

Shale Gas as a Strategic Alternative for the Development of the Algerian National Economy

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Abstract:

In the last twenty years, shale gas has become a major player in global energy, especially as demand for natural gas grows and oil markets become more volatile, which represents a significant opportunity for Algeria, as the country is estimated to have the world's third-largest reserves of technically recoverable shale gas, according to the U.S. Energy Information Administration, where this potential could allow Algeria to bolster its energy security and diversify, which remains heavily dependent on fluctuating revenues from conventional hydrocarbons.

However, developing this resource is not without its challenges, as Algeria faces major environmental concerns, particularly over water scarcity in the south and the risk of contamination, which have also spurred social resistance to extraction projects, in addition to the technical and financial hurdles of high drilling costs and the need for advanced technology.

Therefore, while shale gas is a promising strategic alternative for restructuring the national economy, its success depends on a comprehensive approach, which must be based on sustainable development, include local communities, and use clean, innovative technologies to balance economic growth with the protection of environmental and social well-being.

Keywords: Shale Gas, Algerian National Economy, Strategic Alternatives, Energy Security, Sustainable Development, Environmental and Social Challenges.

Introduction

The global energy sector is undergoing significant transformations, driven by intensifying competitive pressures, growing concerns over cost and import security, and the imperative of environmental preservation, where the Algerian economy is ranked among the rentier economies that rely heavily on hydrocarbon revenues, which render its trade balance highly susceptible to fluctuations in the global oil market, consequently, these fluctuations directly influence the state's economic policy, as petroleum tax revenues constitute the primary source of funding for development projects.

In light of the decline and subsequent collapse of energy prices in international markets since early 2014—coupled with rising global demand—, the necessity to diversify the Algerian economy has intensified, as shale gas has emerged as a strategic alternative capable of repositioning Algeria within the international energy landscape.

In this regard, Geological studies confirm that Algeria possesses the world's third-largest reserves of recoverable shale gas; this potential exists alongside intertwined environmental and social challenges, which range from pollution risks to societal rejection and reservations concerning such projects; therefore, these ventures necessitate in-depth academic studies that reconcile the requirements of economic development with the imperatives of environmental protection.

Study problematic:

This context gives rise to the following central problematic: To what extent can shale gas be considered a strategic alternative and a critical determinant for the development of the Algerian economy?

To answer this question, the study is structured around three main axes:

- The first axis addresses the general characteristics of shale gas.
- The second axis examines the energy potential of shale gas in Algeria.
- The third axis analyzes the reliance on shale gas, balancing its environmental risks against societal acceptance.

First Axis: The General Characteristics of Shale Gas

First: The Concept of Shale Gas

Shale gas is categorized as an unconventional natural gas, a classification it shares with coalbed methane, tight sandstone gas, and methane hydrates; therefore, shale (or oil shale) is a fine-grained sedimentary rock composed of clay, quartz, and other minerals, and it requires specific stimulation treatments to permit gas flow, which is the primary reason specialists classify it as an unconventional resource, where this gas is often rich in natural gas liquids (NGLs), including ethane, which is highly valued as a feedstock in the petrochemical industry.

It is a natural gas that forms within the organic-rich shale source rocks themselves—generated by the same geothermal processes that produce oil—and remains trapped within the low-permeability matrix and fine pores of these dense rocks, which prevent its migration.⁽¹⁾

The first commercial gas well in the United States was drilled in New York State in 1821, predating the first commercial oil well; this was, in fact, a shale gas well, as some analysts have drawn a parallel between the subsequent boom in shale gas development and the 1849 Gold Rush, highlighting its transformative impact on the energy sector. While geological surveys indicate the presence of more than 688 shale formations within 142 sedimentary basins worldwide; however, the potential for commercial production has been rigorously assessed in only a few dozen of these, located predominantly in North America, China, Argentina, Mexico, Algeria, and Australia.

