The Transition to Renewable Energy Economies and Its Role in Achieving Sustainable Development in Algeria

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Abstract

The aim of this research was to investigate how Algeria's shift to renewable energy economies and attaining sustainable development in all three of its dimensions affect the country's economy, society, and environment. The analytical approach was adopted in this study. The results showed that renewable energy occupies an important position in Algeria through investment in renewable energy and enacting laws and decrees that support and finance institutions active in this field locally and internationally with the aim of transitioning to green and sustainable energy. This embodies governmental initiatives and policies to lessen reliance on fossil fuels and shows a clear political vision in the field of renewable energy. Additionally, the research revealed that in renewable energy help Algeria achieve the seventh aim of the Sustainable Development Goals in three areas: environmental protection against pollution, social development, and economic development.

Keywords: Renewable energy, energy transition, economic development, environmental protection, social development.
JEL classification codes: Q2; Q42; Q52; Q57.

التحول إلى اقتصاديات الطاقات المتجددة ودوره في تحقيق التنمية المستدامة في الجزائر

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الملخص:

هدفت هذه الورقة البحثية لدراسة دور التحول إلى اقتصاديات الطاقات المتجددة وتحقيق التنمية المستدامة (بأبعادها الثلاثة) الاقتصادية، الاجتماعية، والبيئية في الجزائر، وتم الاعتماد على المنهج التحليلي في هذه الدراسة . بينت النتائج بأن الطاقات المتجددة تحتل مكانة هامة في الجزائر من خلال الاستثمار في الطاقات المتجددة وسن القوانين والمراسيم التي تدعم وتمول المؤسسات التي تنشط في هذا المجال محليا ودوليا بهدف الانتقال إلى الطاقة الخضراء والمستدامة، وهذا ما يعكس رؤية سياسية واضحة في مجال الطاقات المتجددة؛ في تجسيد البرامج والاستراتيجيات الوطنية لتقليل الاعتماد على الوقود الأحفوري، كما توصلت الدراسة أن الاستثمار في قطاع الطاقة المتجددة يساعد في بلوغ الهدف السابع من أهداف التنمية المستدامة في الجزائر بجوانبه الثلاثة التنمية الاقتصادية والتنمية الاجتماعية وحماية البيئة من التلوث.

الكلمات المفتاحية: طاقات متجددة؛ تحول طاقوي؛ تنمية اقتصادية؛ حماية البيئة؛ تنمية اجتماعية.

تصنيف JEL: Q2؛ Q42؛ Q52؛ Q57.

Introduction

Changes in energy and climate policy, funding, continuous technical advancements, and changes in energy supply and demand will impact all facets of national energy systems in the years to come. As advanced technologies have shown that renewable energy costs are decreasing over time, this is accelerating the transition to this type of energy, which allows for the availability of technologies and capabilities that were previously unimaginable.

Algeria's geographic advantages make it a country with enormous potential for renewable energy. The nation has an average of 2,500 hours of sunshine year, which is a significant amount of solar energy (Benhamou , Boughanmi , & Khelifi , 2020, p. 45). Wind energy resources are also promising, particularly along the coastal regions where wind speeds can reach up to 7 m/s (Khaled , Bouzid , & Zeroual , 2021, p. 112). In recent years, the Algerian government has set ambitious targets for renewable energy production as part of its national strategy.

Algeria declared in 2015 that by 2030, it would produce 22 gigawatts (GW) of power from renewable sources (MEM, 2015). This strategy calls for investments in wind, solar photovoltaic (PV), and concentrated solar power (CSP) plants. However, as of early 2023, renewable sources accounted for only under 1% of the nation's electrical generation (International Renewable Energy Agency [IRENA], 2023).

This research paper focuses on adopting a comprehensive development vision that supports Algeria's shift to renewable energy technology, and how to develop some economic policies to ensure this transition within the overall economic and social variables in Algeria. The Algerian economy, which relies almost exclusively on traditional energies, suffers from price fluctuations in the global market. Over time, reserves have begun to run out, while the needs of the national market have increased, especially for gas, which is the most important element in electricity production. This may negatively affect economic and social development. Therefore, it has become necessary to adopt new policies at the level of the economy as a whole in order to support alternative energy sources and search for other resources to finance development operations. Securing a secure future for energy and development is the biggest challenge facing most countries, and the strongest motivation to develop the use of renewable energy sources. Despite the maturity of some of these energy technologies, such as solar energy, and the rapid spread of their applications in global markets, their spread in Algeria is still very limited and far from the available capabilities.

The availability of suitable climatic conditions for such applications and the expected economic feasibility of their uses, in addition to their social and environmental benefits, raises an important question about the slow spread of them in Algeria. This is what this research paper addresses by posing the following question: What are the most important opportunities and challenges for transitioning to renewable energy economies and achieving sustainable development in Algeria?

Study hypothesis

Transitioning to a renewable-based economy presents both opportunities and challenges for Algeria's economy. On one hand, investing in renewables can create jobs and

stimulate economic growth. On the other hand, there are significant financial barriers that must be overcome. This research paper, We attempt to answer the following hypothesis: There are opportunities and challenges for transitioning to renewable energy economies and achieving sustainable development (in all three aspects) in Algeria.

