
Energy Transition and Innovation in Algeria: Tools for a Safe Energy Supply and a Long-Term Economy

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Abstract:

Algeria's energy security is becoming more and more at risk because fossil fuel reserves are running out and demand is growing at home. This study examines the nation's shift to renewable energy, focussing on the potential of solar, wind, and hydropower. Technological innovation and favourable policies are recognised as essential catalysts for sustainable energy development. The study looks at the current energy infrastructure, investment opportunities, and ways for regions to work together. The results show that a successful energy transition can make the economy more stable, lessen the impact on the environment, and make the country less dependent on energy. To meet its 2030 renewable energy goals, Algeria needs to use strategic planning, work with both the public and private sectors, and adopt new technologies. The study offers valuable information for policymakers and investors looking for long-term energy solutions.

Keywords: Renewable energy, innovation, energy transition, economic stability, energy security.

Jel Classification Codes: Q42, O13.

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1. Introduction:

Energy security is a central concern for Algeria, given its heavy reliance on fossil fuels, growing domestic energy demand, and exposure to global market volatility. Historically, Algeria's economy has depended heavily on hydrocarbon revenues, making it vulnerable to fluctuations in international oil and gas prices. In recent years, the need to diversify the energy mix and reduce reliance on fossil fuels has become increasingly urgent, especially in light of global trends toward decarbonization and sustainable energy solutions.

The transition from fossil fuels to renewable energy sources is not only an environmental necessity but also a strategic economic choice. By promoting innovation in energy technologies, expanding renewable energy capacity, and reforming regulatory frameworks, Algeria can enhance its energy security, stabilize its economy, and strengthen its position in regional and global energy markets. The challenge lies in managing this transition effectively while addressing the technical, financial, and institutional constraints in the country's energy sector.

The main driver behind this transition is the combination of diminishing fossil fuel reserves and increasing domestic and regional energy needs. A sustainable energy strategy would secure supply, promote economic resilience, attract investments, create jobs, and foster technological development. Achieving this requires coherent policies, infrastructure development, and strategic planning at both national and regional levels.

For this, the following main problem arises:

What strategies can Algeria adopt to ensure sustainable energy security and economic stability through energy transition and innovation?

Research Hypotheses:

In order to address this problem, we rely on the following global hypothesis:

Main Hypothesis:

If Algeria implements effective energy transition strategies supported by technological innovation, then the country will improve its energy security and strengthen long-term economic stability.

Secondary hypotheses include:

H1: Innovation in energy technologies and systems significantly enhances Algeria's ability to transition from fossil fuels to renewable energy sources.

H2: Effective policy frameworks and regulatory reforms positively influence the implementation and success of renewable energy projects in Algeria.

H3: Diversification of energy sources, particularly through solar, wind, and hydropower, reduces Algeria's economic vulnerability to fluctuations in global hydrocarbon markets.

Study Objective and Approach:

This study seeks to analyze the current energy landscape in Algeria, evaluate the potential of renewable energy, and assess the role of innovation and policy in enhancing energy security. It also examines the implications of energy transition for Algeria's economic stability and development.

In accordance with the nature of the subject, we adopt a descriptive and analytical approach. This includes a review of literature on energy security, energy transition, and innovation, combined with an evaluation of Algeria's energy policies and international cooperation initiatives.

2. A complete look of Algeria's current energy situation:

Fossil fuels make up the majority of Algeria's energy mix and are the principal source of primary energy. Because it is a major producer of oil and gas, the country has the capacity to use these resources and at the same time build new energy systems. The current energy framework is better because there are so many renewable resources available. The government's focus on energy transition has made innovation one of the most important ways to achieve energy security and, in the long run, a sustainable economy. Algeria has a good chance of developing renewable solar and wind energy. (Benhadji, 2022, p. 252)

Table N°1: Fossil energy resources of Algeria

Resource / Explanations	Crude oil*	Natural gas*	Coal*	Shale Gas**	Tight Oil**
Value	12.2(0.72%)	159(2.19%)	246(0.02%)	706.9	5.7
Unit	billion barrels	Tcf	million short tons	Tcf	billion barrels
Year	2021	2021	2023	2013	2013
Source	[7]	[7]	[7]	[8]	[8]

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Source: AENERT – Energy Industry in Algeria, <https://aenert.com/countries/africa/energy-industry-in-algeria/>

* Share of the country's reserves in world total is provided in brackets

** unproved technically recoverable

The country is in a good spot because of its latitude and the fact that it has a lot of clear days. This gives it an annual solar irradiation of 1,700 to 2,200 kWh/m²/year and an insolation of 4.5 to 6.5 kWh/m²/day. The Sahara has a big effect on how much and how good these resources are. The solar-potential surface area is over 600,000 km², which is one of the largest in the world. The large amount of solar radiation and the large amount of land make it easy for solar technology to spread. The average wind speed across the country is between 4 and 6 m/s. The highlands of the north, near the Sahel, and the south are where the mid-to-high wind-potential areas exist. The average wind speed over the course of a year is between 7.5 and 11 m/s at a height of 10 m. The minimum wind speed needed to use wind energy is about 5 m/s. The country's strong potential for solar and wind energy fits nicely with the idea of switching to green technologies.

