

The Role of Technological Innovation in Achieving the Sustainable Development Goals in Algeria: A Case Study of Goal 7

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Abstract

This study examines the pivotal role of technological innovation in Algeria's pursuit of sustainable development, with particular emphasis on its effectiveness in improving the efficiency of renewable energy resource utilization, particularly solar and wind energy, and reducing dependence on conventional fossil-fuel sources. It highlights Algeria's substantial natural and human potential to support this sector, alongside structural challenges related to infrastructure and weak innovation capacity. The study concludes that technological innovation is a fundamental factor in achieving sustainable development. It recommends the adoption of policies that encourage innovation, increased investment in research and development, and the development of national competencies to facilitate the localization of innovative technologies that contribute to sustainability.

Keywords: technological innovation; sustainable development; renewable energy; solar energy.

1. Introduction

Current environmental and economic challenges require developing economies to accelerate the energy transition toward renewable sources as a strategic option for establishing the foundations of sustainable development and safeguarding the rights of future generations. Algeria possesses promising geographical and climatic characteristics, particularly in the fields of solar and wind energy. However,

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maximizing the economic and environmental returns from these resources remains contingent upon the level of technological innovation, as the latter constitutes the determining variable in enhancing the operational efficiency of energy systems and improving their investment viability.

The practical importance of technological innovation is reflected in overcoming the technical obstacles associated with renewable energy, foremost among which are fluctuations in production, storage capacity, and the challenge of integrating renewable energy systems into national electricity grids. Technological advancement also contributes to reducing the marginal costs of production and expanding the operational scope of these energy sources, thereby directly aligning with the United Nations Sustainable Development Goals 2030, particularly Goal 7, which concerns access to clean and affordable energy.

This study aims to assess the impact of technological innovation on the advancement of the renewable energy sector in Algeria by examining the public policies and strategies adopted and reviewing relevant national and international experiences. It also seeks to diagnose mechanisms for localizing advanced technologies and to examine the role of research and development organizations and public-private partnerships in accelerating this transition.

Based on the foregoing, the central research problem can be formulated as follows:

How does technological innovation contribute to enhancing the efficiency of the economic utilization of renewable energy as an entry point for achieving the Sustainable Development Goals in Algeria?

2. General Concepts of Technological Innovation and Renewable Energy

2.1 Technological Innovation

2.1.1 Definition of Technological Innovation

Technological innovation is the process of reusing existing knowledge and perspectives and generating new knowledge with the potential for practical application in the development of new products or processes, followed by their commercialization and utilization. Technological innovation is therefore a process through which institutions manage, implement, design, and produce new goods and services, regardless of whether they are new to their competitors, their countries, or the world. It is the outcome of an interactive process of generating, disseminating, and applying knowledge (Senoussi & Zine Abdelmadjid, 2020, p. 381).

2.1.2 Types of Technological Innovation

Technological innovation can be classified into several categories, each with its own characteristics and effects. These include the following (Senoussi & Amrani Abdelnour Gammar, 2017, p. 185):

Product Innovation: Product development innovation is a term that describes the development of new products and services that offer improved performance or capabilities.

When product development innovation is applied in the field of information technology, for example, a new software application can be developed to help a company automate its sales and marketing processes, enabling the organization to improve its efficiency and bottom-line profitability.

This type of innovation can also involve improving existing products or services in ways that make them more efficient or easier to use, such as developing new devices that provide better performance or capabilities.

For information technology companies, product development innovation is essential for keeping pace with the latest technological trends and providing customers with the best possible solutions to their problems.

Process Improvement (Existing Product): Process improvement refers to implementing changes to any of an organization's existing processes in order to make them more robust and effective.

An example of process improvement innovation in the field of information technology is streamlining the software development process so that new features can be released more rapidly and with fewer errors.

Process improvement innovations may also include automating manual tasks to enhance an organization's overall performance or introducing new working methods that are more reliable and faster than existing ones.

2.1.3 Impact of Technological Innovation on Various Industries

Increased Efficiency, Productivity, and Competitiveness: Technological innovation enables companies to offer lower-priced products by relying on effective strategies for delivering higher-quality products more efficiently and by utilizing fewer resources to achieve greater benefits (Sherif, 2023, p. 1537).

Improved Product and Service Quality: Technological innovation contributes to providing products and services tailored to individual customers, thereby increasing customer satisfaction and loyalty.

Improved Supply Chains: Technological innovation contributes to reducing costs and increasing delivery speed.

