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Analyzing the reality and prospects of investment in renewable energies as a strategic option for the transition towards a green economy in Algeria

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Abstract:

With the climatic changes that the world is witnessing and the deterioration of the environmental ecosystem as a result of the irrational exploitation of depleted natural resources, it was necessary to search for renewable sources of energy that take into account the ethical and environmental aspects and meet the requirements of sustainable development .This research paper aims to show some of Algeria's achievements in the field of exploiting renewable energies in order to activate the green economy and get the Algerian economy out of the cycle of the rentier economy, through the National Program for the Development of Renewable Energies 2011-2030, and it has been relied on descriptive and analytical approach by standing on the most important concepts related to the study and analyzing its statistics. The study concluded that the exploitation of sustainable sources of energy did not reach the required level despite the enormous natural qualifications that Algeria possesses, as the success of green economy mechanisms requires coordination between the environmental, economic and social fields to develop investment in renewable energies in light of the inevitability of the depletion of oil resources.

Keywords: Green economy, renewable energy, National Renewable energy program.

Introduction:

In view of the various crises experienced by the global economy in general and oil-based economies in particular, and with the inevitability of the depletion of fossil fuels as a non-renewable energy source on which these countries rely to finance their investments, and despite its role as an important energy source, the damage resulting from its use has harmed the ecological system of the environment due to the failure to consider ethical and environmental aspects in the exploitation of these natural resources. The exploitation of these energies has led to an increase in greenhouse gas emissions, such as carbon dioxide, by 20%, which has raised the temperature of the Earth's surrounding atmosphere by 2°C over the past seventy years. It has also resulted in economic and social damage concerning the rights of future generations to these depleted resources.

Under these circumstances, and in an effort to mitigate the severity of factors affecting both individuals and the environment, preserve the stock of depleting energy resources, limit their use in a sustainable manner, and raise levels of economic, social, and environmental development, it became necessary to search for a new development model that takes into account the relationship between humans and the environment within what is known as the green economy or environmental economy. This economy seeks to achieve sustainable development while preserving the environment by providing clean production and optimal exploitation of resources and energies through pioneering development projects that protect humanity from environmental hazards. This is achieved through the use of new technologies in the field of renewable energy exploitation as one of the

strategic sectors of the green economy adopted by most major economies, particularly with regard to investment in solar energy as a sustainable energy resource, due to its great importance in preserving conventional energy resources and enhancing energy security.

Research Problem:

Based on the above, the following research problem is raised:

What is the reality of investment in renewable energies as a mechanism of green financing in light of the inevitability of the energy transition in Algeria?

Importance of the Study:

The importance of this study lies in the fact that resorting to greening the economy has the ability to preserve natural resources and achieve sustainable development. Investment in clean energies also plays a role in preserving the rights of future generations to conventional energies and reducing pollution and emissions that cause global warming.

Objectives of the Study:

The motivation for conducting this study is as follows:

- Moving beyond the rentier economy in order to achieve economic development goals, address structural imbalances in the national economy, and achieve economic and environmental stability.
- Highlighting Algeria's potential in the field of renewable energies.
- Identifying the most important measures taken by Algeria to green its economy.
- Identifying the main challenges that hinder the optimal exploitation of renewable energies in Algeria.

Methodology of the Study:

To answer the research problem raised in this paper, the descriptive approach was adopted to identify the various concepts related to the subject of the study, and the analytical approach was used to interpret and analyze these concepts and related statistics and to draw conclusions.

To cover the aspects of the study topic, the research was divided into the following sections:

First: The concept of the green economy and its objectives.

Second: The concept of renewable energy and its sources.

Third: The reality and challenges of investment in renewable energies within the framework of the transition toward a green economy in Algeria.

First: The Concept of the Green Economy and Its Objectives:

The green economy, in its simple sense, is defined as an economy that produces a low level of carbon emissions, uses natural resources efficiently and rationally, includes all social groups, and prevents the loss of biodiversity and the ecological system of the environment (Bouaziz & Oulad Zawi, p. 3).

The United Nations Environment Programme (UNEP) defines it as an economy that results in improved human well-being and social equity on the one hand, while reducing environmental risks and ecological resource scarcity on the other (Sandy Sabri et al., p. 1).