Algeria has a lot of potential for hydropower because it has a lot of coastline (around 2,500 kilometers) and mountains. The grid gets new hydropower capacity all the time, and hydropower plants make up about 2% of the country's electrical generation. When integrating huge amounts of renewable energy sources that change over time, including solar and wind power, hydropower helps to balance out changes in supply and demand. Based on the country's ability to use renewable energy, it is reasonable to predict that renewables will make up 10% to 15% of the energy mix.

Table N°2: Fossil energy resources of Algeria

Resource/ Explanations	Solar Potential (DNI)*	Wind Potential (50 m)*	Hydro energy Potential**	Bio Potential (agricultural area)	Bio Potential (forest area)	Municipal Solid Waste
Value	5.5 - 6.8	6.0 - 7.0	12	17.3	0.8	0.84
Unit	kWh/m ² /day	m/s	TWh/year	% of land area	% of land area	kg/capita/day
Year	2022	2022	2008	2022	2022	2016
Source	[9]	[10]	[11]	[12]	[13]	[14]

Source: AENERT – Energy Industry in Algeria, <https://aenert.com/countries/africa/energy-industry-in-algeria/>

* For most of the territory of the country

** Gross theoretical hydropower potential

3. A look at the energy sources that are available in Algeria right now:

The demand for energy in Algeria has grown quickly and by a lot, going by more than 250% from 1990 to 2013. This huge rise shows how much more energy the country needs. Algeria is a net energy exporter, which is significant because over 85% of the gas it produces is sent to European markets. However, if we keep using energy at the same rate, experts say that the current reserves of conventional energy resources would only endure for around 50 years. Because this is such an important issue, the government is making a big and thorough effort to switch electricity generating to using renewable energy sources. This change is mostly about making the most of Algeria's plentiful solar and wind energy, which is important for long-term growth. (EIA, 2025)

It is expected that the world's proven oil and gas reserves will be used up by the end of the 21st century. This raises serious worries about the future security of energy sources and the environmental effects of continuing to extract fossil fuels. Algeria relies significantly on oil and gas earnings right now, but it has a lot of room to grow in both wind and solar energy. The ever-growing need for energy is the main reason why fossil fuel supplies are being used up too quickly. When these fossil fuels are burned, they release a lot of greenhouse gases. These emissions are a big part of what causes global warming, which shows up in many ways, like lengthy droughts and very bad weather. Also, Algeria's oil and natural gas supplies are running out quickly, making it even more important for the country to rely on hydrocarbon exports. These resources are very important to the country's economy. For example, it exports around 26 million barrels of crude oil per year, and oil and gas profits make up almost 20% of its gross domestic product (GDP). Since 2014, oil prices have dropped, making things worse. The state budget is now in a big hole, and GDP has dropped sharply. Also, by 2020, the costs of electricity and oil were significantly subsidised, which led to too much energy use. For example, the amount of electricity used per person rose to an amazing 1302 kWh in 2020. The National Energy Commission says that by 2030, the demand for electricity will be more than 150 terawatt-hours (TWh). This is a problem that needs to be solved for long-term energy planning and economic stability. (Kebbaty & Baghli, 2022, p. 2023)

3.1 Fossil Fuels:

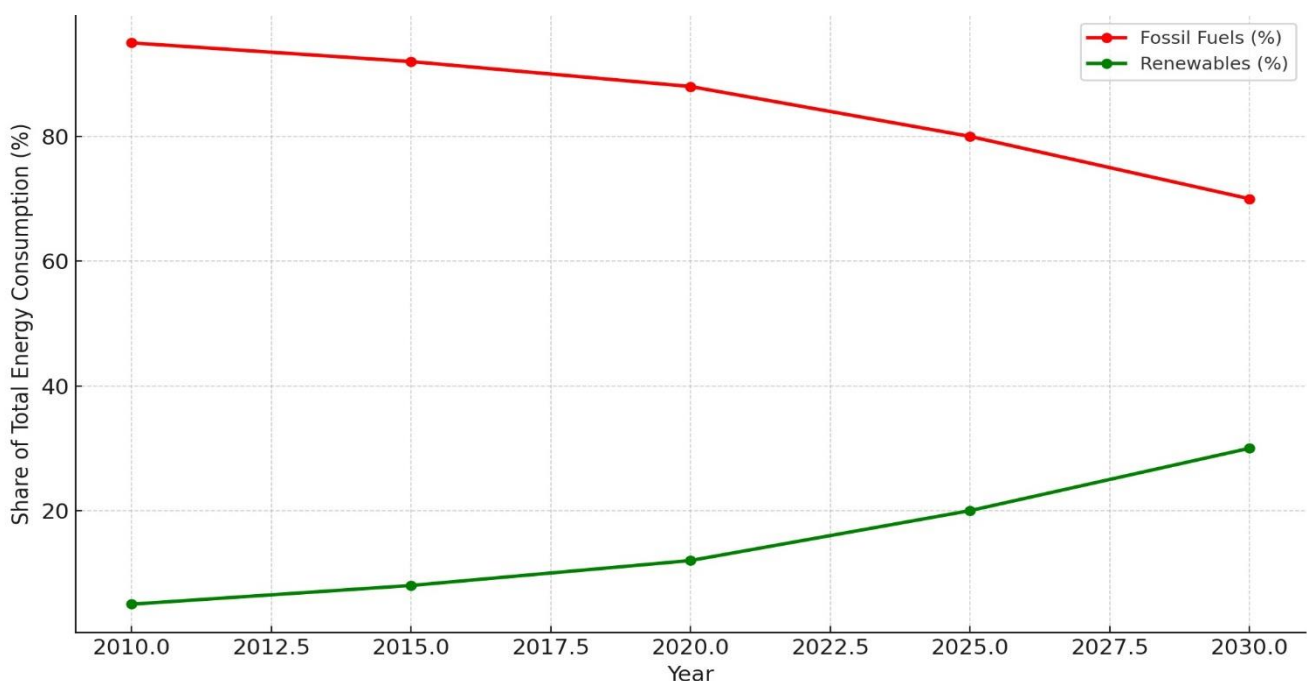
Algeria has serious problems since hydrocarbons are so important to the country's economy, society, and energy systems. Four main problems can be pointed out about the current practices and policies: first, the continued use of unsustainable energy demand-policies, which leads to the loss of capital.