Study Methodology

This study relied on the analytical methodology; it includes a review of previous literature, which is based on the analysis and interpretation of the trend of information and realistic data in the field of economic and social development of the Algerian economy within the current energy conditions for the period 2011-2023, in addition to a prospective study of the status of Algeria in the field of renewable energy for the period 2024-2030. This research paper also analyzes the most important capabilities and components supporting the transition to renewable energy economic sources in Algeria within the changing local and international energy conditions and the general trend towards achieving the conditions of sustainable development.

Importance of the study

The importance of this research paper lies in presenting a scientific study on the process of switch to renewable energy economies and its impact on sustainable development in Algeria, at a time when international policies are heading towards the same goal; which requires us to look for other sources. of traditional fuel. The continued depletion of traditional sources globally leads to economic and social imbalance as a logical future result of their limited stock, high prices, and the costs of expanding investments in them; in addition to the environmental imbalance caused by the combustion of these sources. The importance of the study also lies in trying to suggest possible alternatives to the energy transition process to ensure the transition to a safe energy future, taking into account direct and indirect government intervention and support, with the aim of ensuring the achievement of good economic growth rates; and environmentally, socially, and economically sustainable development.

Study objectives

Algeria's reliance on fossil fuels for sustainable economic development purposes without diversifying sources constitutes in itself an obstacle to the continuity of this development, as the increasing demand for traditional energy locally and internationally, accompanied by a decline in local production, leads to a large deficit in the overall energy balance. This gap between supply and demand has negative repercussions on the mechanism of growth and sustainable development, and requires a review of the energy strategy followed within the economic and social priorities, and the search for alternative energy sources that are more secure and guarantee this development. Accordingly, The purpose of this study article is to:

- shedding light on the interdependence of sustainable development (in all three dimensions) Algeria's economics of renewable energy.

- Focusing on the most important capabilities and components supporting the transition to Algeria's economics of renewable energy; taking into account the changes and fluctuations in energy costs and prices locally and internationally.

- Trying to monitor the effects of the transition to renewable energy economies on Algeria's sustainable development. And focusing on the role of public policies in supporting and accelerating such a transition.

literature review

The topic of renewable energy has been considered as a key to achieving higher economic growth without any harmful impact on the environment; therefore, it has been of interest to many economists, as they have been

interested in studying the effects of the transition to renewable energy economies on both economic growth; sustainable development; environmental quality; and human development; in the near and distant future. Below we review some of these studies:

Study (Radmehr, Ali, Ofori, Jasinska, & Jasi nski, 2022): This research examined the interconnections among ecological footprint (EFP), renewable energy consumption (REC), and wealth within the Group of Seven (G7) nations during the period from 1990 to 2018, employing a dynamic panel data methodology. Findings revealed a significant correlation between GDP levels and renewable energy use. Moreover, the study identified mutual relationships between ecological footprint and renewable energy consumption, as well as between wealth and ecological footprint. Results also indicated that enhancing human capital positively and significantly influences economic performance, environmental quality, and renewable energy adoption. In contrast, financial globalization exhibited a negative and significant impact, whereas economic and social globalization appeared to have limited influence on ecological footprints. Additionally, the openness to international trade showed a strong positive correlation with economic growth and regional economic integration, potentially aiding in the mitigation of environmental damage. Ultimately, the study offered several policy implications derived from these insights for policymakers' considerat

Study (Wang, You, Agyekum, Matasane, & Uhunamure, 2022): This study looks at how ecological footprints in 11 different countries are affected by globalization, renewable energy, democracy, environmental regulations, and economic growth (Bangladesh; Mexico; Turkey; Egypt; Nigeria; Vietnam; Indonesia; Pakistan; South Korea; Iran; and the Philippines) from 1990 to 2018. For statistical analysis, CS-ARDL was applied. The findings indicate that while economic expansion in these nations increases ecological footprint, environmental legislation greatly reduces it. Environmental quality is also affected by globalization, democratic nature, and utilizing renewable energy. As a result, this research has significant policy implications for these nations, as they must increase democratic accountability. They will be more capable of executing environmental policies as a result. The quality of the environment will eventually improve as more renewable energy is produced with the aid of effective environmental policies.

Study (Darke, Karatayev, & Lisiakiewicz, 2022): This research investigates the collaborative efforts between Kazakhstan, China, and the United Nations in the field of sustainable energy. Findings highlight the significant roles that China and the UN have in ensuring Kazakhstan's energy security through sustainability. Both entities function as essential supporters of Kazakhstan's energy transformation, providing financial resources, technology, training, and technical assistance. Furthermore, they engage with international partners to build capacity via policy guidance and governmental advisory services. Such cooperation is essential for achieving targets related to climate change and renewable energy, thereby creating a robust and sustainable energy framework based on integration, interaction, and intelligent management. Consequently, this cooperative framework acts as a global reference point, reflecting successful international partnerships in energy transformation. It can significantly enhance sustainable economic growth, foster political stability, and ensure energy security in both Central Asia and China over the long term.

Study (Mehrzad , Rahim , Reza , & Abolfazl , 2022): The types of renewable energy used in Iran to generate power have been examined in this research. According to studies, 1.5% of Iran's electricity production over the past 20 years has come from renewable sources. Additionally, Iran has a lot more potential for using renewable energy. Iran has the capacity to use 42,000 MW of renewable energy by 2020. On the other hand, Iran has built 800 MW of renewable power plants. The potential for wind, solar, and geothermal energy in various parts of

Iran is high, but it hasn't been fully utilized to meet the country's electricity needs.