This concept emerged in response to several challenges that the world has faced in recent times, including (Al-Jawzi & Bouzida, 2018, p. 315):

- Rapid population growth and its requirements.
- Depletion of non-renewable natural resources.
- The phenomenon of global warming, intensified by carbon dioxide emissions into the atmosphere.

There are also those who define the green economy as an economy based on six main sectors: renewable energy, green buildings, clean transportation, water management, land management, and waste recycling (Al-Fiqi, 2014, p. 05).

The importance of the green economy lies in investing in natural capital to achieve sustainable economic progress. It also seeks to eliminate poverty by creating diverse job opportunities through increased investments in green sectors such as waste recycling, agriculture, buildings, transportation, tourism, and others. The number of jobs could reach 60 million, achieving economic benefits and

environmental improvements simultaneously (International Labour Conference, 2013, p. xiii). The green economy ensures urban livelihoods in many areas by establishing green cities and providing efficient public transportation. Greening the building sector also increases resource-use efficiency and reduces waste and associated risks (Yousefi & Belhadf, p. 250).

The green economy seeks to achieve the following objectives (Al-Jawzi & Bouzida, 2018, p. 315):

- Reducing environmental pollution and greenhouse gas emissions.
- Increasing the efficiency of energy and natural resource use.
- Protecting biodiversity and ecosystems.

The green economy can be viewed from several aspects, the most important of which are (Maazouzi & Ben Othman, 2018, p. 134):

a- Alternative energies: meaning clean and sustainable energies that reduce carbon emissions, such as solar energy, wind energy, biomass, and hydropower.

b- Sustainable transport: providing means of transport and vehicles that partially operate on electricity.

c- Waste management: recycling waste and treating waste that causes toxic emissions.

d- Water management: desalination of seawater and rainwater harvesting.

e- Green buildings: controlling and reducing energy and water use, and being equipped with environmentally friendly and non-polluting materials.

f- Land management: through organic agriculture free of harmful fertilizers to soil composition and reforestation to reduce air pollution.

An amount of USD 2,800 billion has been allocated since 2008 to support the global economic recovery program to finance green investments directed to three areas as follows:

1- Green investments of 67% in railway transport equipment, energy efficiency, clean buildings, and low-carbon vehicles.

2- Allocation of 19% of investments to waste treatment, water management, and carbon reduction technologies.

3- Allocation of 14% of green investments to renewable energy.

Second: The Concept of Renewable Energy and Its Sources:

Renewable energies are considered strategic sectors of the green economy, as they are clean and environmentally friendly energies. Investment in them is among the most important environmental investments, to which the state has allocated a significant portion of its budget due to their great importance in preserving the rights of future generations to conventional energies on the one hand, and protecting the environment and achieving sustainable economic diversification on the other.

The International Energy Agency (IEA) defines renewable energy as energy sources resulting from natural processes such as sunlight and wind, which are replenished in nature at a rate faster than their rate of consumption (Ahmed Salah et al., 2018).

The United Nations Environment Programme (UNEP) defines it as energy whose source is a fixed and limited natural stock that is renewed periodically at a rate faster than its consumption, and which appears in the following five forms: solar energy, wind energy, hydropower, biomass energy, and geothermal energy (Riahaliya & Boudah, 2017, p. 164).

According to the Intergovernmental Panel on Climate Change (IPCC), renewable energy is any energy whose source is geophysical or biological and is replenished in nature at a rate equal to or greater than its rate of use. It is generated from continuous natural flows such as solar energy, biomass energy, geothermal energy, tidal energy in oceans, wind energy, and water energy, and these sources are converted into primary energy using various technologies (Barakat & Nassef, 2020, p. 88).

The importance of investing in renewable energies lies in the fact that they have permanent sources available worldwide and can be continuously exploited without fear of depletion. They are energies obtained

fromtheir natural and periodic recurrence in nature. They are also considered a local alternative to energy in many countries that import fossil energy, being economical in use and suitable for the development needs of isolated and rural areas (Rais, Rahal, & Tewil, 2018, p. 116).

Based on the above definitions, renewable energy can be defined as energy generated from non-traditional natural sources that are continuously available and inexhaustible, such as the sun, water, and air, requiring only their conversion from natural energy into usable energy through various technologies.