Second, the low level of the transformation process, which reduces the potential added value of "downstream industries"; third, the low efficiency of current power-generation installations, which puts a lot of pressure on production figures; and fourth, the unfair access to energy for some groups of people, especially in the interior regions. (Hamiche , Stambouli, & Flazi, 2015, p. 265)

Energy scenarios, based on official projections and estimations from 2010 to 2030, were created to give general ideas about what future energy demand and supply will look like. One of the main areas of focus was structural change within sectors and activities, as well as the development of energy consumption, especially the demand for electricity and gas in the main end-use regions. There were also several market and supply assumptions that guided the outreach method, such as the energy pricing policy and access to exports.

As fossil fuels became a major part of the energy mix, important problems about the long-term viability of demand policies arose. A critical analysis was conducted to create a descriptive picture of how the fossil-based components and markets change in the country. This was done by linking energy production volumes to the behaviours of both upstream and downstream markets. This information will help design strategies to deal with this situation. Using this approach, a small number of situations helped create a range of different energy consumption patterns and their effects. (Kebbaty & Baghli, 2022, p. 2024)

Fig N° 1: Algeria energy mix transition between 2010-2030



Source: Source: Compiled by the authors from Louafi (2016); Matallah et al. (2023); Elkhatat & Al-Muhtaseb (2024).

3.2 The potential of renewable energy:

Algeria is in a good place to use a lot of different types of renewable energy. Solar energy is the most plentiful renewable resource in the country. The Sahara region gets over 3,500 hours of sunshine a year, or 8 hours a day on average, and up to 11 hours in the summer. In both the north and south, the average amount of solar energy that can be used is about 26 kWh/m²day. There are around 1,787,000 km² in the country that are good for concentrated solar power generation. Figure 3 shows where Algeria might get its renewable energy from. Even if there is a lot of renewable energy, hydrocarbons are still the main sources of electricity in Algeria and many other North African countries. A method was developed to map wind energy at different heights to find out how much wind energy is available. This method was used to look into two areas in the Sahara Desert, one in the north and one in the south. The highest annual wind speed is about 9 m/s at 100 m height. Algeria has a lot of room to grow its hydroelectric power industry. There are a lot of small and big sites to choose from, and a lot of research has been done on hydroelectric projects. In the Saharan oases in southern Algeria, hydroelectric power stations are utilised to water the floors. Many hydroelectric power plants and dams in northern Algeria are utilised to provide water to cities, irrigate land, and make electricity. (Benhadji, 2022, p. 253).

4. Problems with Energy Security:

Algeria's economy relies heavily on hydrocarbon rents. The price of fossil fuels affects the growth of real GDP through mechanisms that affect productivity (Louafi, 2016). In 2011, energy exports made up almost 95% of the country's total export profits, or more than 30 billion USD. However, the continual rise in domestic demand makes it hard to keep up with output.

Because fossil fuel supplies are unclear and prices are often changing, the current situation makes people worry about the long-term health of natural resources and the economy. A quick switch to renewable energy sources could help the country become less dependent on hydrocarbons, which makes its supply and economy less stable .

Algeria is a hot spot for renewable energy in the Mediterranean since it has a lot of solar and wind resources. But for new technologies to be developed, there needs to be a pool of people who are trained on how to come up with new ideas.