The New Digital Economy: Technological innovation has created a new digital economy that relies on mastering new skills in areas such as website design, application programming, and data analysis.

Entrepreneurship: Technological innovation encourages entrepreneurship, leading to the creation of innovative start-ups and new employment opportunities.

Sustainable Economic Growth: Technological innovation contributes to sustainable economic growth through the development of environmentally friendly technologies.

Automation and Artificial Intelligence: These contribute to reducing human error, improving process accuracy, and substantially increasing productivity.

Improved Working Environment: New technological innovations enable employees to work remotely or with greater flexibility, thereby improving work-life balance. Online collaboration tools also facilitate teamwork and knowledge sharing among employees. Furthermore, technological innovation encourages the development of digital infrastructure, which supports economic growth.

Technological innovation also has effects on other industries, including the following (EV-Lectron, 2026):

Electric Vehicles: Technological innovations in advanced batteries, thermal management systems, energy recovery, intelligent software, and connectivity have brought about a fundamental transformation in the global transportation sector, making electric vehicles a popular choice among consumers.

3D Printing: 3D printing is a revolutionary technology that transforms digital designs into tangible products by adding materials layer by layer.

2.2 Renewable Energy

2.2.1 Definition of Renewable Energy

Renewable energy can be defined as energy derived from natural resources that are replenished or cannot be depleted. Renewable energy sources differ fundamentally from fossil fuels such as oil, coal, and natural gas, as their residues do not contain gases and other pollutants in the manner associated with the combustion of fossil fuels. Renewable energy is produced from wind, water, and the sun and is widely used in developed countries and some developing countries. However, electricity generation using renewable energy sources has only recently become widespread, primarily to avoid the major threats posed by climate change resulting from pollution and the depletion of fossil fuels, in addition to the social and political risks associated with fossil fuels and nuclear energy (Ben Arous, 2015, pp. 10–11).

Another common definition states that renewable energy comes from an energy resource that is replenished by a natural process at a rate equal to or faster than the

rate at which that resource is consumed. Accordingly, renewable energy will not be depleted “as long as the sun shines,” unlike what are referred to as conventional energy sources, which include fossil fuels such as oil, coal, and gas, as well as nuclear energy (Andexer, 2008, p. 15).

2.2.2 Sources of Renewable Energy

A. Solar Energy: Solar energy has a major role that affects all aspects of human life, whether economic, social, or environmental. Among its most important characteristics are the following:

- Solar energy is an enormous source of energy in terms of its reserves and quantity.
- Solar energy is considered an effective means of energy utilization because it can be converted into different forms of energy, such as thermal, mechanical, and electrical energy.
- Solar energy is a safe and environmentally friendly energy source and does not pose a risk when used.
- Solar energy plays an essential role in photosynthesis, which takes place in the green parts of plants.

Algeria possesses some of the world’s greatest solar energy potential, owing to its vast territory and distinctive geographical location. It has been ranked among the world’s three best solar fields. The amount of energy available per day per square meter reaches 5 kilowatt-hours. In the north of the country, this energy reaches approximately 1,700 kilowatt-hours per square meter annually, while in the south it rises to 2,650 kilowatt-hours per square meter annually (Damdoun & Hasrouri, 2026, p. 61).

B. Hydropower: The history of relying on water as an energy source dates back to before the discovery of steam power in the eighteenth century. Humans used water from wells to operate certain waterwheels, which were employed to drive flour mills, textile machinery, and sawmills. Today, following the advent of the electrical age, water is used to generate electricity, as is the case in several countries such as Norway and Sweden. For this purpose, power-generation stations are established at sites where rainfall accumulates, and artificial dams are constructed to provide large quantities of water that ensure the continuous operation of these stations (Bouatli, 2019, p. 15).

C. Wind Energy: Wind energy is energy derived from the movement of air and wind. In its contemporary sense, the concept refers to its use in generating electricity through turbines that function as engines. These generally consist of three rotating

blades mounted on a shaft that converts the kinetic energy of wind into electrical energy. The amount of energy extracted from wind depends on several factors, including:

- Wind speed and strength.
- The design and shape of the turbine system.
- The specifications and material of the system.
- The principles governing electricity generation.
- The type of control and storage systems used (Sernih, 2023, pp. 328-329).

