

Natural Gas and Energy Transition in Algeria: Sovereignty, Security, and Strategy in a Changing Global Order

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Received: 04/05/2025

Accepted: 03/07/2025

Published: 20/07/2025

Abstract:

In a context of global energy transition and rising geopolitical tensions, this paper analyzes the strategic role of natural gas in Algeria's energy system. Using a multidisciplinary methodology that combines institutional analysis, statistical data review, and energy policy assessment, the study evaluates the dual role of natural gas as both a domestic energy pillar and an export asset. The findings highlight that while natural gas remains central to Algeria's energy security, rising domestic consumption and chronic underinvestment in infrastructure threaten the country's export capacity and long-term energy sovereignty. Moreover, without a coherent transition strategy integrating energy efficiency, subsidy reform, and the accelerated deployment of renewables and hydrogen, natural gas could hinder rather than support sustainable development. The paper concludes with key policy recommendations to reposition Algeria's energy governance within a resilient and forward-looking framework.

Keywords: Natural gas, Energy transition, Energy security, Rentier model, Energy mix diversification



I- Introduction:

Algeria faces a critical challenge in balancing its national energy security with the imperative of transitioning toward a more sustainable energy model. This dilemma is underscored by the country's growing domestic energy demand, which has more than doubled over the past two decades, increasing from 28 million tons of oil equivalent (MTOE) in 2000 to nearly 60 MTOE by 2022 (IEA, 2023). The nation's energy system remains structurally dependent on hydrocarbons, which still account for over 95% of energy exports. This reliance, compounded by aging infrastructure and underinvestment in low-carbon technologies, raises concerns about the long-term sustainability of the energy model.

Within this context, natural gas occupies a pivotal position. It is not only Algeria's most abundant and technically exploitable resource with proven reserves exceeding 2,400 billion cubic meters (BP, 2023) but also a relatively cleaner fossil fuel that can act as a bridge between a carbon-intensive past and a decarbonized future. Thanks to an established infrastructure of over 4,000 km of export pipelines and several LNG terminals, natural gas contributes to both domestic energy needs and export revenues, reinforcing its role in economic stability and energy sovereignty. Additionally, gas-fired plants help stabilize the grid and support the deployment of intermittent renewable sources, such as solar and wind.

However, this transitional potential is increasingly constrained. By 2022, domestic gas consumption reached nearly 70% of total production, thereby reducing the country's export capacity (Enerdata, 2024). In parallel, institutional fragmentation, regulatory inertia, and weak levels of foreign investment representing less than 2% of GDP undermine the effectiveness of energy governance (ISPI, 2024). These structural challenges call for a critical reassessment of Algeria's energy trajectory.

This article seeks to assess how natural gas can support Algeria's national energy security while contributing to a progressive transition toward a low-carbon energy system. The study's importance lies in its relevance to a growing number of fossil fuel-exporting countries that face similar dilemmas, particularly in the Global South. It also addresses a notable research gap in Algerian energy literature, where integrated assessments of gas as a transitional resource remain scarce.

This study adopts a qualitative and interdisciplinary methodology combining three complementary analytical lenses. First, it conducts an institutional and policy analysis, focusing on Algeria's energy governance structures, regulatory frameworks, and strategic planning documents. Second, it mobilizes quantitative data from authoritative sources such as the International Energy Agency (IEA), the Ministry of Energy and Mines (MEM), Sonatrach, and Enerdata to assess production, consumption, and export trends over time. This statistical review allows the identification of structural imbalances and the evaluation of the energy system's resilience.

Third, the article engages in a comparative literature review of peer-reviewed academic work on natural gas transitions in hydrocarbon-exporting economies, particularly in North Africa and the MENA region. This literature ranging from case studies (e.g., Egypt, Qatar) to theoretical contributions on energy rent, sustainability, and infrastructure lock-in serves as a critical benchmark for contextualizing Algeria's situation.

The triangulation of these approaches allows for a comprehensive and contextualized assessment, avoiding a purely technical or purely political reading of the issue. It also provides a basis for testing the three guiding hypotheses presented below, through an analytical structure organized around both macro-level energy security dimensions and micro-level institutional constraints. The core question that guides this work is: ***How can natural gas contribute to ensuring national energy security while enabling a sustainable energy transition in Algeria?***

To answer this, the article develops three central hypotheses. First, natural gas is a viable transitional energy source capable of ensuring short- and medium-term supply security while supporting the gradual deployment of renewables. Second, Algeria possesses significant comparative advantages reserves, infrastructure, and regional positioning that can reinforce its energy sovereignty. Third, domestic structural weaknesses, such as rising consumption, aging infrastructure, and weak governance, limit the optimal contribution of gas to the energy transition.