The sources of renewable energy include the following:

1-Solar Energy: Solar energy is considered a clean and inexhaustible energy as long as the sun exists. The use of the sun's thermal energy has been known for thousands of years in hot regions, where it was used to heat water and dry certain crops to preserve them. Currently, research and experiments focus on exploiting solar energy to produce electricity and use it for heating, air conditioning, metal smelting, and others. Solar radiation is electromagnetic, with 49% visible spectrum, 2% ultraviolet rays, and 49% infrared rays (Rais, Rahal, & Tewil, 2018, p. 116).

There are two technologies for generating electricity using solar energy (Organization of Arab Petroleum Exporting Countries, 2019, p. 100):

-Generation using photovoltaic cells (solar cells), where solar energy is directly converted into electrical energy. The plant's lifespan ranges from 25 to 30 years, but electricity is generated only during daylight hours.

-Generation using concentrated solar power, where mirrors are used to concentrate solar energy on a specific point to heat a solid material that produces steam, which drives a steam turbine to generate energy. The cost of generation using this technology is double that of photovoltaic cells, although it provides an additional four hours of energy generation after sunset.

2.Wind Energy: Wind is moving air and thus possesses kinetic energy that can be converted into regular rotational turbine energy using wind turbines. It has been used for decades to pump water, grind grain, and cut wood, but its use declined with the discovery of fossil energy sources. Wind energy is characterized by well-known and advanced technologies, as its generators operate autonomously, require no continuous maintenance or fuel, and do not emit carbon dioxide.

The average wind speed available worldwide is estimated at about 4 m/s, allowing annual energy generation estimated at 53,000 trillion watt-hours, increasing energy production fivefold (Wakkaa, p. 117).

3- **Hydropower:** This is energy generated from water falling from a height or flowing at high speed in rivers and streams, as well as from differences in temperature, density, and salinity. Water has been used for two thousand years to rotate water wheels made of wood with blades moved by water, often used for grinding grain. These wheels were significantly

And water has been used for two thousand years to operate waterwheels, which are made of wood and have blades that can be moved by water. They were often used to grind grain. These waterwheels were greatly developed, especially when a shortage of conventional energy sources occurred in 1973 and concern about environmental pollution increased. Among the advantages of this source are that it is safe, its cost of energy generation is lower than that of any other sources, it is sustainable and pollution-free, its technologies are simple, its operational lifespan is long, and it does not require fuel; therefore, it does not produce carbon dioxide gas.

4- Geothermal Energy:

Geothermal energy consists of thermal energies buried deep within the Earth. However, the heat currently exploited through available technical means is limited to hot water and hot steam, while hot rocks are still under study, research, and development. To date, there are no comprehensive studies on the size and extent of the possibility of exploiting this resource, as its rate of use remains low, and the increase in its contribution to meeting human needs remains limited. (Rais, Rahal, & Tewil, 2018, p. 117)

5- Biomass Energy:

This is energy derived from organic materials such as the burning of plants, animal bones and waste, garbage, and agricultural residues. Plants used in biomass energy production may include fast-growing trees, grains, or vegetable oils (Ben Arous, 2015, p. 11). Biomass is converted into energy through various methods (physical and chemical). The global stock of this biomass is estimated at about 2,000 billion tons, but only 1% of it is exploited for energy purposes (Ben Mahad, 2016, p. 114).

Third: The Reality and Challenges of Investment in Renewable Energies within the Framework of the Transition toward a Green Economy in Algeria:

Greening the energy sector requires shifting from investment in depleting energies that cause carbon emissions to investments in clean, environmentally friendly energies. Many countries have initiated investment in this sector. In 2011, China's total investments amounted to approximately USD 64.7 billion, ranking first, while the United States ranked second with about USD 34.2 billion, followed by Germany with about USD 19.8 billion, then Japan with USD 16 billion, and Italy with USD 14.1 billion (Yousefi & Belhadf, p. 254).

In order to protect the Algerian economy from shocks caused by global crises in depleting energy prices, the Algerian government had to turn toward investment in renewable energies as an alternative to investments in greenhouse gas–producing energies, and to improve energy-use efficiency in various economic sectors. Over the past two decades, Algeria has taken environmental problems into account in its industrial policies by greening its economy and attempting to provide productive and energy alternatives that ensure sustainable development on both the environmental and social levels.