D. Marine Energy: Ocean energy, or marine energy, is defined as energy generated through the use of advanced technologies to exploit the mechanical movement of seawater or the inherent thermal and chemical properties of the oceans. This renewable energy system relies on six principal sources with different dynamic origins, each of which requires specialized conversion technologies. These sources are wave energy, tidal-range energy resulting from changes in sea level, tidal-current energy, ocean-current energy, and ocean thermal energy conversion.

Although the theoretical potential of these sources is estimated at approximately 7,400 exajoules per year, a figure that exceeds current human energy requirements by several multiples, their commercial application and industrial exploitation remain in the early stages of development.

E. Geothermal Energy: Geothermal energy is energy derived from the heat within the Earth. This heat results from natural geological processes, such as the radioactive decay of elements in rocks, and is utilized to generate electricity and provide heating and cooling.

This energy is considered a renewable and clean source of energy. Heat is extracted from deep within the Earth through specialized wells and used directly for heating or to generate electricity through geothermal power plants.

Geothermal energy is characterized by its continuity and its limited dependence on weather conditions, making it a sustainable option for meeting energy needs (Ben Harzallah, 2025, p. 926).

3.2 Technological Innovation in Renewable Energy

Renewable energy has witnessed significant development in recent years across its various forms, with a range of technologies emerging for each type of renewable energy. These technologies include the following (Manea, 2024, p. 241):

Solar Energy Technologies: Solar energy has received the greatest share of attention in technological innovation. Several technologies have been developed to capture the

energy that can be extracted from the sun. These include concentrated solar power, photovoltaic panels, solar dryers, solar sterilization, flat-plate collectors, evacuated-tube collectors, solar thermal cooling systems, solar electric cooling systems, and solar thermal collectors for heating.

Wind Energy: Two innovations have emerged in the field of wind energy: wind turbines/wind generators and windmills (mechanical wind pumps).

Geothermal Energy: A geothermal heat-energy generator has been developed for use in geothermal energy applications.

Hydropower: Innovations in water-turbine technology have contributed to increasing the efficiency of hydroelectric power plants, making hydropower a sustainable source of clean energy. These turbines convert renewable water energy into electricity without producing harmful emissions.

4.2 Sustainable Development Goals

4.2.1 Sustainable Development Goals Related to Energy

Energy is the fundamental driver of comprehensive development and a central pillar for achieving its environmental, economic, and social objectives. This interrelationship can be highlighted through the following dimensions (Dine & Zerouat, 2018, pp. 81–82):

Environmental Dimension (Atmospheric Protection and Pollution Reduction): The Sustainable Development Goals are linked to the rational use of energy to reduce emissions and limit climate change, in implementation of the outcomes of Agenda 21. This can be achieved by shifting toward a less polluting energy mix, supporting energy-efficiency research, and integrating energy policies with the industrial and transport sectors, while taking into account equity and the economic circumstances of developing countries.

Social Dimension (Human Development and Quality of Life): Energy consumption, particularly electricity consumption, is closely associated with human development indicators. Its sustainable provision contributes to improving living standards and enhancing essential services such as healthcare, education, and lighting.

Economic Dimension (Improving Production and Consumption Efficiency): The energy sector constitutes a central area for reforming unsustainable patterns of production and consumption and reducing waste. Optimal resource utilization requires the adoption of incentive-based pricing policies, legislative and regulatory reforms, encouragement of investment in efficient technologies, and sustainable financing for renewable energy.

4.2.2 Impact of Technological Innovation on Achieving These Goals

The contribution of technological innovation to achieving the Sustainable Development Goals has become evident in several areas. Modern and efficient energy technologies contribute to reducing or eliminating carbon emissions. However, progress in energy-efficiency measures remains below the desired trajectory. The improvement rate reached only 0.6% in 2021, requiring this shortfall to be addressed by increasing the rate of improvement in energy intensity to 3.4% annually through 2030. In this context, renewable energy, such as solar and wind energy, emerges as a sustainable alternative that does not contribute to global warming in the same manner as fossil fuels (Habbbar et al., 2025, pp. 329–330).

The dimensions of technological innovation and its role in supporting sustainable development across different sectors are reflected in the following areas:

- **Enhancing energy security:** Technological innovation has contributed to diversifying energy sources and reducing dependence on a single source, thereby lowering pollution levels.
- **Increasing production efficiency:** Modern technology has led to the development of more efficient and less costly products, which promotes rational resource consumption and supports competitiveness.
- **Environmental sustainability:** Technological innovation has contributed to the development of environmentally friendly products that protect natural resources from depletion and preserve them for future generations.
- **Improving outputs:** Reliance on accurate scientific foundations ensures the precision of production processes, improves product quality, and reduces costs in ways that are consistent with the Sustainable Development Goals.