Algeria may use energy innovation to make energy security less of a worry, cut down on its reliance on fossil fuels, and make its economy less vulnerable. Innovation can help the economy become more stable, which will help with

economic security and lower the country's very high energy-intensity ratio. (Bensafta, 2022, p. 70)

4.1 Factors in geopolitics:

Because Algeria's economy is so unstable, making sure that the country has enough energy is even more important for its long-term growth and sustainability. Energy security is an important concern for Algeria and its trading partners. As the Western Mediterranean and North African Energy Six countries become more economically dependent on each other, this issue has become more important in geopolitics. It is therefore crucially important to enhance Algeria's energy production and make it more diverse, especially by focussing more on clean and renewable energy sources. This is very important for keeping the country's macroeconomic stability and for keeping its strategic position in the centre of the Mediterranean's geopolitical energy landscape. Algeria's potential to have a big impact on the region depends heavily on its ability to keep producing hydrocarbons in a way that is effective and efficient. So, making sure that energy security is strong is important not just for the economy, but also for the balance of power in the region. (Boubaker, 2024, p. 500)

4.2 Economic Dependencies:

Hydrocarbons make up 30% of Algeria's GDP, 60% of its tax revenue, and 97% of its export earnings. Because of this, a lot of imports and trade imbalances are paid for with money from oil and gas. The country wants to make the switch to renewable energy sources, and Algeria sees innovation as a key way to increase energy efficiency and make sure there is a steady supply of power. Oil and gas development have helped the economy grow steadily, but the country's industrial system is still weak and lacks diversity and connections. The government's reliance on oil and gas still affects its fiscal and real wage policies, as well as the incentives it gives people to invest in upstream and middle-stream supply chains. This chapter could be hard but stimulating for a third-year undergraduate student of Economics and Management.

Algeria's energy use changed a lot between 1965 and 2013. If the country's high internal demand stays the same, it will hurt exports and raise the cost of energy. The energy balance must be kept at a level that protects natural resources for future generations. To avoid a serious problem, it is important to put in place a good policy to limit energy use. At the same time, Algeria's reliance on natural gas and oil revenues makes it a rentier economy that isn't very developed. Since the 1970s, Southern European countries have relied heavily on Algerian gas. This has created a geo-energy space in the Western Mediterranean and led to unequal

dependency relationships. Algeria's dependence on hydrocarbons for money has a big impact on how the country fits within the regional gas system. A qualitative approach has been suggested to examine the interconnections among enterprises participating in the gas value chain; a quantitative technique facilitates the evaluation of each country's position and influence within the regional energy system. Algeria can still have its rentier-economy character because it still possesses gas and oil resources. (Oksana, 2023, p. 28)

4.3 Limitations of Infrastructure:

SONELGAZ, the national enterprise, runs Algeria's huge and complicated system of energy transmission and distribution networks. By 2017, these huge networks covered an amazing 64,940 kilometres just for power transmission and an even larger 665,198 kilometres just for distribution lines. This huge infrastructure has made it feasible to reach all 154 communes in the country. This shows how committed the country is to delivering power to all places, even rural and remote ones. However, it's important to remember that almost 1 million people still don't have access to electricity. This shows that there is still a big problem in the continuous effort to make sure that every citizen has access to energy. The country also has about 3.1 gigawatts (GW) of installed capacity for making hydropower and other types of non-renewable electricity. This shows that the country is already involved in many different elements of energy generation, including both renewable and traditional sources .

Still, the fast growth of the population and the ambitious plans to focus more on using more renewable energy sources will inevitably lead to a rise in electricity demand that is much higher than what the current electricity infrastructure can handle. Also, the fact that almost all of the country's power comes from gas-fired thermal plants makes it harder to use a variety of fuels, which makes it much harder to find new, sustainable ways to get energy. This issue brings up important questions about energy security and the government's and the public's desire for a continuous supply of electricity. Algeria still needs to build the infrastructure and technology it needs to effectively lower its overall energy demand. This means that making progress in this area is a top priority for future growth. There aren't enough good thermal insulation systems for buildings, modernised heat production systems that use cutting-edge technology, or modern ways to absorb and store energy. All of these things are necessary to make the country's energy use as efficient as possible. It is also crucial to point out that the current gas transport network is under a lot of stress because it is being used a lot to fulfil local needs, and the share of gas that is sent outside is gradually growing, which

could lead to problems in the future. This growing tendency in exports could make the country's energy security less stable, as it tries to meet both its internal and foreign energy needs without compromising either. (African Development Bank, 2020)

Additionally, the geographical distribution of production capacity and the associated export infrastructures reveals a significant and concerning level of imbalance: oil refining capacities are mainly located in coastal areas, whereas considerable reserves of natural gas are primarily situated in the country's interior regions. These intrinsic governance challenges and infrastructural constraints constitute substantial obstacles that hinder the growth of the gas sector within the overarching framework of natural energy resources in Algeria. It is imperative for policymakers to rectify these disparities to attain sustainable energy development in the future. (Kebour, Belgroune, & Abdeladim, 2025, p. 585)