The article is structured into four main sections. The first examines the global role of natural gas in energy transition pathways and energy security strategies, highlighting its comparative advantages as a lower-carbon fossil fuel. The second analyzes Algeria's domestic context, focusing on geological potential, aging infrastructure, institutional fragmentation, and underinvestment. The third section explores the synergies between natural gas and the development of renewables and hydrogen, emphasizing its role as a transitional complement. The final section addresses the growing tension between domestic consumption and export capacity, proposing structural reforms to reposition natural gas within a sustainable and resilient energy model.

1. Natural gas: An energy source at the heart of transitions

At the intersection of sustainability challenges, energy security, and the transformation of production and consumption systems, natural gas is emerging today as a central energy vector in transition strategies. This position is based both on its physico-chemical properties and its ability to adapt to the new configurations of the global energy market. In a changing world, where the quest for balance between reducing greenhouse gas emissions, ensuring supply reliability, and maintaining economic accessibility is more urgent than ever, natural gas appears as a pragmatic compromise between present-day demands and future ambitions.

1.1. Natural Gas as a Low-Carbon Transitional Solution

Natural gas is frequently presented as a transition energy in the context of the gradual decarbonization of global energy systems. Its environmental profile is generally more favorable than that of other fossil fuels, especially coal and fuel oil. When burned, natural gas emits about 50% less CO₂ than a coal-fired power plant and about 30% less than an oil-fired plant for the same amount of electricity produced (Center for Climate and Energy Solutions, 2023).

Beyond this improved carbon footprint, natural gas also emits significantly fewer air pollutants: it generates very few fine particles and reduced quantities of sulfur dioxide (SO₂) and nitrogen oxides (NO_x), making it the least polluting fossil fuel. This relatively clean profile contributes to an overall reduction in emissions when it replaces more polluting energy sources, as observed in some Asian countries that have progressively shifted from coal to natural gas (IEA, 2022). The following table (1) summarizes CO₂ emissions and average energy efficiency of major electricity production sources:

Tab (1): Comparison of CO₂ emissions and average efficiency of main electricity sources

Energy source	CO ₂ Emissions	Average efficiency (%)
Coal	820	35 %
Fuel Oil	650	38 %
Natural Gas	410	60–70 % (combined cycle)

Sources: Center for climate and energy solutions, 2023.

From a technical standpoint, combined-cycle gas power plants stand out for their high energy efficiency, reaching thermal yields of 60 to 70%, nearly double that of coal or oil-fired plants. These plants use both a gas turbine and a steam turbine simultaneously, which allows for better recovery of the heat produced and thus optimizes the amount of electricity generated from a given volume of fuel.

Another major advantage lies in the operational flexibility of gas. Unlike nuclear or coal power plants, gas plants can respond quickly to demand fluctuations. This modulation capacity is essential for stabilizing electricity grids that integrate intermittent renewable energies such as solar or wind. In the event of a shortfall in renewable generation, gas turbines can immediately step in, ensuring continuity of supply.

Existing gas infrastructure offers a strategic asset for the energy transition, as it can be adapted to carry low-carbon gases like biomethane or hydrogen, and support carbon capture technologies to lower net emissions.

1.2. The strategic role of natural gas in global energy security

Natural gas has emerged today as a central pillar of global energy security. Initially seen as a transitional energy source with lower carbon intensity than coal or oil, it is now asserted as a strategic resource at the intersection of energy, economic, and geopolitical concerns (IEA, 2023, p. 35). The strong growth in global demand (+80% between 1995 and 2022) has increased its share to approximately 24% of total global energy consumption (IEA, 2023, p. 37).

This momentum is driven both by the expansion of extraction capacities particularly shale gas in the United States and the massive development of gas infrastructure: pipelines, liquefaction terminals, and floating regasification units (BP, 2023, p. 18). This logistical diversification has strengthened the resilience of the international energy system by providing flexibility in the face of supply shocks.

Liquefied natural gas plays a structuring role. Its logistical flexibility allows countries to bypass the geographical constraints of pipelines, encouraging a broader diversification of suppliers and a rise in spot trading. The gas market, long regional and tied to long-term oil-indexed contracts, is evolving toward a more fluid and transparent system (IEA, 2023, p. 45). LNG has thus become a key driver of market transformation and a strategic tool for exporting countries such as the United States, Qatar, and Algeria, who see it as a means of projecting geopolitical influence (BP, 2023, p. 22).