5.2 Challenges and Opportunities

5.2.1 Challenges Associated with Technological Innovation in Renewable Energy

A. Access to Energy Sources

The United Nations Climate Action Programme has emphasized the important role of renewable energy in helping countries reduce their dependence on oil imports, diversify their economies, and protect themselves against unexpected fluctuations in fossil-fuel prices. Priorities vary across countries (Emirates Center for Strategic Studies and Research, 2026):

- **Developing countries:** Their energy security is fundamentally linked to access to electricity, at a time when approximately 800 million people, representing around 46% of Africa's population, lack access to electricity.
- **Developed countries:** Their focus is on meeting population needs around the clock without being dependent on weather conditions or the availability of

daylight required for solar energy use, in addition to securing the fuel needed for heavy and strategic industries.

- **Emerging economies:** Energy-security challenges vary among these economies. India relies primarily on imported fossil fuels, particularly coal and oil, and seeks to secure these supplies while domestic renewable energy technologies are being localized. China, despite being one of the world's major producers of renewable energy technologies, seeks to diversify its energy sources to meet domestic demand.

B. Supply Chain Disruptions

The energy transition is closely associated with the nature of supply chains for manufacturing components related to the production, transmission, and storage of renewable energy. These supply chains are concentrated in specific regions of the world, while extraction and refining technologies are even more concentrated in particular countries, most notably China.

According to projections by the International Energy Agency, achieving climate targets will require doubling the length of electricity transmission networks by 2040, implying increased demand for copper. A study also projected the need for approximately 76% additional production, equivalent to 1.6 million tonnes, compared with current copper consumption by 2035 in order to meet projected demand. This represents a challenge to achieving net-zero emissions by 2050.

The International Energy Agency's 2023 report projects that demand for minerals required for renewable electricity generation will increase by between two and seven times by 2030 compared with 2022.

Renewable energy provides greater flexibility in dealing with supply-chain disruptions and can help avoid the immediate disruptions that occur when oil and gas supplies are affected.

C. Economic Challenges

- **High cost:** Global investment requirements for renewable energy are estimated at approximately USD 150 trillion to maintain the 1.5°C target by 2050, with an annual average exceeding USD 5 trillion.
- **Unequal distribution of renewable energy investments:** Investments remain concentrated in a limited number of countries. Approximately 85% of investments in 2022 did not reach more than half of the world's population, while Africa received less than 1% of these investments.

- Although Africa possesses an estimated 40% of the world's renewable energy resources, it received only USD 60 billion, or 2%, of the USD 3 trillion invested in renewable energy over the previous decade.

D. Technical Challenges

Renewable energy plants require greater quantities of minerals than fossil-fuel plants to generate the same amount of electricity. For example, compared with a natural-gas power plant generating one megawatt of electricity, an offshore wind power plant requires approximately 13 times as many minerals, a wind power plant approximately nine times as many, and a solar power plant approximately five times as many to generate the same amount of electricity.

- **Difficulty of storing renewable energy:** Ensuring continuous energy supplies for industrial and economic activities remains challenging, particularly in light of limited investment and the research required to produce high-capacity batteries. To keep the 1.5°C target achievable by 2050, the required energy-storage battery capacity is estimated at approximately 4,098 GW, equivalent to 241 times the 2020 storage capacity of 17 GW. In addition, green hydrogen and pumped-storage hydropower technologies have not yet reached full maturity.
- **Weather variability:** Solar and wind energy technologies depend on weather conditions, while hydropower is affected by drought episodes. Consequently, these technologies may encounter difficulties in generating energy in light of reports confirming increases in the intensity and frequency of extreme weather events resulting from anthropogenic climate change.
- **The need to strengthen and modernize grids and transmission and distribution infrastructure:** Many developing countries lack adequate electricity grids capable of accommodating the energy generated, which constitutes an obstacle to integrating variable renewable energy and expanding its deployment.

E. Environmental Challenges

- **Hazardous waste:** This includes waste resulting from the disposal of energy-storage batteries, such as lithium batteries, and solar panels containing cadmium, arsenic, and lead. There are also technical and economic difficulties associated with recycling panels to separate and purify silicon and with recycling wind-turbine blades.
- **Land-use change:** Biofuels and the construction of wind farms may require increased forest clearing. For example, the rate of deforestation in Southeast

Asia is five times the global average. Similarly, unregulated mining in Africa is one of the major causes of land-use change and deforestation.

