

## Sustainable Energy Transition in Algeria: Factors Influencing Investment

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### Abstract:

The population growth in Algeria has increased energy demand, requiring the country to diversify its resources to ensure energy security. As a result, the Algerian government has prioritized energy transition, planning to implement a mixed energy system combining fossil fuels and sustainable sources.

This article analyzes the state of renewable energy in Algeria, finding that the country is seeking to invest in solar photovoltaic energy due to its significant solar potential, favorable legal framework, and encouraging economic and financial factors. However, Algeria faces challenges of consumer acceptance and technological innovation as it works to address population growth and diversify its energy mix.

**Keywords:** Energy transition, Renewable energy, Determinants, Investments, Sustainable.

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## 1. INTRODUCTION

In recent years, there has been a remarkable global shift in focus towards sustainable energy transition. Countries all over the world have come to acknowledge the urgent necessity of transitioning to cleaner and more sustainable energy sources to combat climate change and mitigate the environmental impacts of traditional energy systems. Algeria, as a developing nation, finds itself in a unique position with its rich endowment of renewable energy resources. Recognizing this potential, Algeria has embarked on a transformative journey towards sustainable energy transition, aiming to harness its abundant renewable energy sources while achieving its economic development objectives (Himri, et al., 2022).

Investing in sustainable energy transition plays a pivotal role in Algeria's pursuit of sustainable development. It acts as a catalyst for economic growth by promoting innovation, creating job opportunities, and attracting domestic and foreign investments. Moreover, the transition to sustainable energy sources addresses the pressing environmental challenges faced by the country, such as reducing greenhouse gas emissions, improving air quality, and mitigating the impacts of climate change. Additionally, investing in sustainable energy helps Algeria enhance its energy security by diversifying its energy mix and reducing dependence on fossil fuel imports. All of this leads us to ask the following question: **What are the key factors that encourage the promotion of these new technologies and the shift towards a new mixed energy system?**

In this article, we will respond to this question by examining the economic landscape in Algeria that either facilitates or hinders investment in renewable energy sources as the country transitions from a conventional economic system to a more sustainable one.

We will shed light on this topic by exploring the following three main axes:

### ✓ Overview of Algeria's energy situation

- ✓ **State of Renewable Energies in Algeria**
- ✓ **The transition towards an energy mix for energy security**

## 2. Overview of Algeria's energy situation

Algeria's economy is characterized by a key feature that sets it apart: an abundance of fossil fuel deposits (Rahmane, Benelbarband, & Traich, 2021). The nation is richly endowed with natural gas and oil reserves, which have significantly influenced the direction of its economy. These natural resources' history and utilization offer important insights into Algeria's energy industry. In this section of our study, we will go into a thorough examination of Algeria's energy situation.

### 2.1. Hydrocarbon revenues in Algeria

The hydrocarbon recipes in Algeria refer to the profits made from the country's petroleum and gas resources' exploitation and sale. Algeria is well-known for being a significant producer and exporter of hydrocarbons, particularly natural gas and petroleum. These recipes are primarily derived from the proceeds of the export of hydrocarbons to foreign markets. The hydrocarbon industry contributes significantly to the state of Algeria's revenue and is vital to the nation's economy (93,7 M TEP in 2022) (The 2022 National Energy Balance Sheet, 2022).

By examining the evolution of hydrocarbon revenues during the period 2013-2018, we observe the following: the variations in hydrocarbon revenues between 2013 and 2018. It confirms that there is a dependency between revenues and global oil prices. This dependency is clearly visible between 2013 and 2016, where revenues experienced a significant decline (from 63,326.2 million \$ to 27,917.5 million\$). This decline can be attributed to the decrease in oil prices. However, a slight recovery was observed from 2017 onwards (\$33,202.8 million), due to the same factors that led to an increase in oil prices.

**Table 1.** Evolution of hydrocarbon exports in the period 2017-2022

| <b>Years</b> | <b>Hydrocarbon revenues in Million Tonnes of Oil Equivalent</b> |
|--------------|-----------------------------------------------------------------|
| 2017         | 108,3                                                           |
| 2018         | 100,8                                                           |
| 2019         | 92,0                                                            |
| 2020         | 81,9                                                            |
| 2021         | 96,5                                                            |
| 2022         | 93,7                                                            |

**Source:** Compiled by us from the National Energy Balance Sheets between 2017 and 2022.

According to the ministry, as quoted by the official news agency APS, the total volume of hydrocarbon exports reached 82.2 million tonnes of oil equivalent (TOE) in 2020, with a value of 20 billion dollars (16.54 billion euros). This represents respective decreases of 11% and 40% compared to 2019. (ALGERIA Press Service, 2021).

Algeria's hydrocarbon revenues experienced a rollercoaster ride between 2017 and 2022, marked by a cumulative decline of 24.1% between 2017 and 2020, followed by a recovery in 2021 and 2022. The year 2017 marked a peak in revenues with 108.3 Mt oil equivalent, while 2020 saw the lowest level with 81.9 Mt oil equivalent, impacted by the COVID-19 pandemic and the drop in oil prices. This volatility is explained by the fluctuations in oil and gas prices on international markets, as well as by the quantity of hydrocarbons exported.

## 2.2. The energy consumption of Algeria

Over time, Algeria's energy use has had a significant evolution (Zahraoui, AlHamrouni , Basir Khan, Mekhilef, & Ahmed , 2021). Many factors, like the expansion of industries, the improvement of citizens' quality of life, and changes in lifestyles, can be used to explain this increase.

First off, the growth of Algeria's industries has been a major factor in the rise in energy consumption. As the nation's economy has grown, new factories, production facilities, and infrastructure have been established to meet growing demand. These industrial activities require a significant amount of energy to power the machinery, equipment, and production processes. Consequently, in response to this industrial boom, there has been an increase in the need for energy.