Study (Sasmaz, Sakar, Yayla, & Akkucuk, 2020): This research examined the relationship between renewable energy use and human development across 28 OECD countries from 1990 to 2017, utilizing cointegration analysis and causality tests. The results indicated that renewable energy consumption positively impacts human development indicators. Additionally, the causality analysis revealed a two-way causal link between renewable energy usage and human development. Based on these findings, the study recommends that policymakers should actively support renewable energy projects and create policy frameworks to encourage private sector engagement in renewable energy production.

Study (HILMI, SAFA, FARAHMAND, SAMETI, & SASSAN, 2017): This research investigated how renewable energy consumption affected economic growth in Iran from 1983 to 2013, employing the Autoregressive Distributed Lag (ARDL) methodology. The study's results indicated a positive and statistically significant relationship between renewable energy utilization and economic growth. Specifically, the analysis revealed that a 1% increase in renewable energy consumption correlates with a long-term economic growth of approximately 4.06%. Additionally, the short-term results suggest that a 1% rise in renewable energy use can enhance economic growth by around 7.5%.

Our current study is similar to previous studies in that it focuses on the significance of moving towards renewable energy sources, considering that the entire world is in the transition phase from traditional energy sources to renewable energy sources on the one hand, and conversely, to accomplish sustainable development. Our study differs from previous studies in terms of choosing the research sample, which is Algeria, due to its adoption of a comprehensive development vision in this field. The reality of energy in Algeria was studied, in addition to the possibility of switching to sources of renewable energy in light of local and international conditions and variables of fluctuations in the prices and costs of traditional energy; and how to transition to renewable energy by setting priorities due to the decline in its financial resources, in order to stimulate social development and ensure sustainable energy security and environmental security.

Algeria's renewable energy potential

Algeria plays an important role of the worldwide energy market as a large producer of crude oil and one of the top natural gas exporters. Consequently, the government intends to enhance exports to foreign markets while decreasing the local usage of gas and oil resources in the upcoming years. However, Algeria has been attempting in recent years to raise domestic pricing (lift subsidies) in order to decrease the consumption of fossil fuels because its natural gas and petroleum product prices are among the lowest in the area. At the same time, it is shifting toward renewable energy. With the world's solar energy potential and wind energy abundance, it has set high targets for renewable energy, such as raising the proportion by 2030, of renewable energy sources in the production of power.

Algeria's Renewable Energy Development Program

Thanks to increased mobilization and research and development efforts to master the technologies used in facilities to convert renewable energy into energy, The political will and dedication of Algeria to utilize these non-polluting and renewable natural resources was confirmed by the ratification of the Kyoto Protocol and the Law on the Advancement of Renewable Energy in the Context of Sustainable Development.

Through technology advancements and scientific studies in the realm of renewable energy centered on certain initiatives that

directly affect the nation's social and economic reality. The main scientific objectives of each program are to assess the areas of renewable energy, regulate the procedure of converting, processing, storing and improving these energies and develop knowledge, from research to the establishment of on-site amenities. A program on renewable energies and sustainable development has been established to encourage the consolidation of projects; to work in a unified network to benefit from multidisciplinary; as well as to promote cooperation with foreign partners and Algerian private partners. The program (Renewable Energy Development Center, 2024) is represented by the following:

- First field: Solar photovoltaic energy;
- Second field: Wind energy;
- Third field: Thermal energy and solar thermodynamics;
- Fourth field: Bioenergy and the environment;
- Fifth field: Hydrogen and fuel cells; Sixth field: Multiple renewable energy sources.

According to the initial government program expected; by 2030, 27% of electricity generated for household use and 37% of renewable energy will come from renewable sources.

Algeria views solar energy as a tool and a chance for social and economic growth, especially by creating enterprises that generate income and jobs, since it dominates the country's renewable energy potential. For this reason, a number of wind farm construction projects have been started, along with pilot projects for cogeneration, biomass, and geothermal energy. Thus, there will be two stages to the implementation of electricity generating projects for the national market (Algerian Ministry of Energy, 2024):

• **Phase I 2015-2020**: 4010 MW of energy were produced during this phase by combining solar and wind power, while 515 MW were produced by combining biomass and geothermal cogeneration.

• **Phase II 2021-2030**: Large renewable energy plants will be able to be installed in the Ain Salah, ADRAR, TIMIMOUN, and BECHAR areas in addition to integrated into the national energy system thanks to the development of the electrical link between the North and the Sahara (ADRAR). Solar thermal energy may now be a profitable option.

In order to eventually hire engineers from Algeria, especially in the fields of project management and engineering, Algeria's approach in this region seeks to create an actual renewable energy source industry in addition to a program for training and knowledge development. This is what the renewable energy program will provide for the national market's requirements for electricity, with several thousand direct and indirect job opportunities.

By promoting substantial investment in all renewable energy sources (solar photovoltaic, concentrated solar power, geothermal, wind, biomass, and cogeneration), the particular renewable energy targets are planned to be accomplished in two timeframes (2015–2020 and 2021–2030).