1-Renewable Energy Potential Available in Algeria:

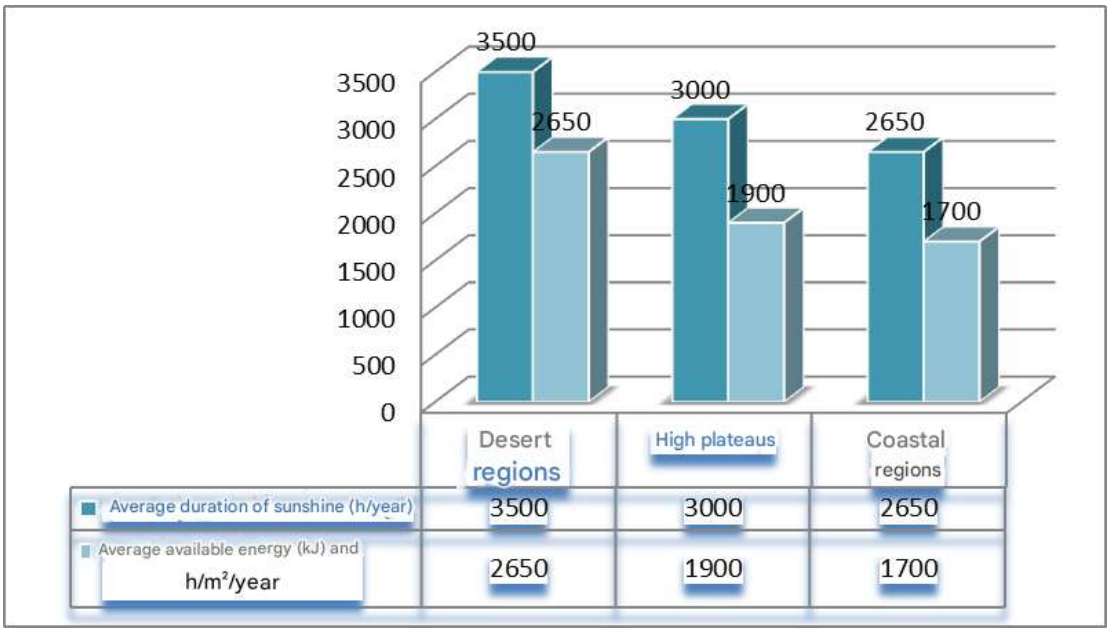
Algeria is among the countries that possess enormous renewable energy potential, due to its abundance of natural resources, especially sustainable ones, which qualifies it to be a leader in renewable energy investment.

Algeria currently produces electrical energy from three energy sources: natural gas at 94.5%, hydropower at about 5%, while solar energy does not exceed 0.5%, despite the country possessing a huge reserve of it (Bekhti & Behiani, 2018, p. 49).

A-Algeria's Solar Energy Potential:

Algeria possesses some of the richest solar fields in the world and has one of the largest reserves of this energy, in addition to other resources such as hydropower and wind energy. With regard to solar energy, Algeria, due to its vast area, strategic geographical location, and diverse topography, has enormous solar energy potential. The duration of sunshine exceeds 2,000 hours annually across the entire national territory and reaches 3,500 hours in the high plateaus and desert regions (Bahri & Ougabi, 2018, p. 100), distributed as follows:

Figure No. (01): Algeria's Solar Energy Potential across the National Territory



Source: Prepared by the two researchers based on: (Bekhti & Behiani, 2018, p. 50).

The average annual energy obtained in desert regions is about 2,650 kWh per square meter, and 1,900 kWh/m², while it does not exceed 1,700 kWh/m² in coastal regions. This energy is exploited by converting solar radiation into thermal energy and using it directly, for example, for heating; indirect thermal conversion through driving generators to produce electricity; and by exploiting photovoltaic solar energy through converting solar radiation into electrical energy via solar cells (photovoltaic panels), thereby meeting the electricity needs of isolated areas. This is considered one of the strategic and sustainable industries characterized by low operating costs and the fact that it does not cause environmental damage (Bahri & Ougabi, 2018, p. 101).