The war in Ukraine marked a turning point: by revealing Europe's energy dependence on Russian gas (over 40% before 2022), it triggered an accelerated reconfiguration of supply routes (IEA, 2023, p. 49). European LNG imports jumped from 135 to 180 billion cubic meters between 2021 and 2023 a 33% increase (see Table 2) thanks to deliveries from the United States (+143%), Qatar (+23%), and even Russia (+12%) via maritime routes (BP, 2023, p. 22). At the same time, Russian pipeline gas deliveries dropped from 78.8 to 42.9 billion cubic meters (IEA, 2023, p. 51).

Tab (2): Evolution of European LNG imports (2010–2023)

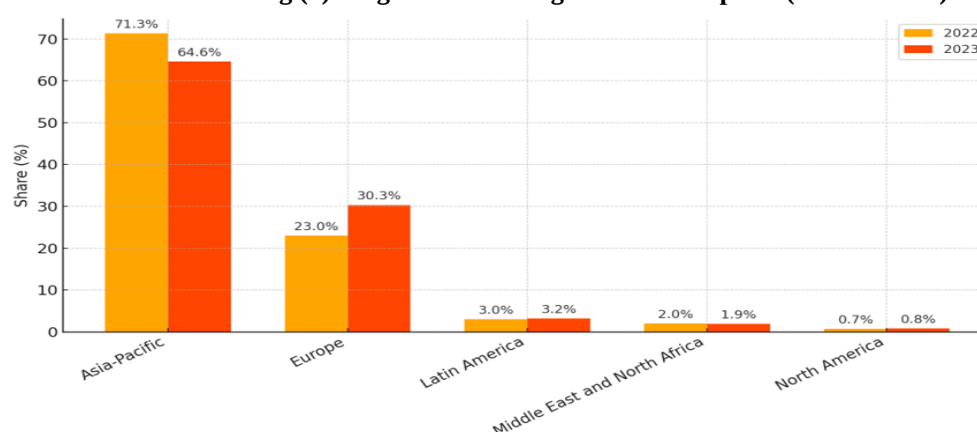
Year	2010	2020	2021	2022	2023
Volume (in billion m³)	80	130	135	155	180

Source: IEA (2023), *LNG Imports of Selected Regions, 2010–2023*, IEA, Paris.

This evolution confirms the shift from a rigid supply model to a more flexible energy architecture. Through this transformation, Europe seeks to strengthen its energy sovereignty in a context of growing geopolitical instability.

Beyond the European case, global LNG import trends show a relative shift in the center of gravity of the gas market: while the Asia-Pacific region remains the largest importer, its share declined from 71.3% in 2022 to 64.6% in 2023, whereas Europe's share rose from 23% to 30.3% (see Figure (1)) a redistribution that reflects a new energy power dynamic (GECF, 2024, p. 17).

Fig (1): Regional share of global LNG imports (as % of total)



Source: Gas exporting countries forum (GECF), 2024

1.3. The limitations of relying on natural gas as a long-term solution

Although it offers several advantages, natural gas remains a fossil energy source whose use presents significant limitations, particularly in the context of a long-term energy transition. From an environmental perspective, it continues to emit greenhouse gases. In addition to the carbon dioxide (CO₂) released during combustion, natural gas is primarily composed of methane (CH₄), a gas with an extremely high global warming potential: over a 20-year period, it is approximately 84 to 86 times more potent than CO₂ (IPCC, Sixth Assessment Report Working Group I, 2021).

Methane emissions throughout the gas value chain are often underestimated. Leaks can occur at every stage extraction, processing, transport, and distribution potentially offsetting the climate benefits associated with the comparatively "cleaner" combustion of gas versus coal. According to the International Energy Agency (Global Methane Tracker, 2022), methane emissions from the gas sector remain significantly underreported, undermining efforts to mitigate global warming. Without strict monitoring and effective reduction of these fugitive emissions, natural gas may continue to contribute substantially to climate disruption.

Another critical issue is the risk of carbon lock-in. Investments in heavy infrastructure pipelines, gas-fired power plants, and liquefied natural gas (LNG) terminals require long-term profitability, often spanning several decades. This amortization logic slows down the transition toward low-carbon energy sources. Sartor et al. (2022), writing in *Energy Research & Social Science*, emphasize that natural gas can hinder sustainable energy transitions by reinforcing technological lock-in and exposing economies to increasing risks of stranded assets, especially if global gas demand declines more rapidly than expected.