Table N°1
Renewable Energy Program 2015-2030

Power Source Unit Megawatt (MW)	Phase 1 2015 – 2020		Phase 2 2021- 2030		Total	
	MW	%	MW	%	MW	%
Photovoltaic energy	3 000	66.3	10 575	60.52	13 575	61.70
Wind energy	1 010	22.32	4 000	22.89	5 010	22.77
concentrated solar power	-	-	2 000	11.44	2 000	09.09
cogeneration	150	03.31	250	01.43	400	01.82
Biomass	360	07.95	640	03.66	1 000	04.55
Thermal and dynamic energy	05	00.11	10	00.06	15	00.07
Total	**4 525**		**17 475**		**22 000**	

Source: (Algerian Ministry of Energy, 2024)

In light of this, in November 2018, the Algerian Electricity and Gas Regulatory Commission (CREG) issued a call for bids to build a number of 150 MW photovoltaic power facilities in southwest Algeria. The projects will be developed on a build-own-operate (BOO) foundation and will be given a 20-year power purchase agreement. They should be between 10 and 50 MW in size. In the GHARDAIA region, around 50 MW of capacity will be installed in GUERARA, and in the BISKRA region, another 50 MW will be installed in DIFFEL. Two solar power plants of the same scale will be deployed in TENDALA and NAKHLA in the EL OUED region, while three other 10 MW installations will be located in the towns of MÉGRINE, NEZLA, and BELHIRANE in the OUARGLA region. This is in line with the nation's goal of installing 22 MW of renewable energy producing capacity by 2030, of which 13.6 MW will come from photovoltaics.

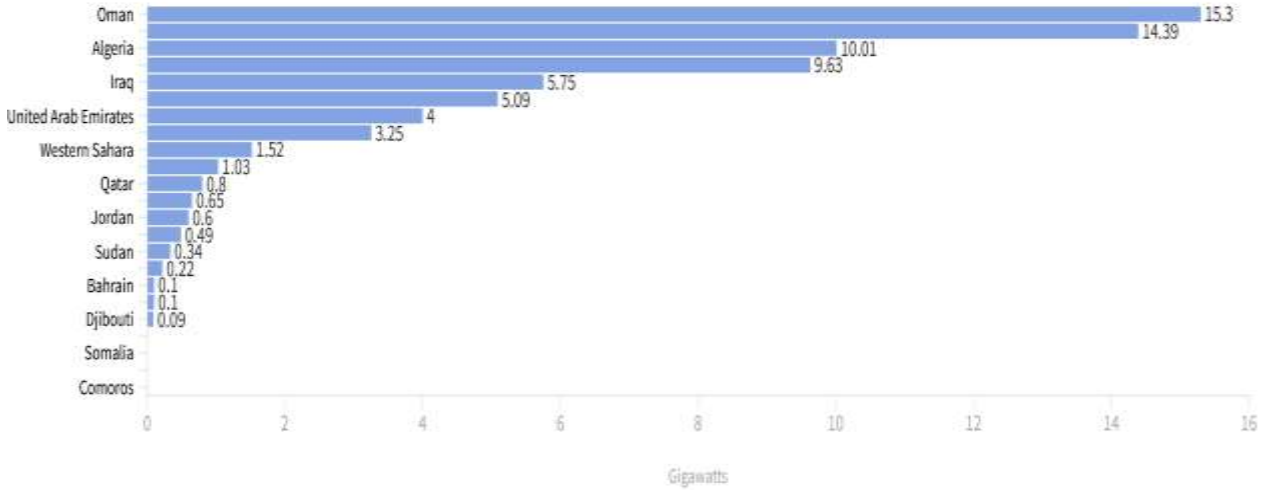
Renewable energy policy in Algeria

With a total expected solar energy production of 5 megawatts, in addition to another 5 megawatts of wind energy, Algeria's production of these two types of energy will increase 20-fold by 2030. The total expected energy production from both sources will reach two-thirds of the targeted production by 2035 of 15 megawatts, according to the Algerian government's plan, 1 megawatt of renewable energy will be added each year. Not only that, Algeria is one of the African countries with the most huge potential for wind energy. According to a report by The World Bank's International Finance Corporation issued in September 2020, Algeria is also capable of producing about 7.7 megawatts. This expected production capacity from renewable energy is expected to contribute significantly to reducing domestic gas consumption. Algeria will also benefit greatly from opportunities to export renewable energy to European markets and sub-Saharan African countries (Ingrid , Kasandra , Shradhey , Amanda , & Nagwa , 2022, p. 13).

Ninety-one percent of the Arab League's renewable energy ambitions for 2030 will come from MENA countries' plans to develop more than 73 GW of new solar and wind projects, which would raise existing capacity fivefold. Regarding possible solar and wind capacity expansions, Algeria ranks among the top five nations in the region, with Oman (15.3 GW), Morocco (14.39 GW), Algeria (10.01 GW), Kuwait (9.63 GW), and Iraq (5.75 GW) coming in second and third, respectively. Figure 1 illustrates this (Ingrid, Kasandra , Shradhey, Amanda , & Nagwa , A Race to the Top ’22 Middle East & North Africa: Arabic-speaking Countries on Pace to Grow Their Utility-scale Wind and Solar Capacity More than 500% by 2030, 2022).