Furthermore, alterations in lifestyle patterns have also had an effect on energy use in Algeria. New consumption habits have emerged as a result of the modernization of society. For example, the growing use of personal transportation, such as cars, has led to an increase in the demand for gasoline. Additionally, the increased urbanization has resulted in an increase in the demand for electricity for building climate control, lighting, and heating (Ritchie & Roser, 2024).

In the same context, the following table allows us to track the evolution of Algeria's energy consumption:

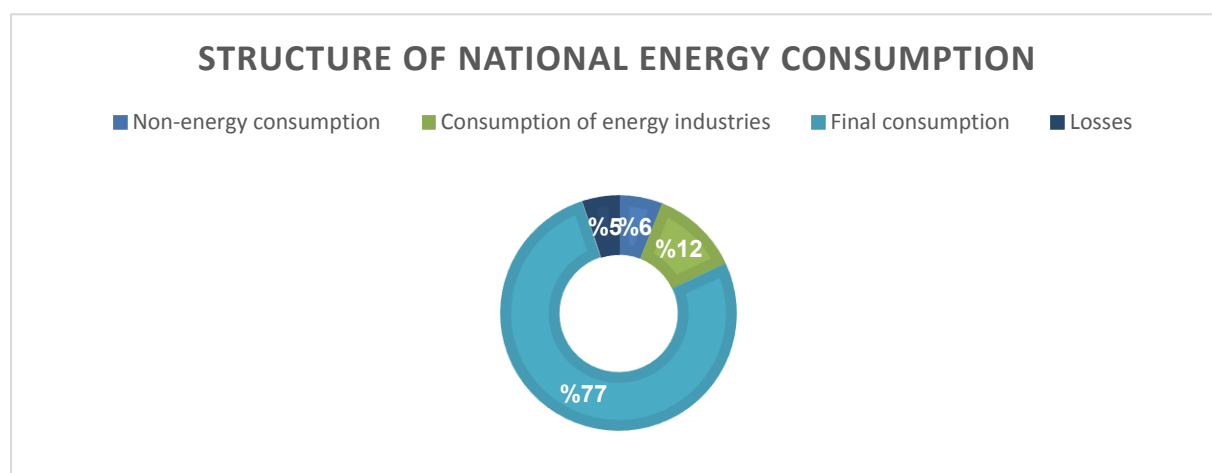
**Table 1.** National consumption by aggregate

| Unit : K toe                     | 2021   | 2022   | Evolution |      |
|----------------------------------|--------|--------|-----------|------|
|                                  |        |        | Quantity  | (%)  |
| Final consumption                | 50 171 | 53 106 | 2 935     | 5,9  |
| Non-energy consumption           | 4 777  | 4 493  | -284      | -6   |
| Consumption of energy industries | 8 268  | 8 158  | -111      | -1,3 |
| Losses                           | 3 936  | 3 307  | -630      | -16  |
| DOMESTIC CONSUMPTION             | 67 153 | 69 063 | 1 911     | 2,8  |

**Source:** The National Energy Balance Sheet, the Algerian Ministry of Energy and Mines, 2022

The previous table, which addresses national consumption, can be illustrated in the following form:

**Fig.1.** Structure of national energy consumption



**Source:** Compiled by us from the data in the previous table.

In 2022, the total energy consumption at the national level, including losses, reached 69.1 million tonnes of oil equivalent (Mtoe), representing a 2.8% increase compared to 2021. This increase was primarily driven by final consumption, which saw a 5.9% rise. On the other hand, energy industries, non-energy industries, and losses experienced respective decreases of 1.3%, 6.0%, and 16.0%.

The national energy consumption varies across different sectors, and the following table illustrates the energy consumption of the main sectors:

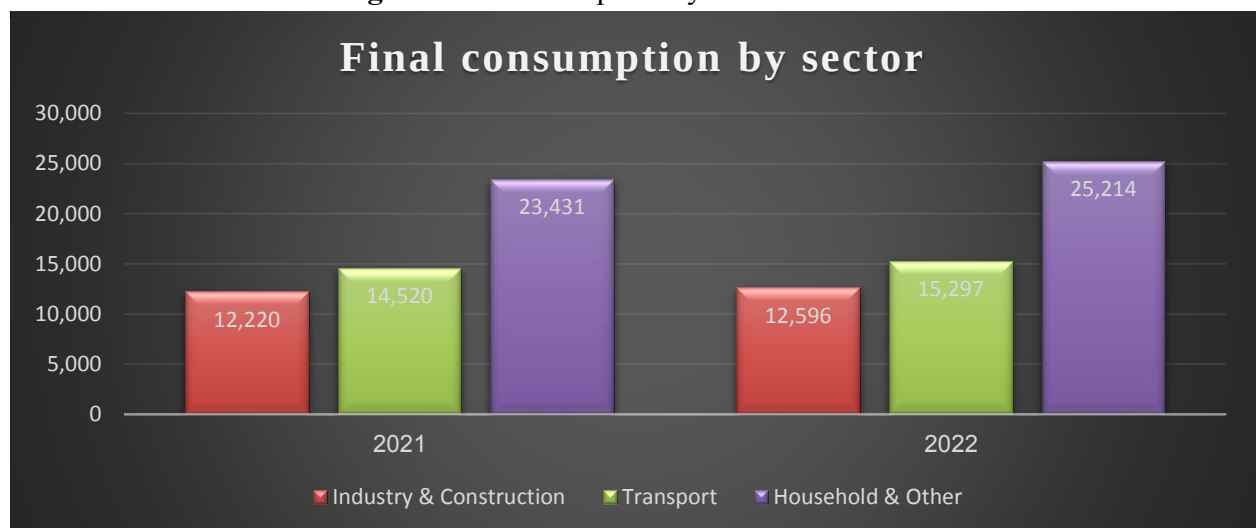
**Table 2.** Final consumption by sector on 2021 and 2022

| Unit: K toe             | 2021   | 2022   | Evolution  |     |
|-------------------------|--------|--------|------------|-----|
|                         |        |        | Quantities | (%) |
| Industry & Construction | 12 220 | 12 596 | 375        | 3,1 |
| Transport               | 14 520 | 15 297 | 777        | 5,4 |
| Household & Other       | 23 431 | 25 214 | 1 783      | 7,6 |
| Total                   | 50 171 | 53 106 | 2 935      | 5,9 |