5. Innovation for the energy transition:

Energy transition means a big, planned change in the energy sector from fossil fuels to cleaner, more sustainable sources of energy. This change is very important for lowering greenhouse gas emissions, which are a major cause of climate change and global warming. It will also make the air cleaner and better for people's health. Energy transition is more than just changing the sources of energy; it also includes a wide range of initiatives targeted at lowering global energy use. This includes making energy use more efficient, better managing resources, using materials more efficiently, and getting both consumers and businesses to change their habits. The process of energy transition is all about changing the way energy is produced and used so that it is safer and more fair for everyone, no matter how much money they have. For a successful energy transition, it is important to understand that good policy making and the development of new technologies are two of the most important factors that will drive this change. In this situation, renewable energy sources, together with novel ways to improve efficiency, become important parts of making the energy transition work. Innovation is very important because it helps new energy technologies get better and better, which could change the way energy is made, shared, and used. Algeria, in particular, has a lot of renewable energy potential, such as large amounts of solar, wind, and hydropower. This potential can be used in a way that works well with the country's energy needs and gradually cuts down on its heavy use of fossil fuels. However, it is vital to emphasise that heavy use of fossil fuels since 2010 has caused serious environmental damage, which is a big threat to sustainable growth and changes how people in the country use fossil fuels. Additionally, it seems that the current economic model is still weak to changes in fossil fuel exports and the

unpredictable nature of global commodity prices over time. So, it is important to start a sustainable energy transition that is based on more inventive activities and technical progress. This strategy is meant to protect the Algerian economy and deal with urgent environmental issues that have come up because of the country's reliance on fossil fuels. So, the way forward must include strong strategic plans to make sure that Algeria has a cleaner, more sustainable, and more stable economy in the future. (Louafi, 2016, p. 47)

5.1 Improvements in Technology:

The Algerian government is putting a lot of money into making renewable electricity generation better, but the process of coming up with new ideas still has to go faster and more effectively. The political economy of hydrocarbon resources is not clear about how long it will last or how well it will work for Algeria's transition to sustainable energy. The new plan must improve energy efficiency and cut methane emissions by encouraging new quality on the demand side. This will help the continuing energy transition and complement renewable energy initiatives. (Matallah, Boudaoud, Matallah, & Ferhaoui, 2023, p. 7)

5.2 Policy frameworks:

Policies' influence in the shift to energy security has been thoroughly studied from a broad economic point of view. Different policy frameworks create the necessary ecosystem of rules and incentives that is needed to make the switch to sustainable energy sources a success. Also, subnational initiatives are also important for filling in the gaps or problems that can happen when national tactics aren't good enough or don't work. These frameworks must change and grow all the time during the whole transition process to keep up with new innovations and problems that come up in the energy sector. This flexibility is essential for making sure that all parts of energy security are well-managed and that the transition stays on track for long-term sustainability. (Elkhatat & Al-Muhtaseb, 2024, pp. 23–24)

6. Renewable Energy Projects:

From 2011 to 2013, Algeria held a number of bidding processes for private companies to take part in big solar photovoltaic (PV) and wind projects in areas with great solar and wind energy potential. There are financial incentives to get private and foreign investors to put money into big and small renewable energy projects. These efforts are part of a plan to build a platform for generating 22 GW of renewable electricity over the next 20 years. The recent tendering campaign, which offered 2.6 GW of project opportunities for projects with a peak capacity of

more than one megawatt (MWp), is the first step in this ambitious plan to increase renewable electricity capacity. (African Development Bank, 2020)

6.1 Solar Energy Projects:

Algeria is making great progress by moving forward with carefully planned large-scale solar projects that will give its economy and infrastructure a big boost in renewable energy. These projects include cutting-edge photovoltaic systems and new concentrated solar power plants, among other things. There is also a futuristic solar breeder project that wants to turn the Sahara Desert into a worldwide clean-energy superhighway, which would change how people get renewable energy. The government is also actively seeking investments in both the renewable energy and hydrocarbon sectors, which shows that it wants to take a balanced approach to energy production. There is already a national plan in place that focusses on developing renewable energy sources so that they are completely realised by 2030. Algeria is also taking part in a groundbreaking hydrogen manufacturing project between Maghreb and Europe, which shows how committed it is to finding new energy sources. One important example of these efforts is the Ain Skhouna solar photovoltaic project, which can produce 20 MW of electricity at first but could quadruple its output to 40 MW in the future. This initiative is an important step forward in Algeria's ambitious plan to use more renewable energy. It is an important aspect of the government's big solar energy plan and also helps the economy become more diverse by promoting sustainable and responsible development projects. (Ihaddadene, El Hassen, Ihaddadene , & André, 2022, p. 15)

6.2 Recent developments in wind energy:

The Algerian government has officially announced a new energy development program that is very ambitious. Its goal is to greatly increase the amount of electricity produced in order to meet the growing demand for energy in the country and support the growth of industries that use a lot of energy .

This important program is carefully based on three primary strategic axes :

- Increasing the production capacity of fossil fuel-powered plants to make sure that the energy supply is stable.
- Building new renewable energy power plants to use different kinds of energy.
- Fixing, improving, and keeping up with the maintenance of existing plants to make them more efficient and reliable .