Thus, positioning natural gas as a long-term solution increases dependence on fossil fuels and raises the likelihood of prematurely abandoning costly infrastructure. For this reason, many experts advocate that its use be restricted to a short and controlled transition phase. Natural gas can serve as a bridge to stabilize intermittent energy systems, but it must not delay the large-scale deployment of renewable energy. Additionally, efforts to "green" gas networks such as by injecting biogas or hydrogen while useful, are not sufficient to justify the prolonged maintenance of the traditional gas sector.

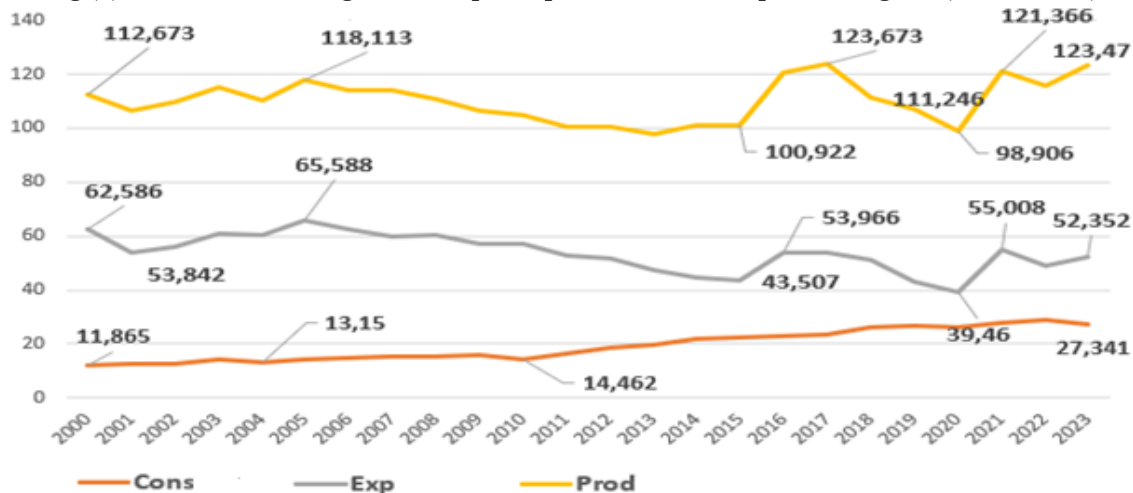
2. Algeria's gas challenge in a context of energy transition and sovereignty

In a global context marked by an accelerating energy transition and the reshaping of geopolitical balances, natural gas holds a strategic position in Algeria's energy architecture. As a key component of the national energy mix, it serves both as a lever for internal transformation of the energy system and as a tool for asserting influence on regional and international stages. However, for this resource to effectively support sustainable development and sovereignty objectives, its governance must be rethought in light of emerging economic, technological, and environmental challenges. This section thus analyzes the central role of gas in Algeria's energy economy, assesses the existing geological and infrastructural potential, and identifies the key levers necessary for a controlled and sustainable transition.

2.1. A Cornerstone resource in the national energy mix

Natural gas plays a decisive role in Algeria's energy system. With lower carbon emissions than coal or oil, it lies at the heart of energy sovereignty policies and efforts to secure electricity supply. Thanks to abundant conventional and unconventional resources (notably shale gas), Algeria has structured its energy model around this resource, which accounts for over 54% of national primary energy production (IEA, 2023).

Fig (2): Trends in natural gas consumption, production, and exports in Algeria (in billion m³)



Source: Prepared by the author based on data from the ministry of energy and mines.

The analysis of Graph 2 highlights a continuous increase in domestic consumption since the 2000s, peaking at 28.93 billion m³ in 2022 before slightly declining to 27.34 billion m³ in 2023. This trend is mainly driven by the residential, tertiary, and agricultural sectors, which together account for approximately 66% of total consumption, primarily for domestic uses such as heating, cooking, and hot water. The industrial sector also remains a major consumer, absorbing around 33% of national demand (MEM, 2023).

Furthermore, natural gas plays a central role in electricity production through combined-cycle power plants, offering flexibility and stability to the grid. This function is all the more crucial as renewable energies (solar, wind) still struggle to establish a lasting foothold in the national energy mix (IEA, 2023).