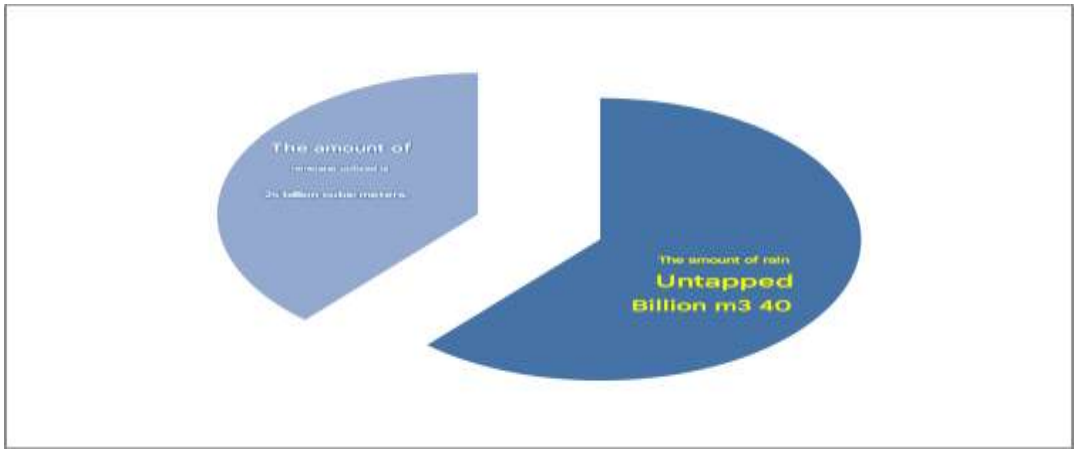
b- Algeria's Wind Energy Potential:

The diversity of Algeria's topography and its climatic variation are among the reasons for the variation in areas where wind energy is available. The average wind speed reaches 5 meters per second in Tindouf, Tiaret, and Oran, and peaks at about 6 meters per second in the regions of Adrar, Timimoun, and In Salah. These fields are suitable for establishing wind farms to generate electrical energy (Mouadhin & Ben Abdel Fattah, 2018, p. 358). In order to optimally exploit this resource, the first wind farm was established in Adrar during the period 2011–2014, with a capacity of 10 MW. During the period 2014–2015, two wind farms were established, each with a capacity of 20 MW. Algeria aims to generate an estimated 2,000 MW from wind resources by 2030 (Bekhti & Behiani, 2018, p. 50).

c- Algeria's Hydropower Potential:

The amount of rainfall in Algeria is estimated at about 65 billion m³, of which only 25 billion m³ are exploited, distributed between surface water at a rate of 66%, with the remainder being groundwater.

Figure No. (02): Algeria's Hydropower Potential.



Source: Prepared by the two researchers based on: (Khoumija, 2016, p. 30).

A total of 103 dams have been completed and 50 dams are under construction (Khoumija, 2016, p. 30). The available hydropower potential is estimated at about 286 GW, which is very low. This is due to the limited number of irrigation sites and their inefficient exploitation, as electricity generation from hydropower does not exceed 3% (Ben Mahad, 2016, p. 113).

d- Algeria's Geothermal Energy Potential:

Algeria possesses a considerable geothermal reserve that has resulted in more than 200 hot springs distributed across the northeastern and western regions of the country. The temperature of these springs exceeds 40°C, with the largest being Hammam Maskhoutine in the province of Guelma, whose temperature exceeds 96°C. The flow rate of this water from underground ranges between 2 and 3 m/s (Ben Mahad, 2016, p. 114).

e- Algeria's Biomass Potential:

Algeria's potential in terms of biomass remains limited when compared to other types. The country's forest potential is estimated at about 37 million tons of oil equivalent, and forest areas cover 10% of the total national territory. Maritime pine and eucalyptus are considered important plants for energy use, but they represent only 5% of Algerian forests (Mouadhin & Ben Abdel Fattah, 2018, p. 350). Algeria also produces about 13.5 million tons of waste annually, 60% of which is recyclable (Qahham & Chergoug, 2016, p. 453). Recycling urban and agricultural waste available in Algeria would produce approximately 33 million tons of oil equivalent of energy per year (Bekhti & Behiani, 2018, p. 52).