The Algerian Wind Energy Development Agency (DAHE) was officially set up by presidential decree to help develop wind power as part of the country's renewable energy sector. It is now the main agency in charge of the national program dedicated to wind energy. In Algeria, a lot of careful and thorough wind measurements have been done in different parts of the country. The country has been separated into several geographical zones for the purpose of measurement and analysis. To make this effort even stronger, the National Renewable Energy Development Centre struck a big partnership deal with the well-known German company BFT Consulting. The goal is to do complete investigations and full wind measurements. The main goal of this partnership is to figure out how much wind energy Algeria could produce and to build a strong, detailed database that will help the sector grow in a sustainable way. In 2016, fifteen wind turbine models were carefully chosen based on important functional features. The pricing for these models ranged from \$393,550 to \$1,621,391. A detailed comparison study employing basic linear regression was performed to ascertain the alternative with the optimal wind energy potential, utilising the Prony model for comprehensive evaluation and insights to inform further decisions. (Charef & Slimani, 2022, p. 22)

The Aurès (10 MW), Ghrab (30 MW), and Tidikelt (79.5 MW) regions contain the most advanced solar and wind project sites out of the thirteen. They are also the most likely to be put into action soon. At the same time, since 2014, the building of multiple wind farms with a total capacity of around 300 MW has begun. This is a big first step in the growth of wind power, even though there have been some delays and changes in plans for site selection and preliminary work. (Abbas, Bouchakour, & Hamidat, 2020, p. 90)

6.3 The potential for hydropower:

Algeria has a lot of untapped hydropower potential, but right now the government only uses a small part of it. The Rhummel, Chelif, Tafna, and Seybouse are some of the biggest rivers that flow through mountains that would be great places to build hydropower plants. But there are a number of selection factors that make it harder to find good places to build power plants. For example, rivers must have high flow rates, steep slopes, and a big enough drop in elevation to make the cost of building them worth it. Climate change also makes river flow very unpredictable, which makes people wonder how long hydroelectric plants in the area would be able to last. However, the government's continued development of minor hydropower projects with capacities below 10 MW shows that it sees

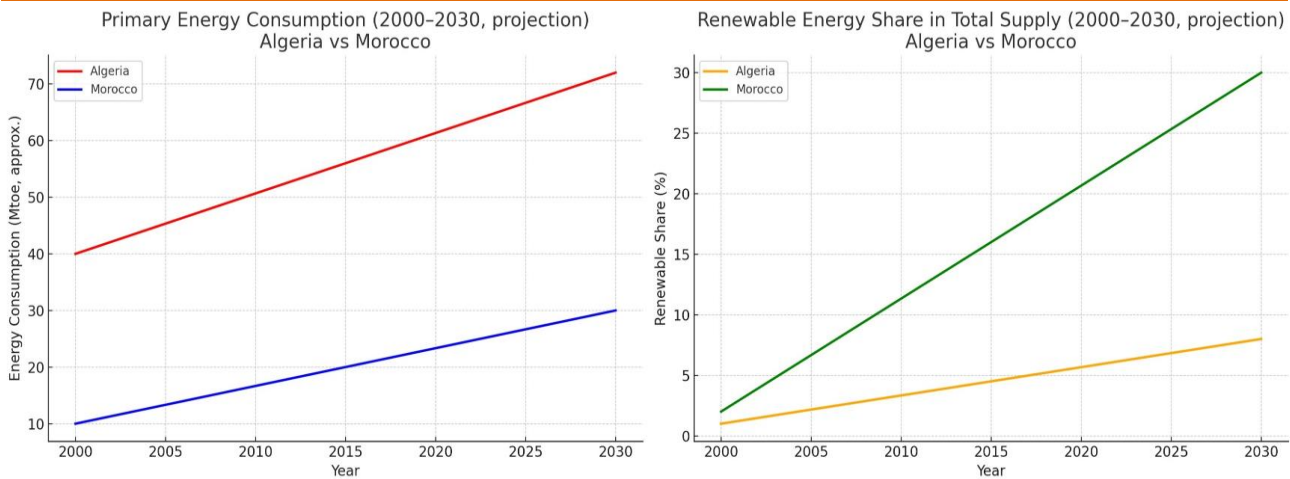
hydropower as an important part of the national energy mix. (Ainou, Belkacem, & Ould, 2022, p. 199)

7. Comparisons between regions:

In 2016, Morocco's energy security measures got a lot worse because the country had to rely more on oil imports and had few resources of its own. This situation got even worse when oil prices on the world market started to change. Because of these problems, later policy suggestions firmly pushed for a comprehensive approach that focusses on getting more people to use renewable energy sources, making energy use more efficient, and using a wider range of energy sources, with a focus on solar and wind. The suggestions also called for stronger international energy alliances and a strong framework for building infrastructure to make sure that energy is available in the future. Since the year 2000, energy use in Algeria has been steadily rising. This is mostly because of long-term patterns of economic growth and the country's distinctive economic structure. On the other hand, Morocco's rise in energy use has mostly been short-term and linked to the country's rapid population growth and growing urbanisation. (Zahraoui, Benkirane, & El Mansour, 2021, p. 146)