- **Water pollution:** Unregulated mining operations can contaminate freshwater resources and may result in geopolitical complications due to the pollution of certain transboundary rivers.
- **Air pollution:** Certain mineral-extraction and manufacturing practices in developing countries can affect local air quality and consequently increase domestic tensions toward companies or governments.

5.2.2 Future Opportunities in Renewable Energy Technology

Solar Energy: Solar energy continues to dominate the market. Investment in utility-scale and rooftop solar renewable energy is expected to reach USD 450 billion in 2025, while global expenditure on battery storage for the electricity sector is expected to reach USD 66 billion (Mawqif al-Taqa, 2026).

These developments are not driven solely by climate objectives and technological progress. In many markets, the construction and operation of renewable energy facilities have become less expensive than those of coal- or gas-fired facilities.

Wind Energy: Although wind energy remains a fundamental pillar of renewable energy growth, momentum in the sector is becoming increasingly differentiated.

Offshore wind energy has lost some of its attractiveness as a result of rising costs, supply-chain constraints, lengthy licensing procedures, and fluctuating electricity prices, all of which weaken the economic viability of projects.

Consequently, investors are increasingly focusing on onshore wind energy. This has led to a 26% reduction in projected offshore wind capacity, equivalent to 26 GW, for the 2025–2030 period, according to the International Energy Agency.

The broader wind-energy sector continues to experience strong growth. Global wind capacity is expected to approximately double, exceeding 2,000 GW by 2030.

Offshore wind energy is expected to add 140 GW during the forecast period, more than twice the growth recorded over the previous five years, driven largely by China.

By contrast, onshore wind energy remains at the forefront. Cumulative additions are expected to increase by 45% to reach 732 GW between 2025 and 2030, supported by improved policy frameworks and expanding markets in Europe, India, and emerging regions.

Electricity Storage: As the deployment of renewable energy sources deepens, electricity storage has become indispensable for grid stability. Investment in electricity

storage is expected to accelerate through 2026, driven by grid modernization, the expansion of data centers, and the electrification of transport.

According to the International Energy Agency, global investment in battery-based electricity-storage systems increased from approximately USD 1 billion in 2015 to an estimated USD 66 billion in 2025, approaching the level of investment in gas-fired power generation.

3.3 Technological Innovation and Its Role in Developing Renewable Energy and Achieving Sustainability in Algeria

1.3 The State of Renewable Energy in Algeria (Daghoun & Dhouifi, 2019, pp. 330–331)

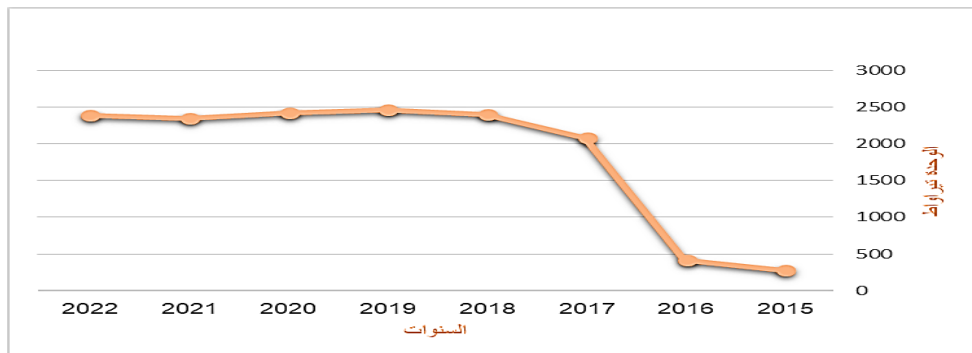
Algeria is among the countries that have devoted considerable attention to renewable energy by developing policies and programmes aimed at developing and exploiting renewable energy resources, given the country's enormous potential in this field, particularly solar energy. The renewable energy development programme that was recently launched is considered one of the promising and ambitious programmes for investment in and the development of sustainable energy.

Accordingly, integrating renewable energy into the national energy mix represents a major challenge for preserving fossil-fuel resources, diversifying electricity-generation sectors, and contributing to sustainable development. In this regard, Algeria has developed a strategy for investment in renewable energy extending to 2030, with the aim of positioning itself as a key actor in electricity generation through photovoltaic and wind energy, while also integrating biomass, cogeneration, geothermal energy, and solar thermal energy. These energy sectors are expected to become among the most important drivers of sustainable economic development, capable of stimulating a new model of economic growth.