However, this sustained growth in domestic demand is generating structural tensions. Between 2021 and 2023, a slight decrease in consumption was observed (from 28.1 to 27.3 billion m³), but this trend remains insufficient to ease the pressure on export volumes. At the same time, national production rose from 101.43 billion m³ in 2022 to 105.48 billion m³ in 2023, reflecting strengthened extraction capacities. Nevertheless, exports declined from 55 billion m³ in 2021 to 52.35 billion m³ in 2023 (OPEC, 2023), illustrating a growing tension between internal needs and international commitments.

Long-term trend analysis, particularly between 2005 and 2015, shows a gradual erosion of exportable volumes due to the constant rise in domestic consumption. If this trajectory persists, it could reduce Algeria's room for maneuver in external markets, weaken its energy diplomacy, and compromise the profitability of its gas contracts.

Thus, although natural gas represents an essential strategic asset for Algeria ensuring internal stability and external influence this dual role calls for proactive governance based on energy efficiency, rationalized consumption, and investment in low-carbon alternatives. Such an approach is key to preserving national energy sovereignty in a rapidly evolving international context.

2.2. Geological and infrastructural potential serving regional influence

The strategic importance of natural gas for Algeria goes far beyond its national borders. With nearly 4,500 billion cubic meters of proven reserves, Algeria ranks as Africa's third-largest holder after Nigeria and Egypt, and tenth worldwide (BP Statistical Review, 2023). This energy potential grants the country a pivotal role on the global energy stage, especially for a Europe eager to secure its supplies in the post-Russia-Ukraine crisis context.

This position is reinforced by a dense and diversified export infrastructure network, which serves as a strategic lever to enhance Algeria's energy influence. On one hand, the country operates several major export gas pipelines. The TransMed pipeline, connecting Algeria to Italy via Tunisia, is the main axis, with a transit capacity of 33.5 billion cubic meters per year. Added to this is the Medgaz pipeline, directly linking Algeria to Spain, whose capacity was increased to between 12 and 14 billion cubic meters per year since 2022 following expansion work. Lastly, the Maghreb-Europe Gas Pipeline (GME), which passes through Morocco to reach Spain, had a capacity of 10.5 billion cubic meters per year before its operation was suspended in 2021 due to diplomatic reasons.

On the other hand, Algeria owns significant liquefied natural gas facilities, mainly located in Arzew and Skikda. These complexes have a total liquefaction capacity of around 30 billion cubic meters per year. However, their effective utilization remains below 50% of their nominal capacity, due to technical limitations, a lack of investment, and aging infrastructure. This situation underlines the need to launch ambitious modernization and rehabilitation programs to restore their full operational potential.

Table (3) below summarizes the theoretical and actual export capacity of Algeria's main gas infrastructures:

Tab (3): Algeria's natural gas export capacities by main infrastructures

Infrastructure	Total capacity (bcm/year)	Estimated utilized capacity (bcm/year)	Remarks
TransMed (to Italy via Tunisia)	33.5	30	Main export route; operational and optimized
Medgaz (to Spain)	12–14	12	Capacity reinforced since 2022
GME (via Morocco, suspended)	10.5	0	Suspended since 2021 for diplomatic reasons
LNG (Arzew and Skikda plants)	30	13–15	Utilization rate below 50% due to technical constraints

Source: Compiled from sonatrach, ministry of energy, BP statistical review (2023).

This table highlights, on the one hand, the predominant role of the TransMed pipeline in Algeria's exports, and on the other, the significant growth potential of the LNG sector, whose modernization could substantially enhance Algeria's competitiveness in European and Asian markets.

In an international context marked by the reorganization of gas flows and Europe's quest for energy diversification, this infrastructure arsenal represents a strategic opportunity for Algeria. It could not only consolidate its position as a major alternative supplier of natural gas, but also serve as a foundation for developing new low-carbon energy sectors, such as flexible LNG, blue hydrogen produced from gas with CO₂ capture, and carbon capture and storage technologies, in line with global carbon neutrality goals.

2.3. Rethinking natural gas governance for a controlled transition

Although natural gas currently plays a central role as an energy buffer and a lever for transitioning to a low-carbon model, it cannot be seen as a sustainable long-term solution. Its status as a fossil fuel exposes it to increasing pressures from climate challenges, market volatility, and new international environmental requirements. In this context, it is urgent for Algeria to adopt renewed governance capable of anticipating global transformations and safeguarding national energy interests.