**Source:** The National Energy Balance Sheet, the Algerian Ministry of Energy and Mines, 2022.

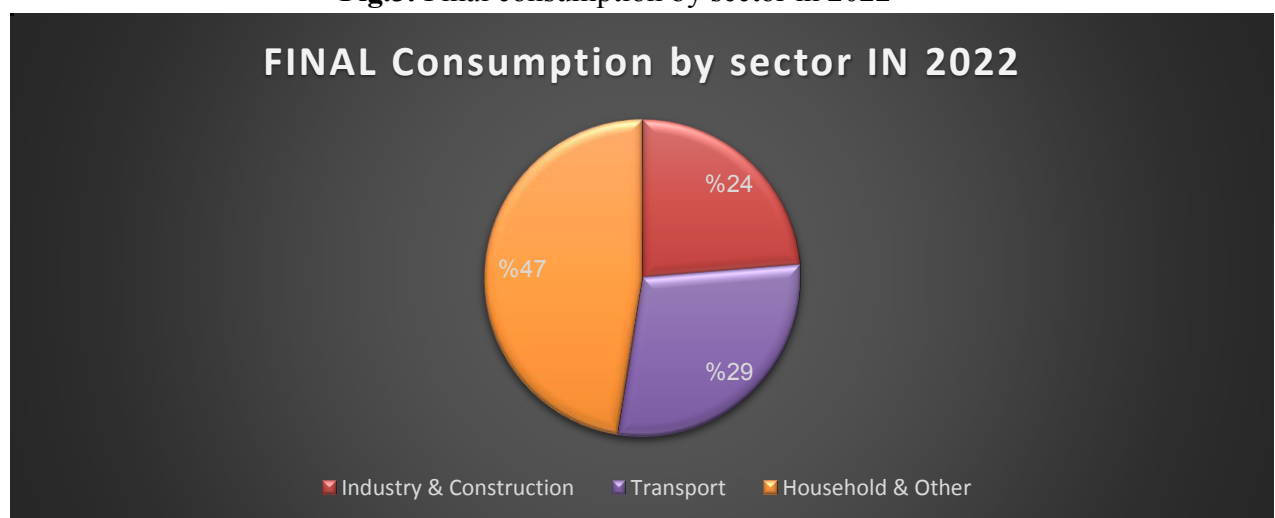
The contribution of each sector to the country's energy consumption is displayed in the following graph:

**Fig.2.** Final consumption by sector in 2021



**Source:** Compiled by us from the data in the previous table.

**Fig.3.** Final consumption by sector in 2022



**Source:** Compiled by us from the data in the previous table.

According to the 2022 National Energy Balance Sheet<sup>1</sup>, published by the Ministry of Energy and Mines, the final consumption in 2022, categorized by sector of activity, can be described as follows:

- The sector of "Households and others" experienced an increase in demand (7.6%), rising from 23.4 million Tep in 2021 to 25.2 million Tep in 2022. This growth was primarily driven by the residential sub-sector (6.5%).
- The "Transportation" sector continued to see growth (5.4%) in consumption since the lifting of COVID-19 restrictions, reaching 15.3 million Tep in 2022 compared to 14.5 million Tep in 2021. This increase was fueled by land fuels, particularly due to the recovery of road transportation (both passengers and goods). The final consumption of petroleum products in this sector is primarily composed of diesel at 62%, gasoline at 24%, and LPG/C at 12%.
- The "Industries and Construction" sector saw an increase (3.1%) in consumption, reaching 12.6 million Tep in 2022. This growth can be attributed to the recovery of economic activity, particularly in the ISMME and construction materials sub-sectors.

**It should be noted that global primary energy consumption reached 604.04 exajoules in 2022, representing a 1.1% increase compared to 2021** (Connaissance des Energies, 2023).

The increasing consumption in Algeria necessitates the adoption of new energy resources, especially considering the recognized demographic changes. The population of Algeria reached 45,350,000 inhabitants in 2022, and projections indicate that it will reach 50,360,000 inhabitants in 2030 and 60,923,000 inhabitants in 2050 (Papadopoulos, 2022). These figures clearly indicate the imperative need for increased energy requirements in the country. Addressing this demand requires the integration of alternative sources that meet both national needs and international demand, while prioritizing efficiency and sustainability.

### **3. State of Renewable Energies in Algeria:**

#### **3.1. Energy Transition's Origin**

The concept of energy transition was born in Germany and Austria in the early 1980s. Developed by the German association Öko-Institut<sup>2</sup>, its goal at the time was "to abandon dependence on fossil and fissile energies." This clarifies that energy transition is the process of moving from a fossil fuel-based energy system to one that is more varied, sustainable, and dependent on clean and renewable energy sources (Tahar HAMAZ, Abdelhamid AIT

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<sup>1</sup> The National Algerian Energy Balance Sheet refers to a comprehensive record that provides information on the energy supply, demand, and utilization within Algeria for a specific period. It offers a detailed account of the various energy sources and their respective contributions to Algeria's overall energy mix.