The most credible technical studies estimate global shale gas in-place resources to be approximately 16,110 trillion cubic feet (Tcf), or 456 trillion cubic meters (Tcm), and this figure compares to roughly 187 Tcm of proven reserves for conventional natural gas, where it is further estimated that only about 40% of this shale resource possesses significant economic viability.⁽²⁾

The following table presents the top ten countries ranked by technically recoverable shale gas resources for the year 2024:

Recoverable reserves size	Country	Classification
1,275 TCF	China	1
1,688 TCF	United States	2
802 TCF	Argentina	3
707 TCF	Algeria	4
681 TCF	Mexico	5
573 TCF	Canada	6
290 TCF	Libya	7
229 TCF	Saudi Arabia	8
229 TCF	United Arab States	9
124 TCF	Australia	10

Table one (1) : shows the largest ten countries possessing recoverable reserves for the year 2024 ⁽³⁾

Second: Methods of Extracting Shale Gas

Three primary drilling and stimulation techniques are central to shale gas extraction:

a. Vertical Drilling Technique:

Vertical drilling is typically employed during the initial exploration and experimental testing phases of a nascent shale play; in this technique, wells are drilled to depths ranging between 1,500 and 4,000 meters, and once discoveries are confirmed to be commercially viable, large-scale development commences using horizontal drilling. ⁽⁴⁾

b. Horizontal Drilling Technique:

This technique represents a pivotal advancement that has revolutionized the exploitation of unconventional shale gas resources, largely superseding traditional vertical drilling, as the process begins with a vertically drilled section until the target depth of the shale formation is reached; the drill bit is then gradually steered at a 90-degree angle to continue drilling horizontally within the target rock layer for distances often exceeding 2,000 meters.

This method drastically increases the contact area between the wellbore and the gas-bearing reservoir, which significantly enhances production rates from a single surface location, and it reduces the need to drill a multitude of vertical wells, thereby minimizing the surface footprint and associated environmental impact, but it is important to note that despite its advantages, horizontal drilling necessitates substantial financial investment and sophisticated technological expertise to precisely control the well trajectory, furthermore, its economic viability is intrinsically linked to the subsequent application of hydraulic fracturing operations to stimulate gas flow⁽⁵⁾; Thus, horizontal drilling constitutes the fundamental basis for the commercial development of shale gas fields.

c. Hydraulic Fracturing Technique:

Hydraulic fracturing is an essential pillar of shale gas development, representing the critical stimulation stage that follows both vertical and horizontal drilling, to enable the trapped gas within the fine pores and low-permeability matrix of the shale rock to flow into the wellbore. The technique involves injecting large volumes of a high-pressure fluid—composed predominantly of water, mixed with chemical additives and proppants (typically sand)—into the target formation, as this pressurized fluid creates a network of microscopic fractures in the rock; the proppant particles then hold these fractures open, allowing the trapped gas to be released and flow into the production well.⁽⁶⁾

In this regard, hydraulic fracturing is the subject of significant environmental controversy due to associated risks, including the potential for groundwater contamination, the substantial consumption of freshwater resources, and its possible connection to induced seismicity (human-caused micro-earthquakes).

Third: The Importance and Role of Shale Gas in the Economies of Nations

Over the past two decades, shale gas has evolved into a pillar of strategic transformation within the global energy sector, as it is not merely an additional energy resource but also a structural factor shaping national economic growth trajectories and

development policies, while this influence operates through several interrelated dimensions:

a. Diversification of National Income Sources:

Shale gas constitutes a vital resource that enables resource-owning nations to mitigate their excessive reliance on revenues from crude oil or conventional natural gas, and its abundance contributes to a broader national revenue base, thereby ensuring greater fiscal stability in the face of volatility in global oil markets.

b. Enhancement of Energy Security and Economic Sovereignty:

The development of domestic shale gas resources allows countries to reduce energy imports, which alleviates pressure on the balance of payments and liberates economic policymaking from dependence on external suppliers, as the American experience serves as a prime example, where it transformed from one of the world's largest natural gas importers into a leading exporter.

c. Support for Local Industries and Competitiveness:

Shale gas provides access to abundant and often lower-cost energy supplies for domestic industries, particularly energy-intensive sectors such as petrochemicals, which enhances the international competitiveness of local manufacturers and, in turn, creates attractive opportunities for foreign direct investment.

d. Reshaping Geoeconomic Power Balances:

The development of shale gas resources facilitates a strategic shift for nations—from net energy importers to exporters, or from rentier economic models toward more diversified and resilient economic structures, as this transition strengthens their international bargaining power and reinforces the foundations of their long-term sustainable development strategies.

