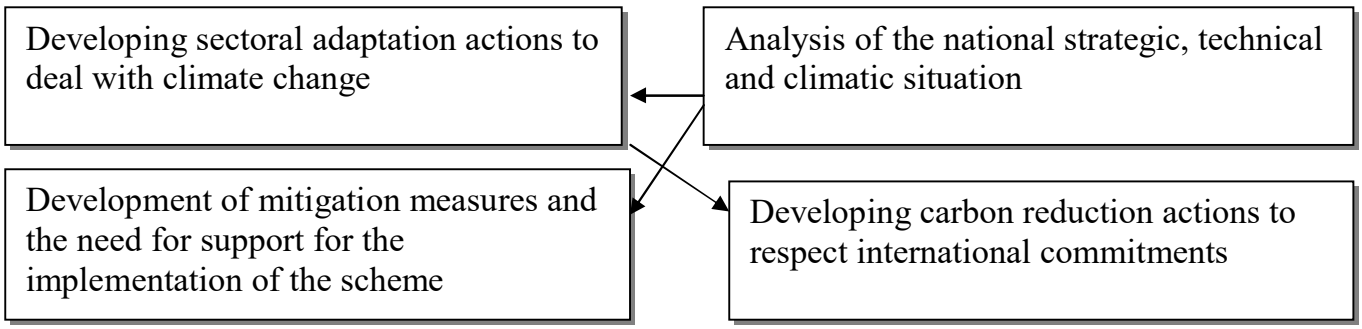
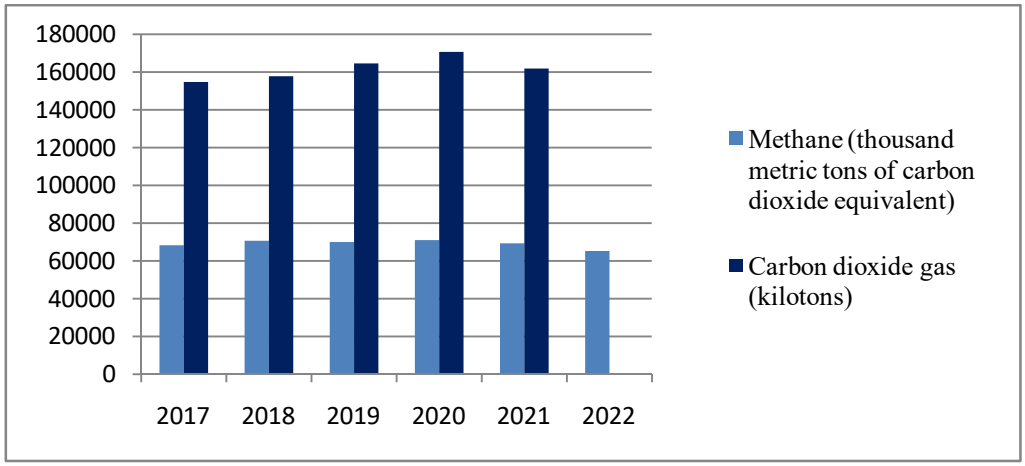


Figure 06: Emissions of gases from the energy sector in Algeria (2017-2022)



Source: Prepared by researchers based on (World, 2023)

Methane is one of the main contributors of global warming, although it is less harmful to the climate compared to carbon dioxide, but its emission rates are high and it is produced by natural gas in production and consumption processes, and as we can see from the graph, methane emission rates in Algeria are very high compared to carbon dioxide, where in 2020 the highest emission rate since 2017 amounted to 70952.5 thousand tons, an increase of 2798.5 thousand tons, to reduce by 5796 One thousand tons in 2022, which is reflected in the Algiers agreements on preserving the climate and reducing the emission of harmful gases to the environment,

As for carbon dioxide, as mentioned before, it is the most harmful to the environment, as international policies seek to implement agreements to reduce gas emissions, through the manufacture of products that emit less carbon dioxide, the latter is not produced from traditional energy sources only, but also from agricultural pesticides, building materials, pharmaceutical products and others... As for the statistics shown in the figure, we note that the percentage of carbon dioxide emission in Algeria ranges between 15 kilotons and 17 kilotons since 2017, and its highest increase was in 2020 by 170,582.4 kilotons, to decrease in 2022 by 9019.4 kilotons, which explains Algeria's application of international laws that provide for reducing the emission of gases harmful to the environment, including the Paris Agreement mentioned earlier, which estimates the reduction rate of gas emissions to %.2, Algeria is placing renewable energies, especially solar energy, as a bet to achieve environmental cleanliness that is almost free of toxic and greenhouse gases and other environmental problems such as drought, rain and water pollution, damage to agricultural products and even the direct impact on animals and humans.