Figure N° 1

MENA's Current and Future Renewables Leaders Country-Level Operating and Prospective Wind and Solar Capacity in the Arabic-Speaking Region



Source : (Ingrid, Kasandra , Shradhey, Amanda , & Nagwa , A Race to the Top ’22 Middle East & North Africa: Arabic-speaking Countries on Pace to Grow Their Utility-scale Wind and Solar Capacity More than 500% by 2030, 2022)

By including the private sector in the nation's renewable energy market and permitting independent energy businesses to carry out such projects, Algeria promotes international investment in wind and solar energy projects. It also grants foreign investors investment in Algeria; for example, the investment law limits foreign capital ownership of projects to 49% or less. On the other hand, Algeria seeks to support the local economy by obligating foreign investors to purchase project supplies from local manufacturers, which investors have implemented in solar power plants in BATNA, OUARGLA and BOUGUERANA, which have a combined total production of 310 megawatts (Ingrid , Kasandra , Shradhey , Amanda , & Nagwa , 2022, p. 13).

The first hybrid solar-gas project, NEW ENERGY ALGERIA, was also introduced by the renewable energy development business (NEAL) as part of a comprehensive solar and wind energy program, which has the greatest potential in Algeria. The World Bank received a finance proposal for the HASSI R'MEL project. There are just five other projects worldwide that have already been granted a $50 million soft credit arrangement. A supplemental program for three hybrid solar-gas power plants, which were twice as large as the original HASSI R'MEL project, was then introduced in 2006. EL MEGHAIR (east), HASSI R'MEL (center), and NAAMA (west) are the locations of these three 300 MW power stations (Hasni, Malek, & Zouioueche, 2021, p. 06).

These projects, developed by NEAL, were a continuation of the solar energy program that began with the installation of the first hybrid

natural gas-solar power plant in HASSI R'MEL in July 2011. During the period 2016-2020, four thermal power facilities were built with an overall storage ability of about 1,200 MW, followed by an annual capacity addition of 500 MW up to the year 2023, and subsequently increasing to 600 MW each year by 2030. This presents a significant challenge for the Algerian government in its efforts to reduce dependency on fossil fuels.

There is also significant investment potential in Algeria. The IRENA Coalition for Action, Business and Investors Group, which has significant renewable energy assets worldwide, plans in the coming years to contribute significant additional investments to achieve a green economic recovery to reach global climate goals. It is keen to engage in the Algerian market, and IRENA has put forward the following key recommendations that the government may consider to achieve higher shares of renewable energy (IRENA International Renewable Energy Agency, 2020, p. 02):

- **Enhance clarity on the strategy for implementing renewable energy policies:** Consider developing a long-term energy roadmap detailing annual capacity additions through tenders. The IRENA Group is particularly interested in learning more about Algeria's announced 4 MW renewable energy tender (under SONELGAZ), which has been postponed several times, as well as the 1 MW tender (under SONATRACH).

- **Re-evaluate the 49% ownership rule for renewable energy projects:** to attract more FDI, enhance competition in the short term; allow local industry to build capacity; and reduce the cost of renewable energy sources.

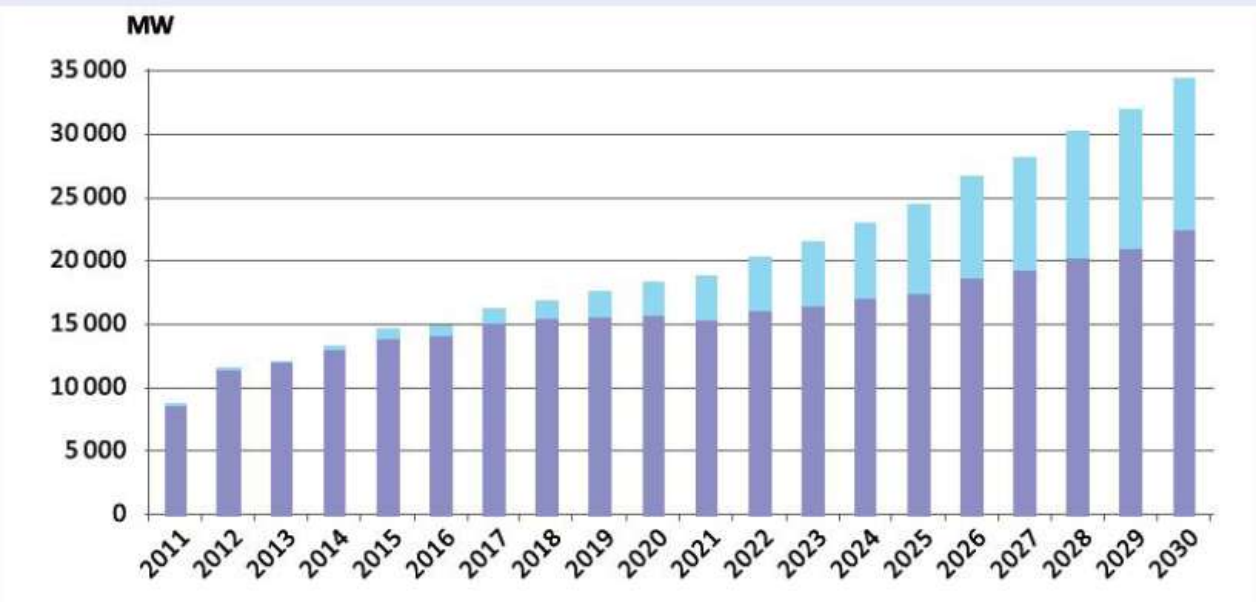
- **Develop a transmission network development strategy:** develop the transmission network to connect new renewable energy sources, especially in the south.