2- Algeria's Efforts to Green Its Economy and Exploit Sustainable Energies:

The efforts of the Algerian government to make the green economy the main pillar of development and technological advancement are reflected in the National Program for the Development of Renewable Energies (2011–2030).

The National Program for the Development of Renewable Energies 2011–2030:

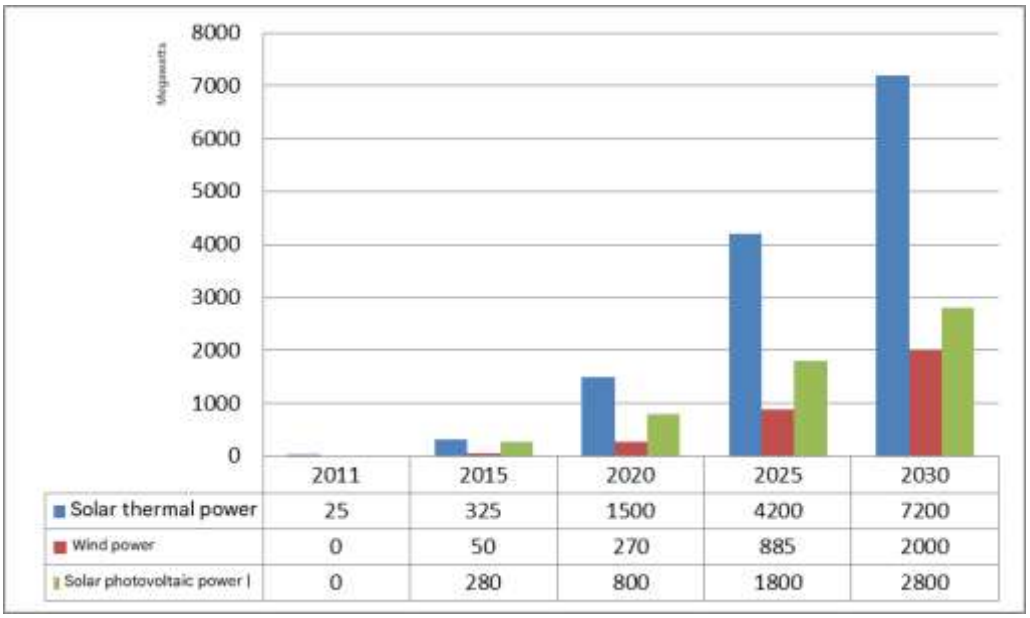
Algeria's interest in investing in renewable energies began in the 1980s; however, it did not take any action to exploit these energies until the issuance of Law No. 99-09 on energy management, dated 28 July 1999 (Bahri & Ougabi, 2018, p. 99). In order to preserve the rights of future generations to depleting resources, Algeria worked to integrate these energies into the national energy mix within the framework of the National Program for the Development of Renewable Energies 2011–2030. Through this program, Algeria seeks to develop solar energy, wind energy, geothermal energy, in addition to biomass energy. The total cost of this program is estimated at between USD 80 and 100 billion (Ben Mouwafaq, 2019, p. 302).

Specialized research and development institutions have also been established, including the Algerian Institute for Renewable

Energy Research and Development, in addition to several research and development centers (the National Agency for the Promotion and Rationalization of Energy Use, the Unit for the Development of Silicon Technologies (UDTS), and the Unit for the Development of Solar Energy Equipment (UDES), among others) (Sanoussi & Djaba, 2016, p. 269). Furthermore, a joint company was created between the national company Sonatrach, Sonelgaz, and the SIM agri-food group, known as New Energy Algeria (NEAL), to exploit solar energy in the south and convert it into electrical energy (Bahri & Ougabi, 2018, p. 101).

Through this program, Algeria works to produce wind energy and both photovoltaic and thermal solar energy, as illustrated in the following figure:

Figure No. (03): Forecasts of Thermal and Photovoltaic Solar Energy and Wind Energy Production up to the 2030 Horizon.



	2011	2015	2020	2025	2030
Solar thermal power	25	325	1500	4200	7200
Wind power	0	50	270	885	2000
Solar photovoltaic power I	0	280	800	1800	2800

Source: Prepared by the two researchers based on: (Boutoura & Azzaz, 2019, p. 287).