e. Environmental Challenges as a Catalyst for Innovation:

Notwithstanding the associated environmental risks, the challenges posed by shale gas extraction have stimulated substantial investment in research and development, driving innovation toward more sustainable and efficient technological solutions.⁽⁷⁾

In conclusion, shale gas is not simply an alternative energy source but a strategic economic driver, because it offers nations a pathway to achieve a composite of objectives, including enhanced energy security, economic diversification, improved industrial competitiveness, and the generation of long-term added value. Its successful exploitation, however, is contingent upon the capacity of governments to manage a complex equilibrium between economic profitability and pressing environmental and social considerations.

Axis Two: The Energy Potential of Shale Gas in Algeria

Algeria possesses substantial shale gas potential, with estimated resources of 707 trillion cubic feet (Tcf), or approximately 19,796 billion cubic meters (Bcm); the majority of these resources are located in the southern regions, which are geographically distant from adequate water resources, and despite this significant challenge, numerous international oil companies—including ExxonMobil, Shell, and ENI—have expressed interest in conducting exploration activities in these southern areas, where this interest emerges at a time when Algeria's share in global liquefied natural gas (LNG) export markets has experienced a decline.

To facilitate this development, the Algerian government has prioritized the establishment of a fiscal regime designed to attract foreign investment, as the Algerian parliament approved legislation authorizing the official commencement of shale gas extraction in early June 2015, while the Prime Minister has publicly pledged to implement all necessary precautions and preventive measures during the exploitation of this energy resource, with the explicit objective of safeguarding the environment and groundwater reserves from potential contamination by chemical substances.

Confirming the commercial viability of these resources necessitates an extensive exploration program, comprising a minimum of 11 test wells and extending over a period of 7 to 13 years, as this assessment is corroborated by the U.S. Department of Energy's analysis of unconventional hydrocarbon reserves, which ranks Algeria third globally—after China and Argentina—in terms of technically recoverable shale gas resources.

The following table outlines the most significant shale gas basins in Algeria, which collectively hold an estimated 19,800 Bcm in resources.

Number	Basin	Estimated reserves
1	Ahnet	About 19800 trillion Cubic feet
2	Berkine	
3	Timimoun	
4	Reggane	
5	Tindouf	

Table showing the most important shale gas basins in Algeria.⁽⁸⁾

Seismic studies and exploratory efforts have confirmed that these basins contain substantial shale and clay sequences rich in organic matter, capable of generating significant quantities of unconventional gas, while the application of advanced techniques—such as horizontal drilling, hydraulic fracturing, and fracture modeling—collectively supports the feasibility of efficient shale gas extraction.

Algeria is further positioned to leverage international expertise through strategic partnerships with global energy firms, and the country benefits from an extensive network of pipelines and processing facilities extending from the south to the north, complemented by direct export routes to Europe, as detailed below:

- The Medgaz Pipeline, operational since 2011, transports gas directly from Algeria to Spain via the Mediterranean, with an annual capacity of 10 billion cubic meters.
- The Transmed Pipeline, functioning since 1983, delivers gas from Algeria to Italy through Tunisia, with an annual capacity of 32 billion cubic meters.
- The GME (Gaz Maghreb Europe) Pipeline, established in 1996, supplied gas from Algeria to Spain and Portugal via Morocco, with an annual capacity of 12 billion cubic meters; however, operations were suspended in 2021 due to political tensions with Morocco.⁽⁹⁾

This established infrastructure offers a distinct competitive advantage, as future shale gas production can be integrated into these systems—thereby reducing initial investment costs and enhancing export opportunities.¹⁰⁾

It is also important to emphasize that shale gas development contributes to enhancing national energy security on one hand, while diversifying revenue sources and reducing overdependence on traditional oil exports on the other, as it represents a strategic opportunity for Algeria to strengthen its influence in the global gas market, particularly amid rapidly evolving geopolitical dynamics.

Axis Three: Challenges of Relying on Shale Gas: Between Environmental Risks and Social Rejection

Despite Algeria's vast energy potential in shale gas—being ranked among the world's top ten countries in terms of recoverable reserves—the exploitation of this resource faces several structural, environmental, technical, and economic challenges.