Both nations are presently facing a multitude of substantial hurdles as they attempt to satisfy the rising energy demand while also working to diminish greenhouse gas emissions in alignment with international environmental requirements. After 2014, Algeria's hydrocarbons sector saw significant weakening tendencies. This can be connected to dropping oil prices and a fiscal strategy that relies too much on direct hydrocarbon revenues and related subsidies. Morocco, on the other hand, has seen a steady and worrying drop in national oil production since 2000, and there are no major local reserves to fall back on. The energy architecture designs that have been put in place in both countries cover between 71% and 92% of the primary energy supply. Also, worldwide coverage trends have stayed the same or gone up a little bit from 2012 to 2017. This shows how energy needs change on a bigger scale. Algeria's natural abundance of viable renewable energy sources, especially solar energy, fosters the search for and use of new technical solutions that have been made in areas with a wider range of renewable resources. This also helps to put the justification for different green innovation methods and architectures into action, which helps to match alternative fit models with field findings and make the energy landscape in both countries more sustainable and resilient. (Himri, Boudghene Stambouli, & Chellali, 2022, p. 312)

Fig N° 2: Algeria & Morocco: Energy Mix Transition to 2030



Source: Projections based on trends in Zahraoui et al. (2021), Himri et al. (2022), IEA & Our World in Data.

8. The future of Algeria's energy sector:

The future energy prognosis for Algeria stresses the importance of incorporating renewable energy sources as a key response to the urgent and pressing problems caused by climate change, as well as the necessity to diversify energy sources. More and more, these elements are being seen as important tools that are very important for making the country's energy security better. Solar energy is one of the most important and well-known renewable energy sources in Algeria. This is especially true in areas along the Mediterranean coast and in the vast, dry desert fringes that make up much of the landscape. The Atlas Solaire Algérien project has been a very important part of a number of assessment efforts to fully evaluate the possibilities of solar energy in the country's energy mix. Algeria's overall energy balance and its comprehensive development strategy show a clear and significant move towards limiting the use of fossil fuels while also speeding up investment in renewable energy sources that are important for the country's future. This change is made even clearer by the need to keep enough reserves to sustain industrial growth and make exports easier, which are both important for Algeria's long-term economic stability. Algeria is also an important energy hub on the African continent because of its strategic location and large energy reserves, which make up an amazing 42% of the overall continental reserves. This condition makes it even more important to quickly and widely diversify the energy base, which is in line with the main goal of making sure the environment stays healthy in a world that is changing quickly. (Bergougui & Meziane, 2025, p. 235)

8.1 Future Trends and Developments:

The Algerian government has laid out three strategies for the national energy sector to grow between 2017 and 2030. This is to make sure that energy demand

can be satisfied even while supplies are limited. These scenarios imply that the economy will grow between 3.6% and 5% per year, with population increase and economic growth being the main drivers of energy demand. Even if actual growth rates have been lower than expected in recent years, long-term trends nevertheless help with planning. One possibility is that energy use might go up by 5.2% every year from 2020 to 2030. This would mean that by 2030, we would need to meet more than 140 million tonnes of oil equivalent, depending on how fast the expansion happens. Another one estimates that the amount will go up by about 4.6% each year, which will add up to almost 120 million tonnes of oil equivalent over the same time span. So, total primary energy use is predicted to be 129 million tonnes of oil equivalent by 2030. (Sakhraoui, 2025, p. 218)

These expected rises in energy use in Algeria have people very worried about the long-term viability of the country's energy grid. Of course, the government wants to keep the national market moving and keep sending hydrocarbons out for export. So, it plans to lower its estimates for how much energy people will use at home to keep its competitiveness and export capability. The scenarios show that energy demand will outstrip sustainable supply capacities in the next ten years, which shows how important it is to prepare ahead and take action. (Benhadji Serradj, Khelifi, & Touati, 2022, p. 156)

9. Strategic Suggestions:

The views presented here arise from a thorough analysis of Algeria's complex energy landscape, marked by its historical intricacies, fundamental strengths, and intrinsic shortcomings in the present energy industry. This study also looks at different investment opportunities, the social and political factors that affect the energy climate, and the rules that control the energy sector. Key opportunities for progress include a strong growth of renewable energy sources, the use of effective energy-saving measures, the improvement of research and development projects, the encouragement of regional partnerships, the creation of strong financial and institutional systems, and the addition of comprehensive regulatory systems. The imminent exhaustion of fossil fuel reserves, coupled with an overdependence on exports, presents a significant threat to the long-term viability of Algeria's current energy paradigm .