- **Strengthen cooperation between international renewable energy developers and local industry:** Relationships between international developers and the local private sector are essential to strengthen local supply chains and support the renewable energy market. The IRENA Group and the Algerian CLUSTER ENERGIE SOLAIRE could serve as key platforms for such cooperation.

The report of the Renewable Energy Authority also indicated the integration of renewable energies into the development plans of state institutions to varying degrees, as Algeria witnessed a 7% increase in installed energy, with an additional capacity of 27.6 megawatts, compared to the accumulated capacity at the end of 2019. At the end of December 2021, the entire installed capacity in the field of renewable energies in Algeria amounted to 567.1 megawatts, of which 438.2 megawatts excluding hydroelectric power. According to the report, the entire installed capacity in the field of renewable energy includes 401.3 megawatts connected to the grid, and 36.9 megawatts off-grid, as this growth is due to the off-grid solar energy installations in Algeria, which recorded an additional capacity estimated at about 15.6 megawatts, an increase of 73% compared to the end of 2019. The report indicated that "Kit Solar" solar installations constitute nearly half of the total off-grid solar photovoltaic energy, up to 46%, as a significant increase in off-grid solar energy installations in Algeria has been recorded during the recent period (kaddour, 2022).

The goal of all this is to achieve a 40% electricity production capacity rate from renewable sources by 2030. This is based on an estimate of the development of the previously installed capacity defined (Figure 2) below; provided by the Ministry of Energy and Mines (MEM), which assumed a total annual consumption of 150 terawatt hours/year (TWh/an). In quantitative terms, the goal aimed to guarantee a capability for producing electricity from renewable sources of 22.000 MW, of which 10.000 MW is destined for export (YASSAA & KHELIF, 2020, p. 46).

Figure N° 2
Estimated development of the national electricity production park according to the Ministry of Energy and Mines (MEM)



Source : (YASSAA & KHELIF, 2020, p. 46)**.**

Renewable Energy's Contribution to Achieving the Dimensions of Sustainable Development

Apart from the inherent fluctuations in the climate observed over similar durations, according to the United Nations Framework Convention on Climate Change (UNFCCC), climate change is any alteration in the global atmosphere's composition that is either directly or indirectly brought on by human activities. Though it presents a number of difficulties, energy production is a necessary part of social and economic development. Energy security and accessibility are crucial, but reducing the energy sector's impact on climate change is of utmost importance (Edenhofer, Madruga, Sokona, Farahani, & Kadner, 2014).

Algeria has incorporated the environmental component into its economic development process and initiated a number of ambitious programs for the acceleration of sustainable Energy use and efficiency to attain sustainable development on all levels economically, socially, and environmentally realizing that North Africa is among the regions most impacted by the consequences of climate change. Sustainable development is a broad idea that satisfies people's needs now and enhances their quality of life without endangering the capacity of next generations to accomplish their objectives. Economic development, social development, and environmental conservation are its three interrelated foundations.

The role of renewable energy in achieving sustainable economic development

In the national energy backdrop, which is marked by robust domestic sector consumption growth, new housing building, public utility infrastructure development, and industry recovery, energy transition and energy efficiency are crucial. According to the Ministry of Energy Transition and Renewable Energy, Algeria's policy on energy efficiency targets a 10% reduction in overall energy usage, equivalent to preserving approximately 6 million tons of oil, or about 45 million barrels, for future generations. Achieving this goal through targeted initiatives and projects is expected to foster the development of a sustainable energy efficiency market in Algeria in the long term.

A significant obstacle to protecting fossil fuels, diversifying the generation of power, and promoting sustainable development is incorporating renewable energy into The energy mix of the nation. Algeria's energy and economic policy are centered on these energies. Construction, transportation, and industry are the primary consumer industries that significantly influence energy consumption (Algerian Ministry of Energy, 2024):

• **For the construction sector**: Promote the application of innovative techniques and tools for thermal insulation in buildings, both modern and old. At the architectural design stage of the housing project, appropriate measures will be planned. In order to increase interior comfort while consuming less energy, there is also the problem of encouraging the extensive use of high-performance appliances and equipment in the neighborhood marketplace, especially energy-saving lights and solar water heaters. An advantage for the expansion of energy efficiency in this sector is the establishment of a local industry for high performance and insulation against heat devices and appliances (such as energy-efficient lighting and solar water heaters). By 2030, this will save over 30 million tons of oil equivalent.

• **For the transport sector**: In addition to the positive impacts on the environment and human health, the objective is to improve the fuel supply system and help lower the proportion of diesel by promoting more affordable and less polluting fuels. By 2030, this will save over 16 million tons of oil equivalent.

• **For the industrial sector**: Encourage manufacturers to be more rational in their energy consumption. Since the industry's energy usage is predicted to rise due to its resurgence, it poses a challenge for energy management. Over 30 million tons of oil equivalent will be saved for this industry.

Renewable energy's contribution to socially sustainable development

Integrating energy efficiency into different corporate sectors has a variety of social effects. Citizens' quality of life is enhanced, and wealth and employment are generated. Since access to contemporary services for sustainable energy contribute to the eradication of poverty, save lives and enhance health, and meet fundamental human requirements, energy is necessary for the process of development that is sustainable. According to the 2015 "Transforming our world: the 2030 Agenda for Sustainable Development" document from the United Nations Sustainable Development Conference in New York, 51% of The majority of people on the planet do not have access to energy. The following measures are being taken to guarantee that everyone has access to contemporary, Sustainable and reasonably priced energy services (United Nations; Department of Economic and Social Affairs Sustainable Development, 2015):

- Ensure availability of contemporary, dependable, and reasonably priced energy for all by 2030.