Algeria covers an area of more than 2.3 million square kilometres, of which approximately 80% is desert, representing 20% of the total area of the African desert. This constitutes an important advantage for the country, as it provides it with an enormous solar energy resource that is considered among the largest reserves in the world. Solar energy remains the most important renewable energy resource available in Algeria, as the country possesses the largest share of solar energy among the Mediterranean countries. Its potential is equivalent to four times the world's total energy consumption, that is, approximately 37 billion cubic metres of gas per year. Algeria has established a hybrid power plant at Hassi R'Mel, the first of its kind in the world, operating jointly on gas and solar energy with a production capacity of up to 150 megawatts, as well as another plant in Ghardaïa with a capacity of 1.1 megawatts.

Despite these enormous natural capacities and resources, however, Algeria still ranks among the lowest countries in terms of renewable energy production. According to the International Energy Agency in 2015, Algeria ranked 131st out of 133 countries, with production estimated at 0.03 million tonnes (Daghoun & Dhouifi, 2019, p. 330). The following figure illustrates the development of solar and wind energy production in Algeria from 2010 to 2022.

Figure 1. Solar and Wind Energy Production in Algeria



Source: Prepared by the researcher based on data from the World Bank.

The curve in Figure 1 shows the production of solar and wind energy in Algeria over several years. It can be observed that production increased gradually between 2015 and 2018, reflecting the impact of technological innovation in enhancing the efficiency of renewable energy. Between 2018 and 2022, renewable energy production remained relatively stable, which can be explained by challenges related to infrastructure and financing in the renewable energy sector.

2.3 The National Renewable Energy Development Programme (Daghoun & Dhouifi, 2019, p. 332)

Algeria has placed renewable energy at the centre of its political and economic concerns in order to preserve fossil-fuel energy resources and address environmental challenges. It launched an ambitious programme for the development of renewable energy through the installation of 22,000 megawatts during the period 2011–2030, of which 12,000 megawatts are intended to meet Algerian electricity demand and 10,000 megawatts for export. Algeria's national renewable energy potential is particularly significant in the field of solar energy. The country therefore regards this energy source as an opportunity and a driver of economic and social development through the establishment of industries capable of creating wealth and employment opportunities. The programme through which Algeria seeks to promote renewable energy consists of the following main components:

- Renewable energy development programme.
- Energy efficiency and energy conservation development programme.
- Industrial capacities to be developed to support the programme.
- Research and development.
- Legal and regulatory framework and incentive measures.

Approximately four years after the launch of the Renewable Energy and Energy Efficiency Development Programme, approved by the government in February 2011, new and pressing elements emerged during the experimental and technological testing phase at both the national and international levels. These developments required a revision of the Renewable Energy and Energy Efficiency Development Programme. Accordingly, the updated renewable energy programme envisaged the installation, from the outset, of renewable energy capacity amounting to 22,000 megawatts by 2030. Through this new programme, renewable energy and energy efficiency would become central components of Algeria's energy and economic policies. By 2030, 37% of the installed capacity and 27% of electricity production intended for national consumption are expected to originate from renewable sources. Table 1 presents the renewable energy development programme in Algeria.

Table 1. Renewable Energy Programme for the Period 2015–2030 (MW)

Type of energy	Phase 1 (2015–2020)	Phase 2 (2021–2030)	Total
Photovoltaic solar energy	3,000	10,575	13,575
Wind energy	1,010	4,000	5,010
Solar thermal energy	--	2,000	2,000
Cogeneration	150	250	4,000
Biomass	360	640	1,000
Geothermal energy	5	10	15
Total	4,525	17,475	22,000

Source: Ministry of Energy, *Renewable Energy and Energy Efficiency Development Programme*, Algeria, 2016, p. 9.

Algeria's strategy in this field aims to develop a genuine industrial base for renewable energy, accompanied by training and research programmes and the acquisition of the necessary expertise. This is expected, in the near term, to enable Algeria to exploit its national capacities throughout the various stages of developing these fields.

Electricity production is expected to reach 90 terawatt-hours in 2020 and 170 terawatt-hours in 2030.

3.3 National Projects for Promoting Renewable Energy in Algeria (Nasib, 2024, pp. 199–201)

- **Agency for the Development and Rationalization of Energy Use:** This agency was established pursuant to Decree No. 85-235, issued on 25 August 1985, which provided for the establishment of an agency responsible for coordinating and implementing public policies related to energy management and improving energy efficiency. It does so by launching comprehensive sectoral programmes in cooperation with the industrial, transport, and agricultural sectors, in addition to supporting investors and establishing specialized research and training centres in solar energy.