<sup>2</sup>The Oeko Institute, founded in 1977, is a German institute that plays a crucial role in promoting sustainable development at the global, national, and local levels. Through scientifically grounded research, it provides advice to policymakers, businesses, and civil society on topics such as digitization, energy transition, climate policy, nuclear energy, sustainable mobility, sustainable economy, resource management, and environmental law.

TALEB, 2020).

In the same context; we can put forth the following definition: Energy transition refers to the process of meeting human energy needs through the use of a new, transparent system developed in response to technological advancements and environmental requirements in order to produce sustainable and wholesome economic and environmental conditions. The energy transition is based on two pillars (DJEDDI, 2022):

- **Energy Efficiency:** is the relationship between the amount of energy supplied and the amount consumed. It is equivalent to a panel of technical and/or logistical solutions implemented to restrict energy consumption for the same or even better service; by using the same energy system based on fossil fuels with/ or low emissions of greenhouse gases.
- **Clean energy solutions** must be developed and widely adopted, in order to create and preserve a sustainable environment. This includes the creation of novel renewable energy sources as well as their effective application in a range of industries. We can lessen climate change, safeguard our natural resources, and lessen our reliance on fossil fuels by concentrating on the study, creation, and application of clean energy alternatives.

In line with the same context, we can put forth a third pillar that offers a rational solution for nations seeking to ensure their energy security and access multiple resources to address future challenges in accordance with the evolving global landscape since its inception:

- **The Mix Energy:** It's a solution that combines renewable and fossil energy sources to increase energy output in a profitable and efficient manner. It can be used in nations that currently have access to fossil fuels and are looking to increase their energy productivity by utilizing other sources. Additionally, this method can be applied in nations that lack the energy resources to meet their energy needs<sup>1</sup>.

### 3.2. The Potential of Renewable Energies<sup>2</sup>

Algeria is a geographically strategic country, with its Sahara Desert covering almost 90%<sup>3</sup> of its territory. This advantage gives it a powerful solar potential, resulting in a strong energy characteristic. Thus, Algeria is embarking on a new era of sustainable energy. The updated renewable energy program aims to install a renewable power capacity of around 22,000 MW by 2030 for the domestic market, with the strategic objective of maintaining the option for exportation if market conditions permit.

#### ➤ **Solar Potential:**

Algeria has one of the highest solar resources in the world. It will be explained in the following table:

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<sup>1</sup> For instance, adopting an energy mix could be an advantageous solution for Algeria due to its abundance of natural resources.

<sup>2</sup> The data comes from the official website of the Ministry of Energy and Mines, <https://www.energy.gov.dz/?rubrique=energies-nouvelles-renouvelables-et-maitrise-de-lrenergie>; Accessed on: 20/03/2024.

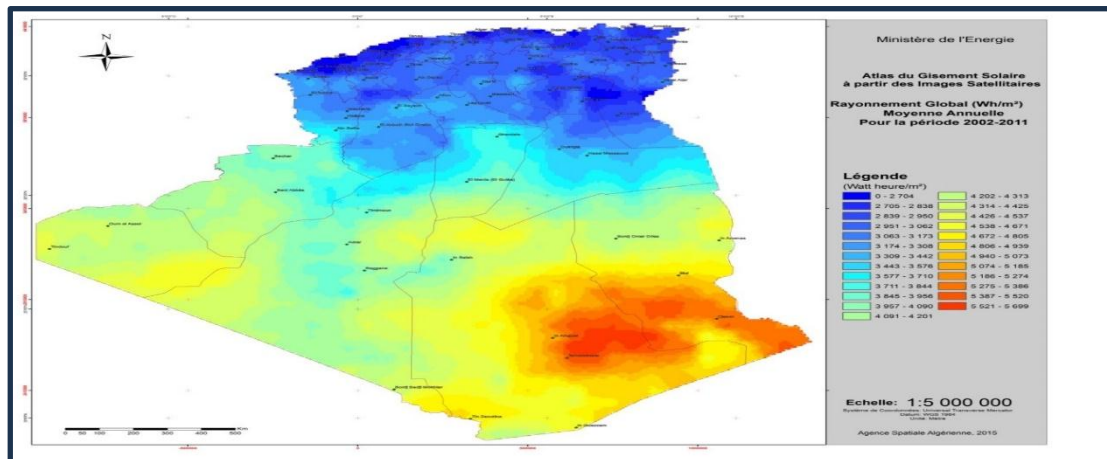
<sup>3</sup> [https://fr.wikipedia.org/wiki/Sahara\\_alg%C3%A9rien](https://fr.wikipedia.org/wiki/Sahara_alg%C3%A9rien) ; Accessed on: 20/03/2024.

**Table 1.** Structure of Solar Potential in Algeria

| Total Duration of sunlight                                                 |                        |
|----------------------------------------------------------------------------|------------------------|
| Over the majority of the territory                                         | 2000 hours/ annually   |
| High Plateaus and Sahara                                                   | 3900 hours/ annually   |
| The energy received annually (on a horizontal surface of 1m <sup>2</sup> ) |                        |
| In the Northern Region                                                     | 3 kWh/m <sup>2</sup>   |
| Far South                                                                  | 5,6 kWh/m <sup>2</sup> |

**Source:** Compiled by us from the data published by the Ministry of Energy and Mines ([Ministère de l'Énergie | Algérie \(energy.gov.dz\)](http://Ministère de l'Énergie | Algérie (energy.gov.dz))), Accessed on 20/03/2024)

**Fig.1.** Map of Average Annual Direct Global Irradiation (Period 2002-2011)



**Source:** [https://www.energy.gov.dz/Media/upload/image//1528888901\\_Carte-de-l-Irradiation-Globale-Directe-Annuelle-Moyenne.jpg](https://www.energy.gov.dz/Media/upload/image//1528888901_Carte-de-l-Irradiation-Globale-Directe-Annuelle-Moyenne.jpg), Accessed on 20/03/2024