First: Technical and Economic Challenges

Shale gas production relies on two main techniques—horizontal drilling and hydraulic fracturing—both of which are significantly more expensive compared to conventional gas extraction methods ⁽¹¹⁾.

The cost of a single shale gas well, for instance, exceeds 25 million USD, while its productive lifespan often does not extend beyond three years, and in certain regions, such as Poland, drilling costs are nearly three times higher than in the United States, primarily due to the lack of local extraction materials and the consequent need to import equipment—further increasing production expenses ⁽¹²⁾.

Algeria also faces financial constraints stemming from fluctuations in global oil and gas prices since 2014; these constraints are compounded by difficulties in mobilizing the necessary investments to develop this capital-intensive industry; consequently, the country's existing infrastructure remains largely oriented toward conventional gas, necessitating substantial additional investment in advanced and complex equipment⁽¹³⁾—particularly for obtaining accurate geological data, while experts suggest that it may take two to three years of exploratory drilling and analysis to identify the most promising shale gas production zones ⁽¹⁴⁾.

Second: Environmental and Social Challenges

Shale gas extraction entails environmental impacts comparable in certain respects to those associated with nuclear energy; hydraulic fracturing, in particular, releases

toxic gases—including methane, sulfur oxides, carbon monoxide, and carbon dioxide—which contribute significantly to global warming.

Furthermore, fracturing operations consume vast quantities of water, exacerbating water scarcity in arid regions and increasing the risk of chemical leakage and groundwater contamination. Additionally, the process of fracturing rock formations has been linked to induced seismicity, including minor earthquakes and landslides⁽¹⁵⁾.

These concerns have sparked widespread public opposition in Algeria, especially in the southern regions—such as Ain Salah and Illizi, where shale gas reserves are concentrated—leading to sustained popular protests since 2015; in response, the government has been compelled to suspend certain projects (16) and reconsider its strategic approach to shale gas development.

Third: Institutional and Geopolitical Challenges

The shale gas sector is further hindered by the absence of a comprehensive legal and regulatory framework; such a framework is essential to clearly define investment mechanisms, partnership models with foreign companies, and environmental safety standards, moreover, Algeria must balance the exploitation of its unconventional resources with its international commitments to energy transition and carbon emission reduction—particularly amid growing European emphasis on renewable energy sources, which situates shale gas investment within a complex web of strategic constraints. In addition, the highly competitive international environment—especially the dominance of the United States, which possesses advanced technical expertise—requires Algeria to enhance its own technical and regulatory capabilities to maintain its role as a reliable energy supplier⁽¹⁷⁾.

Conclusion

The issue of shale gas in Algeria represents one of the most strategic and multidimensional topics at the intersection of energy, economy, and environment; as one of the world's top holders of technically recoverable shale gas reserves, Algeria faces a historic opportunity to leverage these resources to enhance its energy security and diversify its economy beyond conventional hydrocarbons.

Nevertheless, despite this significant potential, the development of shale gas is confronted with multifaceted challenges. These include technical and economic obstacles—such as high extraction costs and substantial capital requirements—as well as environmental and social risks, particularly related to water scarcity and the vulnerability of desert ecosystems, while institutional and geopolitical constraints underscore the need for modernized legal frameworks and diversified international partnerships, especially within a global context increasingly oriented toward energy transition and carbon emission reduction.

Therefore, the future of shale gas exploitation in Algeria hinges on the state's capacity to formulate a comprehensive and balanced strategy, as such a strategy should incorporate the adoption of advanced technologies through international partnerships that facilitate knowledge transfer; the strengthening of institutional and regulatory frameworks to ensure transparency and sustainability; and the implementation of robust policies for water management and environmental protection. Equally critical is the active involvement of local communities in energy decision-making, which constitutes a fundamental prerequisite for social acceptance and the long-term viability of shale gas projects.

The true challenge, therefore, extends beyond merely harnessing shale gas as an alternative energy source. It lies in transforming this resource into a catalyst for structural economic change and sustainable development—underpinned by economic diversification, investment in scientific research, and technological mastery, and if Algeria can address these challenges through rational policymaking and long-term planning, shale gas may well evolve from a subsurface asset into a dynamic engine of economic growth, reinforcing the country's role as a key regional and global energy player in the coming decades.

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