- **Renewable Energy Development Centre:** A research centre specializing in renewable energy was established under the higher education sector pursuant to Decree No. 88-60, issued on 22 March 1988. Its activities focus on solar, wind, and geothermal energy through resource assessment, equipment design and measurement, the determination of manufacturing standards, and site selection.

- **National Observatory for the Promotion of Renewable Energy:** The National Observatory for the Promotion of Renewable Energy was established pursuant to Law No. 04-09. It is responsible for monitoring and guiding policies aimed at relying on clean energy, supervising the qualification of specialized personnel, and disseminating technical knowledge in accordance with the orientations of the National Spatial Planning and Sustainable Development Plan.

- **Algerian Institute of Renewable Energy:** This institute was established pursuant to Executive Decree No. 11-33, issued on 27 January 2011. It is a public institution with an industrial and commercial character, endowed with legal personality and financial autonomy. The institution operates under the supervision of the Minister of Energy and seeks to promote investment in renewable energy projects and develop related applied research.

Our examination of the various institutions and bodies entrusted with developing renewable energy and working to establish mechanisms and means for expanding its use reveals the large number and diversity of these institutions and structures, whether administrative and public, scientific, or industrial and commercial in nature. This reflects the considerable attention Algeria has devoted to supporting and investing in the renewable energy sector. This orientation also reflects a move towards adopting a new economic model based primarily on environmental protection, which represents a strategic option that Algeria should adopt, with a particular focus on preserving the environment and achieving sustainable development.

4.3 Major Achievements of Algeria in the Field of Renewable Energy (Site Énergie, 2026)

As part of the Algerian government's efforts to increase the share of solar energy in total electricity production, several projects have been implemented in a number of remote areas in the south and the High Plateaus. These projects include the following:

- **Hassi Delaâ Project – 362 MW:**

The Turkish company Özgün is developing this project as part of the “1,000 MW” programme. The project includes the construction of substations and electricity transmission lines with a capacity of 220 kV.

- **El Oued Province Project – 300 MW:**

The project is being implemented by the Chinese State Construction Engineering Corporation and constitutes part of the plans under the 1,000 MW programme, according to data from the Algerian renewable energy sector reported by the specialized Energy Platform.

- **Ouargla Project – 300 MW:**

The project is being developed by the Algerian company Cosider in cooperation with an Italian partner for the production of solar inverters. The project also includes solar panels.

- **Biskra Project – 220 MW:**

The project is being developed by the Chinese company PowerChina and is expected to produce 400 million kilowatt-hours of clean electricity annually.

By the end of December 2023, the installed renewable energy capacity at the national level had reached 600.9 MW, including 472 MW excluding hydropower. This figure includes 47.85 MW of off-grid capacity.

The report also highlights a significant increase in the installation of photovoltaic solar plants during the previous three years. It indicates that solar generator sets with a capacity of 23.06 MW now account for nearly half (48.2%) of the off-grid photovoltaic solar fleet.

With the completion of photovoltaic solar power plants, particularly the Gara Djebilet plant, with a total capacity of 3,200 MW, along with other plants currently being installed, the installed renewable energy capacity is expected to exceed 4,000 MW.

Furthermore, the Renewable Energy and Energy Efficiency Commission emphasized the sector's dynamism, which has led to the emergence of a large number of

engineering consultancy firms and companies specialized in the installation of solar energy systems.

In addition, according to data provided by the Ministry of Industry and Pharmaceutical Production based on the same report, by the end of 2023 Algeria had six factories for assembling photovoltaic modules, with an estimated annual production capacity of 469 MW.

Another significant development has been the substantial increase in the number of graduates from vocational training and education programmes specializing in renewable energy.

Between 2020 and 2023, the Ministry of Vocational Training and Education trained 2,351 graduates in various specializations related to renewable energy and energy efficiency, including 1,222 graduates during 2022-2023.