In 2015, the government postponed the deployment schedule for Concentrated Solar Power (CSP) and lowered its capacity target from 7,200 MW to 2,000 MW. On the other hand, the solar power capacity target was set at 13,575 MW, accounting for 62% of the total renewable energy production (Un fort potentiel pour les entreprises vertes (Algérie) : les vents favorables de la croissance démographique et la stratégie de l'Europe pour se désengager de la Russie, 2022)

If we compare the solar potential to natural gas in Algeria, the Algerian solar potential is equivalent to a volume of 37,000 trillion cubic meters, which is more than eight (8) times the country's natural gas reserves. It's worth noting that solar potential is renewable unlike natural gas (Tahar HAMAZ, Abdelhamid AIT TALEB, 2020)

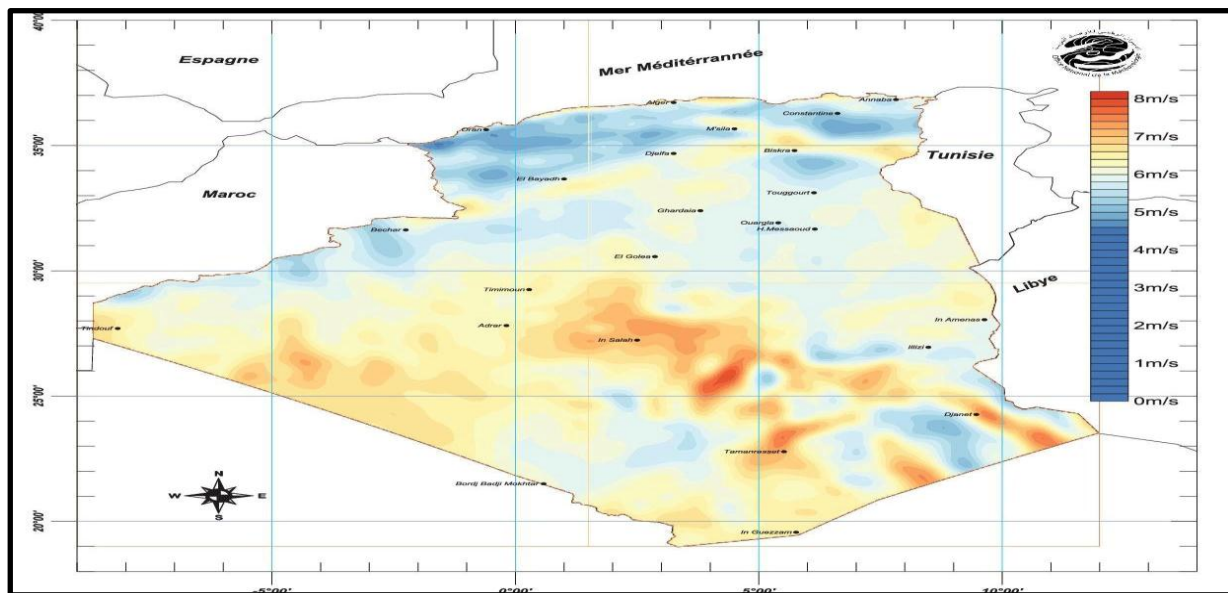
### ➤ Wind Potential :

The wind resource in Algeria exhibits significant variation from one location to another due to the diversity of topography and climate in our country. The territory is divided into two distinct geographical zones: the Mediterranean North with its 1200 km coastline and mountain ranges of the Tell Atlas and Saharan Atlas, and the South characterized by a Saharan climate.

Overall, the North experiences relatively low average wind speeds, but favorable microclimates can be found along the coastal sites of Oran, Béjaïa, and Annaba, as well as on the high plateaus of Tébessa, Biskra, M'sila, and El Bayadh, where speeds reach 6 to 7 m/s. In the Grand South, wind speeds exceed 8 m/s.

The map below highlights that the South benefits from higher wind speeds compared to the North, particularly in the Southeast where speeds exceed 7 m/s and even reach over 8 m/s in the Tamanrasset region (In Amguel).

**Fig.2.** Map of Mean Annual Wind at 50m (Period 2001-2010)



**Source :** [1528889302 Carte-du-Vent-Annuel-Moyen-a-50m.jpg \(1240×1151\) \(energy.gov.dz\)](https://www.energy.gov.dz/1528889302_Carte-du-Vent-Annuel-Moyen-a-50m.jpg) ;  
Accessed on : 20/03/2024

### ➤ Geothermal Energy Potential :

Through the compilation of geological, geochemical, and geophysical data, more than two hundred (200) hot springs have been identified in the northern part of the country. Approximately one-third (33%) of these hot springs have temperatures exceeding 45°C. In particular, there are high-temperature sources reaching as high as 118°C in Biskra. Studies focusing on the thermal gradient have successfully identified three regions where the gradient exceeds 5°C per 100 meters:

- ✓ The region encompassing Relizane and Mascara.
- ✓ The area including Aïne Boucif and Sidi Aïssa.
- ✓ The zone covering Guelma and Djebel El Onk.

**Table 2.** Location and temperature of some thermal springs in Algeria

| Thermal spring             | Geographical location | Temperature (°C) |
|----------------------------|-----------------------|------------------|
| Hammam Rabi                | Saida                 | 49               |
| Hammam Bouhajar            | Ain TIMOUCHANT        | 66.5             |
| Hammam Ain Mentila         | Relizane              | 31               |
| Hammam Righa               | Ain Defla             | 67               |
| Hammam Melouane            | Blida                 | 38.5             |
| Hammam El Mesrane          | Djelfa                | 42               |
| Hammam Ksenia              | Bouira                | 60               |
| Hammam Sidi Yahia El Aidli | Béjaïa                | 58               |
| Guelma Hammam Meskhoutine  | Guelma                | 98               |
| Hammam Hammamet            | Tébessa               | 35               |

**Source:** Compiled by us depending on : “Ouali, Salima. (2018). Eléments de l'Atlas géothermique de l'Algérie. The Renewable Energy Bulletin No. 44 – 2018, page 11 »

### ➤ The Hydroelectric Potential:

The total amounts of water falling on Algerian territory are significant, estimated at 65 billion cubic meters, but ultimately provide limited benefits to the country due to factors such as a low number of precipitation days, concentration in limited areas, high evaporation rates, and rapid drainage towards the sea.