The National Renewable Energy Program aims to achieve the following objectives by 2030:

1. Cover 40% of the country's electricity needs by 2030, of which 37% will come from solar thermal energy and photovoltaic (PV) solar energy, and 3% from wind energy.
2. Create approximately 200,000 jobs.
3. Save about 600 billion cubic meters of natural gas.
4. Establish the first hybrid power plant for electricity generation from both solar energy and gas at Hassi R'Mel, which is the first of its kind globally, in order to provide 150 MW of power. (Abu Abdullah, *Renewable Energies in Algeria: The Awakening of a Giant*, 2015)

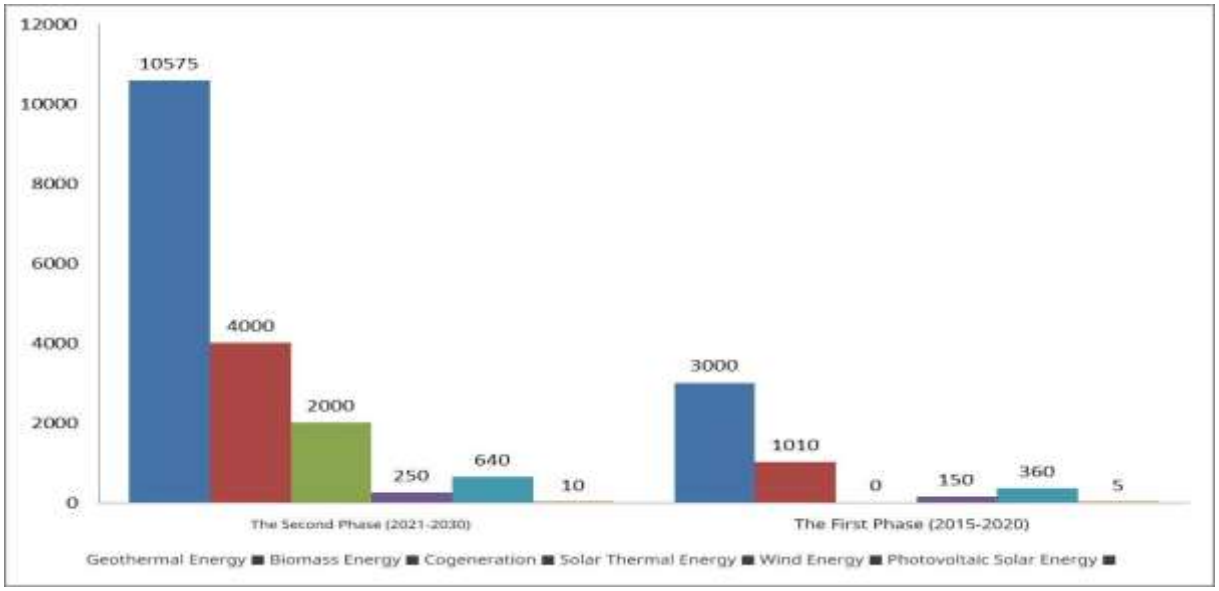
These objectives were distributed across the following phases: (Sanoussi & Jaba, 2016, p. 269)

- **2011–2013:** Provision of energy with a total capacity of 110 MW.
- **2015–2020:** Provision of the equivalent of 4,010 MW of solar and wind energy, and 515 MW from biomass energy and geothermal energy. (Khoumija, 2016, p. 33)
- **By 2020:** Establishment of a total capacity estimated at 2,600 MW for the national market, with the possibility of exporting 2,000 MW.
- **2021–2030:** Installation of large solar power plants in Adrar, Béchar, Timimoun, and In Salah. (Khoumija, 2016, p. 33)

- **2030:** Expected provision of a total local capacity of 12,000 MW and the export of approximately 10,000 MW.

These phases can be summarized into two main stages, as shown in the following figure:

Figure No. (04): Cumulative capacities of the renewable energy program during the period (2015–2030).