Overall, the installed renewable energy capacities and their contribution to various activities can be presented according to the following table:

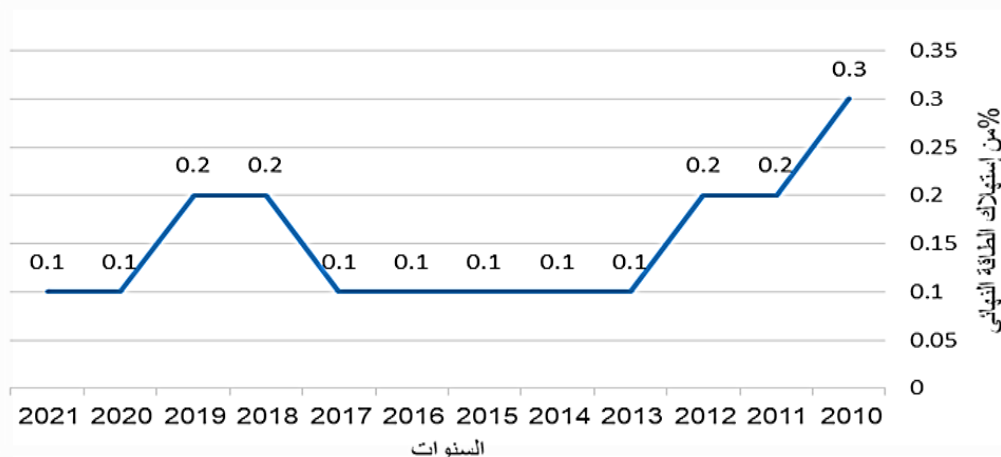
Table 3. Contribution of Renewable Energy to Electricity Production in Algeria

Applications	Installed Capacity
Household electrification	1,352,800
Pumping	288,400
Public lighting	48,430
Telecommunications	49,800
Other activities	165,630
Total	2,353,260

Source: Ministry of Energy and Mines, *Renewable Energy and Energy Efficiency Programme*, Algeria.

The table above shows that renewable energy production in Algeria is still at an early stage. Biofuel production remains nonexistent, while electricity generation from naturally renewable resources also remains limited. This can be attributed to insufficient financing, technological innovation, and the expertise required in this field. The following figure illustrates this situation.

Figure 2. Renewable Energy Consumption in Algeria (% of Final Energy Consumption)



Source: Prepared by the researcher based on data from the World Bank.

The World Bank data indicate that actual renewable energy consumption in Algeria remains limited. In 2010, it reached 0.3% of final energy consumption for the first time, before declining to 0.1% of final energy consumption and remaining at the same level from 2012 to 2017. It subsequently increased to 1% in 2018 and 2019 before declining again by 1%. This indicates that renewable energy production in Algeria continues to face several challenges, the most important of which will be discussed in the following section.

4. Conclusion

This study examined the analytical framework of the topic “The Role of Technological Innovation in Achieving Sustainable Development Goals in Algeria” through a methodological approach combining theoretical and applied dimensions. The approach sought to highlight the pivotal role of technological innovation as a source of strength for improving the efficiency of renewable energy exploitation and as a major driver of sustainable development in Algeria, particularly in light of growing economic challenges and environmental pressures.

Main Findings

- **Centrality of technological innovation:** The findings demonstrated that technological innovation constitutes a fundamental pillar for improving the efficiency of renewable energy and maximizing the utilization of available resources, particularly in the fields of solar and wind energy.

- **Promising natural potential:** The study concluded that Algeria possesses substantial environmental potential to support the energy transition, particularly in the southern region, which benefits from high levels of solar radiation.
- **State of innovation and development requirements:** The findings revealed tangible growth in local innovation indicators, while also highlighting the urgent need to strengthen infrastructure and intensify research and development efforts in order to meet existing aspirations.
- **Integration of energy and sustainability:** The study confirmed a positive relationship between reliance on renewable energy and the achievement of sustainable development, given its contribution to reducing dependence on fossil-fuel resources and protecting the environment.

Main Recommendations

- **Strengthening national policies and capacities:** It is essential to adopt comprehensive national strategies to stimulate technological innovation within the renewable energy system, while directing investment towards the localization of scientific research and the development of qualified human capital.
- **Activating investment partnerships:** Mechanisms for cooperation between the public and private sectors should be strengthened to finance and support innovative projects, particularly in developing regions and remote areas, in order to ensure energy equity.
- **Supporting the entrepreneurial environment and empowering enterprises:** An integrated system of incentives should be established to support start-ups and micro-enterprises based on technological innovation by simplifying access to financing and providing technical support and specialized assistance.
- **Scientific diplomacy and international cooperation:** Strategic partnerships should be established with international institutions and advanced research centres to develop knowledge, facilitate technology transfer, and adopt international best practices in the field of energy transition.

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