Broadly speaking, surface water resources decrease from north to south. Currently, the estimated usable and renewable water resources amount to around 25 billion cubic meters, with approximately two-thirds attributed to surface water resources.

A total of 103 dam sites have been identified, with over 50 dams currently in operation.

### 3.3. The Renewable Energy and Energy Efficiency Development Program

#### 3.3.1. The Renewable Energy Development Program<sup>1</sup>

Through this renewable energy program, Algeria aims to position itself as a major player in electricity generation using photovoltaic and wind energy, while also incorporating biomass, cogeneration, geothermal, and, beyond 2021, solar thermal. These energy sectors will drive sustainable economic development, fostering a new model of economic growth.

By 2030, 37% of the installed capacity and 27% of the electricity production for domestic consumption will come from renewable sources.

Given that solar energy dominates the national renewable energy potential, Algeria sees it as an opportunity and a catalyst for economic and social development, particularly through the establishment of wealth and job-creating industries.

However, this does not exclude the launch of numerous wind farm projects and the implementation of experimental projects in biomass, geothermal, and cogeneration.

The renewable energy program's target for the domestic market during the period of **2015-2030** is to achieve a total capacity of **22,000 MW**, distributed among different sectors as follows:

**Table 1.** The consistency of the Renewable Energy Development Program Between 2015 and 2030

| Unit : MW         | First Phase | Second Phase | TOTAL  |
|-------------------|-------------|--------------|--------|
|                   | 2015-2020   | 2021-2030    |        |
| Photovoltaic (PV) | 3 000       | 10 575       | 13 575 |
| Wind Energy       | 1 010       | 4 000        | 5 010  |
| CSP               | -           | 2000         | 2 000  |
| Cogeneration      | 150         | 250          | 400    |
| Biomass           | 360         | 640          | 1 000  |
| Geothermal energy | 5           | 10           | 15     |
| TOTAL             | 4 525       | 17 475       | 22 000 |

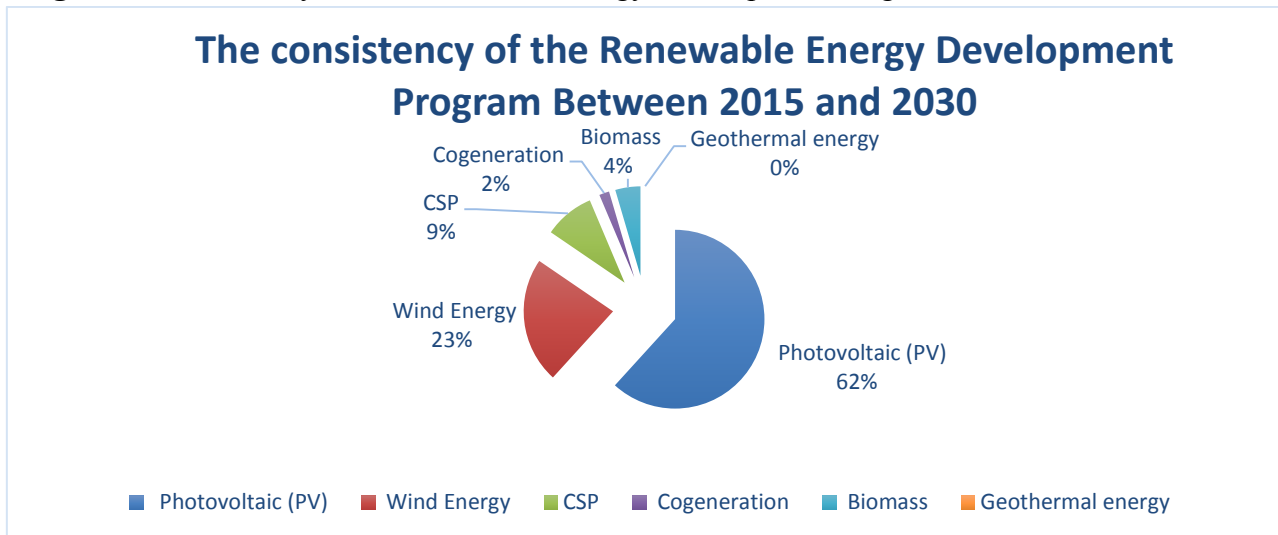
**Source:** Established by us through the data published by the Ministry of Energy and Mines (Ministère de l'Énergie | Algérie ([Ministère de l'Énergie | Algérie \(energy.gov.dz\)](http://Ministère de l'Énergie | Algérie (energy.gov.dz))), Accessed on 20/03/2024)

<sup>1</sup> Several studies have been conducted, including:

- Updating the national wind atlas in collaboration with the National Meteorological Office (ONM).
- Identification of eligible sites for wind farm installations in the Touggourt, Hassi Messaoud, and Ghardaïa areas in collaboration with the Center for Renewable Energy Development (CDER).
- Development of the Solar Atlas of Algeria in collaboration with the Algerian Space Agency (ASAL).
- Identification of a set of high solar potential sites capable of hosting solar power plants, in collaboration with the Algerian Space Agency (ASAL).
- Assessment of the impact of renewable energy integration on the Algerian electricity grid by Sonelgaz in collaboration with RES4MED/CESI.