Moreover, the entrenched production methods and established infrastructure hinder rapid transition, thereby impeding the development of nascent sectors and creative entrepreneurial initiatives. So, we really need a wide range of strategic measures and activities to protect and promote other sources of economic growth and sustainability. To make the best use of limited resources across competing

initiatives, industries, regions, and stakeholders, there needs to be a governance framework that is open, clear, and welcoming. This kind of governance will eventually make the growth model that comes from these projects more stable and long-lasting. It is becoming more and more important to look for other ways to get energy because forecasts show that fossil fuel sources could run out in the next fifty years. Algeria still has once-thriving primary and secondary industry clusters, as well as integrated tertiary services, which can help the country go forward compared to other regional economies. The country has a lot of intangible assets, such as its macroeconomic importance, a strong economy, a large population, and the ability to maintain high-quality production even when the economy is having a hard time. Algeria is also well-positioned to make the most of its intellectual resources because it is committed to investing in people through progressive educational programs. (Benabdallah, 2023, p. 215)

The 2020 Energy Concept Note started reforms in the legal, institutional, and strategic areas that are still going on. These changes are meant to make the energy industry more competitive and flexible in the future. Notably, northern Algeria has made great strides in building a more competitive industrial environment, high-value clusters, and strong innovation agencies. They have also been able to successfully market their goods across the Mediterranean, setting the way for future growth and collaboration. To build on these successes, it is important to improve regulatory frameworks that encourage investments in renewable energy, encourage cooperation between the public and private sectors, and put research and development projects at the top of the list. Also, improving regional collaboration and sharing of information will speed up the energy transition, making sure that Algeria has long-term energy security and sustained economic growth. (Sellers, Thompson, & Van der Meer, 2015, p. 135)

10. Conclusion:

Energy transition and innovation are key ways to improve energy security and start a sustainable economy in Algeria. To deal with the heavy reliance on hydrocarbons and the rising demand at home, a varied approach is needed. By 2030, Algeria wants to increase the share of renewable energy to 27%. The country is focussing on solar and wind projects as well as hydropower potential. Innovation, both in technology and in rules, is what makes smart grids, clean technologies, and targeted frameworks that are needed to integrate renewables possible. Energy efficiency solutions in the construction, industrial, and transportation sectors make the transition even better. Investment mobilisation through public-private partnerships and foreign direct investment speeds up the

modernisation of infrastructure. This has big social and economic benefits, such as creating jobs and making communities more resilient. The environment will gain from the preservation of biodiversity and the decrease of carbon emissions, which is in line with Algeria's climate goals. Case studies from around the world and in specific regions can help shape national plans by giving them useful information. These factors together show a method for Algeria's energy industry to grow in a way that improves security, boosts the economy, and ensures long-term sustainability.

11. Recommendation:

Based on the analysis presented in this study, it is evident that Algeria faces both opportunities and challenges in ensuring energy security while advancing its transition toward sustainable energy sources. The findings highlight the need for a multi-faceted approach that combines policy reform, technological innovation, infrastructure development, and regional cooperation. The following recommendations are proposed to guide decision-makers in strengthening energy security, fostering economic growth, and supporting a sustainable energy transition.

- **Refine the research problem and hypotheses:** The study should clearly define the main research problem by emphasizing the dual challenge Algeria faces: ensuring energy security while transitioning to a sustainable economy. Hypotheses should be adjusted to specifically test the impact of renewable energy adoption, technological innovation, and policy frameworks on energy security and economic stability. For example, one hypothesis could examine whether the expansion of solar and wind energy directly improves Algeria's long-term energy security.
- **Strengthen policy and regulatory frameworks:** Algeria should focus on creating credible and stable policies that encourage private and foreign investments in renewable energy projects. Laws and regulations should be assessed for their economic impacts to avoid distortions and ensure they effectively support the energy transition.
- **Invest in innovation and technology:** Greater attention should be given to fostering research and development in renewable energy technologies, including solar, wind, and hydropower. Investment in energy efficiency technologies across industrial, transport, and construction sectors will accelerate the energy transition.
- **Enhance infrastructure and capacity:** Expanding and modernizing energy transmission and distribution networks is crucial. This includes developing

smart grids, upgrading gas and electricity networks, and ensuring a balanced geographical distribution of renewable energy projects.

- **Promote human capital development:** Building a skilled workforce capable of driving innovation in energy technologies is essential. Training programs, technical education, and partnerships with international research institutions should be strengthened.
- **Diversify energy sources and reduce hydrocarbon dependency:** Algeria should accelerate the diversification of its energy mix to reduce economic vulnerability linked to fossil fuel exports and global price volatility. This includes scaling up solar, wind, and small hydropower projects while maintaining strategic fossil fuel reserves.
- **Foster regional and international cooperation:** Strategic partnerships with Mediterranean and African countries can improve technology transfer, investment flows, and regional energy security. Collaboration can also facilitate knowledge sharing and enhance Algeria's role as an energy hub.
- **Monitor and adapt to changing dynamics:** Continuous assessment of energy demand projections, technological advances, and policy impacts is needed. Flexible and adaptive strategies will ensure that the energy transition is resilient, sustainable, and aligned with long-term economic objectives.
- **Encourage sustainable investment and social benefits:** Public-private partnerships and foreign direct investment should be mobilized to modernize infrastructure, create jobs, and promote community resilience. Investments should also consider environmental sustainability, reducing emissions and preserving biodiversity.

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