- Significantly raise the proportion of renewable energy in the world's energy mix by 2030.

- Double the rate at which energy efficiency is improving globally by 2030.

- Strengthen International collaboration to make clean energy research and technologies more accessible, including for advanced and cleaner fossil fuels, energy efficiency, and renewable energy technologies, and encourage spending on sustainable energy and energy infrastructure technologies, by 2030.

- Increase infrastructure and modernize technology to deliver energy services that are sustainable and modern for everyone in emerging nations, in accordance with support programmes by 2030.

- Encourage full and productive employment, decent work for all, and

consistent, inclusive, and sustainable economic growth.

Every dollar invested in renewables creates three times as many jobs as in the fossil fuel sector. By 2030, the IEA predicts that the shift to net-zero emissions would result in an overall rise in the number of jobs in the energy sector, with approximately 14 million new jobs—a gain of 9 million jobs—being created in clean energy, while around 5 million jobs may be lost in the production of fossil fuels. Furthermore, An additional 16 million workers will be needed in businesses related to energy, such as to cover production-related roles of high-efficiency appliances and electric cars or in cutting-edge technologies like hydrogen. Accordingly, Efficiency, low-emission technology, and sustainable energy could provide more than 30 million new jobs by 2030. People's needs and rights must be at the forefront of the energy transition in order to ensure that no one is left behind (International Labour Organization, 2015).

Worldwide employment in renewable energy is projected to hit 13.7 million in 2022, an increase of 1 million since 2021 and up from 7.3 million in 2012, primarily fueled by solar PV, bioenergy, hydropower, and wind (International Labour Organization, 2023).

In Algeria, renewable energy, especially the use of solar energy in remote areas for thermal heating, steam generation, or crop drying, has contributed to breaking the isolation of remote areas and gaining many experiences and skills, thus contributing to achieving local development. A major qualitative leap has been achieved in the number of graduates and students in the field of renewable energy in Algeria, as Algerian universities and research centers provide about 1,020 permanent researchers and research professors working in this field; this increases the number of jobs and creates wealth, especially in the field of small and medium enterprises as well as emerging institutions in the field of developing the local industrial fabric and supporting the field of solar energy in Algeria, especially solar photovoltaic panel production plants, whose annual production capacity can reach 450 megawatts, in addition to companies manufacturing lines, metals, and structures carrying photovoltaic modules, a solar energy converter factory under construction, and a large number of engineering offices and companies installing solar energy systems.

Renewable energy's contribution to climate and environmental protection

Natural resources like the wind and sun, tides, and wave movement are the source of renewable energy, which is believed to have significant effects on both people and the environment because it is (United Nations, 2024):

- **Renewables are everywhere:** Every nation has availability of renewable energy sources, but they still haven't reached their full potential realized. By 2050, 90 percent of the global electricity might and ought to originate from sustainable sources, according to the International Renewable Energy Agency.
- **Renewables are cheaper:** By 2030, It is anticipated that suitably priced renewable energy sources may provide 65% of the world's electrical supply. By 2050, 90% of the electrical sector will be decarbonized, they may help combat climate change and drastically cut carbon emissions.
- **Renewables are healthier:** The combustion of fossil fuels significantly contributes to air pollutants, particularly fine particulate matter and nitrogen dioxide emissions. In 2018 alone, pollution resulting from fossil fuels caused substantial economic and healthcare burdens, amounting to approximately $2.9 trillion globally, or nearly $8 billion daily. Consequently, adopting renewable energy sources like wind and solar power can effectively mitigate climate change, reduce air pollution, and improve public health.
- **Renewable energy creates jobs:** Investment in renewable energy generates approximately threefold the number of jobs compared to traditional fossil fuel industries. Data from the International Energy Agency

indicates that transitioning towards net-zero emissions is expected to increase overall employment opportunities in the energy sector. Although the fossil fuel sector may experience a reduction of around five million jobs by the year 2030, this loss would be more than compensated by an estimated fourteen million new positions arising in clean energy fields, resulting in a net employment growth of approximately nine million jobs.

- **Renewable energy makes economic sense:** The upfront cost may be prohibitive for many resource-limited countries, and many will need financial and technical support to make the transition. But investments in renewable energy will pay off. The globe could save up to $4.2 trillion only by reducing pollution and its effects on the environment annually by 2030.

In this context, Algeria seeks to strengthen its legal arsenal related to the environment, by introducing a paragraph on climate change, as confirmed by the Director General in charge of climate change, in coordination with several ministries to strengthen the current legal arsenal of the environment. The Paris Agreement has Algeria as a signatory on climate 2016, and is working to adapt its legislation to the current situation characterized by the growing phenomenon of climate change. Algeria is committed to reducing its emissions of greenhouse gases by 7%, and increasing this ambition to 22%, in the event that it benefits from international funding, technological transfer and assistance to enhance its technical capabilities. In September 2019, the government approved the National Climate Committee; this committee reflects the country's climate policy, in order to protect natural resources, opportunities for innovation and investment, and provide jobs, and integrate actions related to combating climate change into sectoral development plans (kaddour, Climate Change: Algeria Strengthens Its Environmental Legal Arsenal, 2024).