The previous results can be illustrated as the following:

**Fig.1.** The consistency of the Renewable Energy Development Program Between 2015 and 2030



**Source:** Compiled by us from the data in the previous table

The graph above illustrates the share of each type of renewable energy in the renewable energy and energy efficiency development program by 2030. It displays the proportion of each renewable energy type within the program during the period from 2015 to 2030.

The shares are presented as follows (in Megawatts):

- ✓ **Photovoltaic solar: 13,575**
- ✓ **Wind: 5,010 MW**
- ✓ **Solar thermal: 2,000 MW**
- ✓ **Biomass: 1,000 MW**
- ✓ **Cogeneration: 400 MW**
- ✓ **Geothermal: 15 MW**

We can observe that solar energy holds a prominent position, representing more than half of the total energy production with a capacity of 13,575 MW. This significant share is justified by Algeria's privileged geographical location and its vast solar capabilities.

Algeria is situated in a region that benefits from abundant sunshine throughout the year. Its expansive desert areas and clear skies contribute to an optimal potential for solar energy production. The favorable climatic conditions enable Algeria to fully harness this abundant renewable resource.

By committing to the development of renewable energies, particularly solar energy, Algeria can not only meet its growing energy demand but also emerge as a regional leader in sustainable energy transition.

### 3.3.2. The National Energy Efficiency Program

The energy efficiency program is driven by Algeria's commitment to promoting responsible energy use and exploring all avenues to preserve resources while promoting efficient and optimal consumption.

The objective of energy efficiency is to produce the same goods or services while using the least amount of energy possible. This program includes actions that prioritize the use of energy forms best suited to different purposes, requiring behavioural changes and equipment improvements.

The program encompasses the implementation of energy efficiency measures in three sectors: **buildings, transportation, and industry**. It also encourages the establishment of a local industry for the production of efficient lamps, solar water heaters, and thermal insulators by promoting local or foreign investment.

#### **4. The transition towards an energy mix for energy security**

An important factor in a nation's stability and economic development is its energy security. A nation becomes vulnerable to global market changes, geopolitical conflicts, and price volatility when it heavily relies on a single energy source, such as petroleum. This might have serious political and economic repercussions that would affect country sovereignty, employment, and growth.

We can see these effects by looking at the rise in oil prices that followed the start of the conflict between Russia and Ukraine, where the price of oil that Russia exports has reached record highs. The economic status of the petroleum-importing nations was negatively impacted by this price increase as they were unable to comply with the new international regulations.

This leads us to ask: Would the scenario be the same if the importing countries had multiple sources of energy that could be substituted for one another or if they had a sizable enough energy reserve to deal with this situation? The answer is straightforward: in actuality, no.

This event made clear how important energy security is and how having two or more energy sources is necessary to put a country in a position of power where its only source of power would come from its own policies.

Furthermore, the shift to a more diverse energy mix encourages the growth of new sectors and cutting-edge technology. She promotes local job creation, encourages investment in renewable energy sources, and supports steady economic growth. Leading countries in the energy transition can also improve their standing internationally by becoming pioneers in the field of renewable energy and drawing foreign investment and partnerships.

##### **4.1. Algeria and the energy transition**

The global energy trend has prompted nations with non-renewable resource bases to shift toward more efficient and long-lasting energy systems. The climate crisis, which has a significant influence on political and economic decisions, is one factor driving this evolution. Rethinking their energy provisioning has become necessary in many countries because to the growing awareness of the harmful effects of fossil fuels on the environment and climate change. The use of renewable energy sources, such as solar, wind, hydro, and geothermal energy, has significant benefits in terms of lowering greenhouse gas emissions and protecting natural resources (Raquel Ersoy & Terrapon-Pfaff, 2021).

Algeria is not an exception among these countries. After revising its economic, environmental, ecological, and energy policies, the country finds itself in a situation where it needs to embark on at least a partial transition within its energy policy framework.

Algeria has long relied on oil and gas resources for its economic development. However, the growing awareness of environmental and climate concerns has prompted the country to reconsider its energy model. Excessive dependence on fossil fuels presents long-term risks, both economically and environmentally (Layachi & Mokhtar , 2023).

To address these challenges, Algeria has committed to a gradual energy transition. This involves diversifying its energy mix by incorporating more renewable energies. This partial transition aims to reduce reliance on fossil resources, promote environmental sustainability, and foster more resilient economic growth (Chibani, 2022).

## **4.2. Determinants of investment in sustainable energy transition in Algeria**

**4.2.1. Global determinants:** The global sustainable energy transition investment determinants are complex and impacted by a multitude of factors. These elements fall into four categories: political, environmental, regulatory, and economic (Investing in Sustainable Energy For All, 2023)

### **Economic factors :**

- Investment and operating costs.
- Cost of capital.
- Expected returns.

### **Regulatory:**

- Investment climate (e.g. planning process)
- Sector regulations (e.g. electricity pricing)
- Fiscal tools

### **Technological :**

- Readiness and suitability of technologies, intermittency issues
- Availability of technological and human capacity
- Surrounding infrastructure, transmission lines, storage

### **Environmental :**

- Presence of fossil fuel resources
- Renewable energy potential
- Climate and environmental concerns

**Political context:** Energy security concerns, nationally determined contributions, energy transition strategies

## **4.2.2. General determinants for Algeria**

In Algeria, there are several determinants that can influence the policies guiding governments' investment decisions and utilization of renewable energies.

These determinants can be listed as follows:

**4.2.2.1. Legal Determinants:** make reference to the rules and laws that affect these investments. An environment that is more or less conducive to the growth of renewable energy sources can be produced by these rules and regulations.