Source: Prepared by the two researchers based on: (Boutoura & Azzaz, 2019, p. 287)

Outcomes of the Implementation of the Renewable Energy Program 2011–2030:

1. Establishment of the first hybrid power plant operating on natural gas and solar energy in July 2011 at Hassi R'Mel, in the Tilghemt area, covering an area of 130 hectares with a total capacity estimated at 150 MW, of which 30 MW is produced from solar energy. (Gaham & Chergouk, 2016, p. 450)
2. Distribution of solar energy systems in 2012 to 495 households in isolated areas of Illizi Province, with a financial envelope estimated at 210 million Algerian dinars.
3. Supplying 10 remote areas in Tindouf Province with 300 photovoltaic solar systems, with a financial envelope estimated at 106 million Algerian dinars.
4. Establishment of photovoltaic power generation stations with a capacity of 324 MW, considered an effective alternative for supplying Saharan villages with electricity.
5. Exploitation of solar energy to operate engines in 14 water wells in southern Algeria (Illizi), in cooperation with the two Algerian companies CEPSA and ENI, benefiting nomadic populations. (Bahri & Ougabi, 2018, p. 101)

3. Challenges Facing Algeria in Exploiting Renewable Energies:

1. Algeria's lack of technological capabilities and material and human competencies necessary for promoting and developing renewable energy sources.
2. Lack of coordination between governmental and executive bodies regarding the promotion of the renewable energy sector in order to achieve a green economy. (Jbayli & Ben Imrane, 2021, p. 131)
3. The dominance of the hydrocarbons sector over the bulk of local and foreign investments, placing Algeria in a major challenge between the inevitability of energy transition and the continuation

of developmental projects related to fossil energies already underway.
4. Weak financing mechanisms for renewable energy projects and their high capital costs, which has led to the failure to keep pace with modern technologies and expertise in this field.
5. Lack of interest in renewable energy sources by the concerned parties.
6. Absence of prior planning for programs related to renewable energy exploitation, due to the limited number of research centers in this field.
7. Failure to encourage the private sector to invest in renewable energy exploitation, such as granting temporary tax exemptions.

Conclusion:

Algeria, like other oil-based economies, has suffered from imbalances in its economic and environmental system due to its reliance on the hydrocarbons sector, which has experienced severe crises that contributed to the deterioration of economic growth in the absence of economic diversification, and to the increase of environmental pollution problems given their serious damage to the environment. Algeria has therefore set out an ambitious program for the development of renewable energies extending over the period 2011–2030, within a clearly defined strategy aimed at advancing a green economy and moving away from a rent-based economy dependent on hydrocarbons.

Algeria continues to move at a slow pace in developing its capabilities for clean energy production by investing in sustainable energy resources, especially solar energy, despite possessing some of the highest levels of solar radiation in the world.

Study Findings:

1. The increase in greenhouse gas emissions causing global warming has led most countries to green their economies through green industries, such as innovating solar heaters, electric cars, and recycling waste.
2. Renewable energies are considered effective mechanisms of the green economy through which growing energy consumption needs are met, the environment is protected from climate change, and sustainable development is achieved.
3. Investment in renewable energies plays a prominent role in greening the economy and achieving sustainable development by creating job opportunities and enhancing electricity supply from clean sources, thereby reducing greenhouse gas emissions and environmental pollution.
4. Algeria possesses enormous solar energy potential, ranking first globally in terms of solar radiation reception, which could lead to an economic revolution in the energy sector if the necessary capabilities and competencies are provided.
5. Investment in renewable energy sources raises Algeria's level in energy exports by redirecting quantities of oil and gas previously used for electricity generation toward export.

Recommendations:

1. The necessity of adopting various policies and measures that help optimize the use of renewable energies.
2. Planning the implementation of pioneering renewable energy projects in Algeria by benefiting from international experiences in solar energy exploitation, which requires the Algerian government to harness this resource.
3. Algeria should rely on alternative, non-depleting, renewable economic resources to ensure sustainable economic growth.
4. Creating investment partnerships in renewable energies with countries that have successful experiences in this field to benefit from their expertise.
5. Avoid focusing solely on solar energy investment and diversify investment into other clean energy sources available in Algeria.
6. Creating partnerships between the public and private sectors in renewable energy investment.

7. Establishing training centers in renewable energies to develop national expertise instead of importing it from abroad.

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