In terms of reducing pollution and improving human health; there are functions related to environmental protection measures, such as extensive recycling, garbage treatment, and selective sorting. Algeria has many resources and is a vast country when it comes to recycling tools and materials, so the problem of recycling organic waste, which has become out of control in the north, must be solved. This is done by building an electric railway from north to south; so that organic waste is transported by train from north to south to fertilize the lands designated for desert agriculture. Simultaneously, it brings back a lot of sand, which is a limited resource for northern construction. A nation with the most solar potential may easily electrify its transportation system. The effects of the decrease in internal combustion vehicle use have been demonstrated to us by the Corona pandemic. The Algerian labor is capable of constructing electric vehicles and infrastructure (Hasni, Malek, & Zouioueche, 2021, p. 09).

Algeria is one of the few nations in North Africa to have developed comprehensive national climate change adaptation and mitigation strategies. This is due to the country's environmental challenges and its heavy dependence on fossil fuels, which generate 99 percent of its electricity. As a result, The government has invested in mitigation and adaptation strategies for climate change. These tactics mostly concentrate on three areas (Nachmany, Fankhauser, Davidová, & Singleton, 2021, p. 03):

- Area 1: Implementation of the orientation plans for social, economic and environmental development.
- Area 2: establishing new organizations and enhancing and incorporating current human resources.
- Area 3: Mitigation of emissions of greenhouse gases as a result of energy diversification by investing in renewable energies.

Therefore; Without a question, the ultimate renewable energy development plan poses a significant challenge for the nation. This plan will cut greenhouse gas emissions by as much as 60% overall. If certain requirements are met,

such as the development of qualified human capacities, the integration of all possibilities, strong coordination, and good administration, Algeria has a good chance of successfully mitigating climate change.

Conclusion

The transition towards a renewable energy economy represents not just an environmental imperative but also an opportunity for economic diversification within Algeria's broader development agenda aimed at achieving sustainable development goals outlined globally through frameworks such as Agenda 2030.

By leveraging its natural resources effectively while overcoming existing barriers through strategic policy implementation combined with public engagement initiatives—Algeria stands poised not only transform its own domestic landscape but also contribute meaningfully toward regional stability concerning climate resilience efforts across North Africa.

Algeria's energy transition also places top priority on renewable energy. In addition to diversifying energy sources through the advancement of renewable energy, improving efficiency of energy is a crucial supplementary endeavor. Thus, the country aims to gradually free itself from dependence on traditional resources and start the dynamics of the emergence of green and sustainable energy, locally available and abundant such as solar and wind energy, in light of local and global changes in fossil energy prices. Therefore. In order to embody national, international, and local energy practices and policies, it is imperative that a goal be set that reflects a shared political vision in the field of renewable energies. It is important to establish a long-term, ambitious aim that demonstrates political commitment. This gives the general populace and investors a long-term political vision.

Results

Confirming the study's hypothesis, despite the potential advantages of renewable energy, there are many challenges that hinder Algeria's transition towards a sustainable energy future:

- Infrastructure Limitations: Existing electrical grids are primarily designed for centralized fossil fuel generation rather than decentralized renewable sources.
- Regulatory Barriers: Although recent laws have improved conditions for investment in renewables, bureaucratic hurdles still exist which can delay project approvals.
- Market Competition: Fossil fuels remain cheaper due largely due subsidies provided by government policies which complicate market dynamics favoring renewables.
- Technological Gaps: There is a need for technological advancements tailored specifically toward local conditions which may require partnerships with international firms experienced in deploying such technologies effectively.

Addressing these challenges requires coordinated efforts between government entities at all levels alongside private sector stakeholders committed toward fostering innovation within this emerging industry. In summary, the transition to renewable energy economies plays an essential role in achieving sustainable development goals within Algeria, offering pathways toward economic diversification while addressing pressing environmental concerns associated with reliance on fossil fuels:

- Renewable energy plays a significant part in increasing the rate of economic growth, increasing wealth and economic development; as renewable energy is considered the most economically viable alternative.

- Renewable energy plays a significant part in enhancing the living environment of the citizen, and creating job opportunities, wealth and well-being.

- Renewable energy plays a significant part in enhancing human health and protecting the environment from pollution.

Proposals

Here are some suggestions:

- Expanding the enactment of laws and issuing legislation to improve energy consumption, and developing renewable energy projects, with emphasis on implementing these projects.

- Increasing participation between both the public and private sectors when it comes to renewable energy investment.

- Enhancing clarity on the strategy for implementing renewable energy policies in Algeria.

- Developing a national strategy for developing the transportation network by developing the transportation network to connect new renewable energy sources, especially in the south.

- Enhancing cooperation between international renewable energy developers and local industry.

- Providing assistance and support to emerging, small and medium-sized businesses to make investments in the field of renewable energy.

- promoting scientific research in the fields of renewable energy and exchanging expertise with nations who have a lot of experience in the new energy sector, particularly those with innovative programs like Germany.

- Providing an appropriate investment climate for investment in the field of renewable energy, issuing legislation to attract local and foreign investors, and providing qualified human resources and spending generously on training them, so that they contribute to the development process.

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