### **4.2.2.1.1. The International Institutional and Regulatory Framework for Energy/Climate<sup>1</sup>**

#### **✓ United Nations Conference on Environment and Development (UNCED):**

In the global context, the international community has become aware of the gravity of economic systems that have led to the intensive exploitation of natural resources. This excessive exploitation has had detrimental consequences on the environment, such as

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<sup>1</sup> The data comes from the official website of Nations Unit “[Conférences | Environnement et développement durable | Nations Unies](#) » Accessed on 20/03/2024

**Fig.1.** The 17 Sustainable Development Goals (SDGs)



By analysing the policies, movements, and reactions surrounding climate change, it is evident that the position of fossil fuels is gradually diminishing. This shift can be attributed to the inherent dangers associated with their use, such as the emission of greenhouse gases, which contribute to higher temperatures and other negative effects. Awareness of the environmental impact of fossil fuels has led to a global movement towards cleaner and more sustainable energy sources. Governments, organizations, and individuals are increasingly

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recognizing the need to transition away from fossil fuels and towards renewable energy alternatives.

#### ✓ **United Nations Development Programme (UNDP)**

The United Nations Development Programme (UNDP) is the primary agency of the United Nations responsible for international development. It operates in 170 countries and territories. The UNDP is dedicated to promoting sustainable development, democratic governance, peacebuilding, and strengthening climate and disaster resilience to support the achievement of the Sustainable Development Goals.

#### ✓ **United Nations Environment Programme (UNEP)**

The United Nations Environment Programme (UNEP) strives to bring about transformative changes for people and nature by addressing the root causes of the three planetary crises: climate change, nature and biodiversity loss, and pollution and waste. UNEP implements seven interrelated sub-programmes of action: climate action, chemicals and pollution management, nature action, scientific policy, environmental governance, financial and economic transformations, and digital transformations.

Through its campaigns, including World Environment Day, UNEP raises public awareness and advocates for effective environmental action.

#### **4.2.2.1.2. The national institutional and regulatory framework for energy/climate:**

Algeria has a favourable legal framework for promoting renewable energies and energy efficiency. This framework includes several laws and regulations:

- **Law No. 02-01 of February 5, 2002:** This law liberalizes the electricity and gas sector and includes provisions to promote electricity production from renewable energies and its integration into the grid. It guarantees the purchase of renewable energy and covers associated costs.
- **Law No. 04-09 of August 14, 2004:** This law aims to promote renewable energies within the framework of sustainable development. It provides for the development of a national program to promote renewable energies and the creation of a National Observatory for Renewable Energies to support their development.
- **Interministerial and executive decrees:** Several regulatory texts have been published to strengthen the regulations regarding renewable energies in Algeria. They encourage investments and provide subsidies to cover additional costs on the national electricity system (Tahar HAMAZ, Abdelhamid AIT TALEB, 2020).

#### **4.2.2.2. Economic and Financial determinants**

Economic determinants play a crucial role in the integration of renewable energies in Algeria. One key factor is the price of these energy sources. When the cost of renewable energies decreases and becomes competitive compared to conventional energy sources, it promotes their adoption.

In Algeria, the government has implemented measures to encourage investments in renewable energies, including offering guaranteed purchase tariffs for electricity produced from renewable sources. These tariffs ensure producers a stable income and incentivize the implementation of green energy projects. We can mention (Tahar HAMAZ, Abdelhamid AIT TALEB, 2020) :

- ✓ **Guaranteed purchase tariffs:** Preferential tariffs have been established for electricity produced from renewable energies, particularly solar and wind. These tariffs guarantee producers a reasonable profitability over a period of 20 years.
- ✓ **National Fund for Renewable Energies and Cogeneration (FNERC):** The Algerian government contributes to financing renewable energy projects through this fund, which is funded by a 1% levy on oil royalties.
- ✓ **Development of industrial capacity:** Algeria aims to strengthen its industrial fabric in the field of renewable energies. Integration targets of 80% for photovoltaic solar and 50% for solar thermal and wind have been set. Plans are underway to establish factories for manufacturing photovoltaic modules, as well as the development of engineering and research activities in renewable energies.

#### 4.2.2.3. Geographical determinants

Algeria benefits from a geographical location conducive to the integration of solar energy into its energy mix. Due to its location in a sunny region and its arid climate, the country has significant and exploitable solar potential. This abundance of solar resources offers significant advantages for the development of solar technologies and their integration into the national energy system.

### 5. CONCLUSION

After conducting an analysis of the economic landscape in Algeria, it has been observed that it predominantly relies on hydrocarbons as the primary source of energy. However, due to population growth, there is a pressing need to explore alternative energy sources that can meet the demands of various sectors (with households being the most energy-intensive sector in 2022). Consequently, investment in solar photovoltaic energy emerges as the most viable alternative in Algeria, given its abundant solar potential. This investment can be justified for the following reasons:

- ✓ **Geographical reasons** grant Algeria a significant and exploitable solar potential.
- ✓ **Legal reasons** are evident through the country's vision and policy in favour of renewable energies, by implementing and enacting new laws that encourage investments in these new technologies.
- ✓ **Economic and financial reasons:** can arise from tariff measures and the lower cost of these new energies.

These incentives encourage various stakeholders to replace fossil fuels with other, more sustainable alternatives.

These three determinants may not be the only ones influencing investment choices. Other factors must also be considered, such as technological innovations playing a crucial role in the transition to renewable energies. Continuous technological advancements allow for the development of more efficient, affordable, and sustainable solutions. For example, progress in solar panels, wind turbines, and energy storage has made these technologies more economically competitive. Additionally, consumer acceptance of substitutions is a determining factor. Consumption habits are often deeply ingrained, making it challenging to change established energy behaviours. However, as the benefits of renewable energies

become more evident, such as long-term cost savings and a reduced environmental footprint, consumers are more inclined to adopt these new energy sources.

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