Indicators of generating electricity from solar energy: The use of solar energy contributes to achieving environmental cleanliness and reduces the emission of greenhouse gases, but to generate electricity from clean energy, indicators must be available that help increase productivity, including:

Solar radiation: Among the main indicators is the availability of strong solar radiation, where the rays are captured by the photovoltaic solar panels directly and there is an increase in electricity production,

Sunshine hours: The solar panels do not have a period of time for operation, but rather work around the clock, the higher the hours of sunshine, the more the work of solar panels and the higher the storage rate in batteries,

The area used: In order to generate electricity from solar energy, a user must be located that has the two previous conditions (solar radiation, sunshine hours), the solar panels must be directed to sunlight directly and there is no building, column or shadow that hinders the work of solar panel cells.

By analyzing the indicators, we conclude that the Algerian desert has all the conditions, and for the area, the Algerian desert is one of the largest deserts in North Africa, and this is what qualifies it to exploit solar energy and produce energies from a clean source and with huge capabilities due to the hours of sunshine and solar rays that the desert has, especially the Adrar and Timimoun regions throughout the year, especially in the summer, when brightness and temperatures rise.

Hence, the exploitation of renewable energies, especially solar energy, has a positive impact on the environment and climate, as it is a clean energy that supports the economy and humans as a whole because it is characterized by the lack of toxic gas emissions that have destroyed the environment throughout the ages, by exploiting oil and gas in the production of energy and electricity generation in the world, and this has negatively returned to humans, living organisms and even agricultural production, which has become suffering from the problem of scarcity due to the lack of rainfall due to global warming, which poses a threat to the future of humanity.

Mentioning the advantages and advantages of solar energy, it is necessary to expand its dissemination and exploitation widely to produce electricity, and thus we have achieved energy security, environmental security, and thus the development of the national economy and the dissemination of modern energy technologies, and the relationship between solar energy and the environment is a direct relationship, the more the spread and expansion of the exploitation of renewable energies in a region, the more the region is clean and does not suffer from environmental pollution.

But although solar energy is clean energy and achieves environmental sustainability, there are environmental and economic waste resulting from it, through the exploitation of land (arable land and reconstruction) or its destruction of landscapes (household roofs), which have an impact on human health (releasing substances invisible to the naked eye and harmful gases), and the economic waste is represented in the high costs of solar panels and the speed of deterioration and scratching of panels, due to high temperatures and dust or because of birds and animals, and this is what costs the entrepreneur to change the panels And maintained every time.

5. CONCLUSION

The transition from the exploitation of traditional energies to the exploitation of renewable energies has become necessary for all countries of the world, due to the depletion of traditional energies and the decline in global reserves, which can cause a global energy crisis, so the trend towards renewable energies is the best solution to compensate for fossil energies to ensure the continuity of energy supplies in the future and maintain energy security, environmental cleanliness and climate.

Algeria has exploited its renewable energy potential to install fields to generate electricity from the various renewable energy sources available in the country (solar, wind, hydropower, geothermal energy...) It also focused on connecting electricity to remote areas in the south using solar energy, to facilitate the process of delivering electricity to the population and rationalizing

electrical consumption, to provide the region with geographical and climatic capabilities that help to exploit solar energy and establish fields for energy production, and it also looks forward to investing in the region by establishing new energy projects that contribute to raising the national economy and diversifying energy exports, by exporting solar energy to Europe through the German DIZERTIC project, the SOLAR BREDER project, in addition to local projects, Algeria's exploitation of solar energy is a preliminary step to preserve the sustainability of the environment, given the role of solar energy in maintaining the cleanliness of the climate due to its low production of carbon gas that causes environmental pollution that is produced during power generation.

Hypothesis test results:

The first hypothesis, has been verified because Algeria is located in a strategic region and is characterized by a continental climate that provides it with solar and wind energy throughout the year and in different regions of the country, and this explains the achievement of future energy security for Algeria,

The Second hypothesis, has been confirmed, because solar energy is energy with clean production and does not have a specific reserve that contributes to diversifying electricity production and preserving the environment and climate.

Study Results: Through our study, a set of results were reached:

✓ the transition from conventional energies to renewable energies has become necessary in every region of the world, especially the economic problems it faces with conventional energies (the problem of depletion, price fluctuations, low reserves, the energy market...),

✓ Energy availability and future energy supply guarantee based on today's energy policies and the transition towards sustainable energies,

✓ Algeria is a field of renewable energies for its availability of various types and elements of renewable energy, which contribute to the provision of energy at the local and global levels, through energy projects in the Great South region,

✓ Solar energy is a major alternative to oil because of its lifelong abundance, ease of exploitation, inexpensive, contribution to climate preservation and non-polluting to the environment.

Recommendations and suggestions:

✓ Allocate a national fund to support the development of solar energy,

✓ Providing the necessary information on renewable energies (prices, machinery and their installation technologies, production costs...) so that the investor can know the appropriate areas for investment, and it is advisable to develop electronic maps,

✓ Establishing a national organization to follow up on completed renewable energy projects with the inclusion of information in a digital platform for renewable energies so that the process is sophisticated and facilitates access to information and statistics related to it,

✓ Training of solar and renewable energy project owners in line with the era of technological development,

✓ Financing micro-projects, start-up owners and patents in renewable energies,

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