The first strategic challenge lies in controlling domestic natural gas consumption, which continues to rise, thereby reducing volumes available for export. To reverse this trend, it is necessary to rationalize energy use in the residential, industrial, and transport sectors, while modernizing distribution networks to reduce technical losses. A proactive policy of raising awareness among users about energy-efficient behaviors, supported by economic and educational incentives, would also help trigger a genuine dynamic of energy efficiency.

At the same time, Algeria must accelerate the development of renewable energy sources, starting with photovoltaic solar energy, which represents a credible alternative to natural gas for electricity production. The country's exceptional solar potential, especially in Saharan regions, is a strategic opportunity to diversify the energy mix, reduce greenhouse gas emissions, and free up gas volumes for export. The gradual integration of these renewable sources into the national grid would contribute to building a more resilient and less hydrocarbon-dependent energy transition.

Finally, modernizing and diversifying the energy supply appears to be essential for preserving Algeria's competitiveness in international markets. This involves rehabilitating aging gas infrastructure, as well as investing in innovative technologies such as flexible-use liquefied natural gas, green hydrogen, and carbon capture and storage systems. Strengthening strategic partnerships with foreign players, particularly in Europe and Asia, is also crucial for expanding export opportunities and benefiting from knowledge transfer.

By structuring its governance around these three pillars energy efficiency, renewable energy development, and technological innovation Algeria can consolidate its energy sovereignty while preparing for a more sustainable model. It would thus equip itself to enhance its economic resilience in the face of global uncertainties, while asserting its role in the emerging global energy landscape (IEA, 2023).

In summary, this section reveals that while Algeria's gas sector benefits from significant geological potential and a dense export infrastructure network, it remains structurally hindered by deep governance deficiencies, limited investment, and poor institutional coordination. These findings are consistent with previous studies that highlight the vulnerability of rentier-based energy systems in North Africa (Aïssaoui, 2016; Bouznit & Pablo-Romero, 2016; ISPI, 2024). The chronic underutilization of gas infrastructure, coupled with persistent legal uncertainty and weak incentives for investors, confirms the urgency of a comprehensive reform of Algeria's energy governance model. Such reform is necessary to reconcile domestic energy needs with export ambitions and to secure long-term energy sovereignty in a rapidly evolving global energy landscape.

3. Natural gas in Algeria's energy transition

At the crossroads of climate requirements, national budgetary constraints, and global geopolitical reconfigurations, Algeria is called upon to profoundly rethink its energy model. In this transformation, natural gas stands out as a structuring vector of the energy transition: it combines local abundance, technological mastery, and adaptability potential, while serving as a realistic bridge between a carbon-based system and a decarbonized future (Aïssaoui, 2016, p. 102).

3.1. Natural gas as a strategic substitute for heavy fossil fuels

In many industrial and rural areas of Algeria, the use of heavy fossil fuels especially heavy fuel oil and diesel remains widespread. These high-carbon, costly fuels generate a negative environmental footprint while weakening national energy performance (IEA, 2023, p. 35). In light of this, natural gas emerges as an economically rational and environmentally responsible alternative.

In the industrial sector particularly in steel, cement, and agri-food industries integrating natural gas could yield several benefits. The reduction of CO₂ emissions is a major advantage, as natural gas combustion emits about 50% less CO₂ than coal and 30% less than oil (IEA, 2023, p. 37). This would significantly contribute to the country's decarbonization trajectory. Furthermore, gas-powered installations improve production units' energy efficiency, resulting in cost reductions and increased competitiveness of Algerian products in international markets. This transition also promotes faster alignment with international environmental standards, thereby strengthening Algeria's credibility in multilateral climate agreements (UNFCCC, 2021, p. 11).

In rural areas, especially in the south and the High Plateaus, diesel-powered generators remain common. These machines are noisy, polluting, and costly to maintain. Developing gas-powered mini-plants could provide a more stable, cost-effective, and

sustainable solution. Access to stable energy would significantly enhance electricity quality essential for both domestic comfort and local productive activities. Additionally, lower operating costs related to maintenance and fuel supply would help reduce local energy bills. This energy transition would also serve as a powerful tool to combat energy poverty by ensuring reliable and affordable energy supply, unlocking marginalized regions, and promoting their integration into the national development dynamic (World Bank, 2022, p. 54).

3.2. Supporting the rise of renewables and hydrogen

Beyond its role in replacing more carbon-intensive fossil fuels, natural gas plays a structuring role in the energy transition dynamic, particularly in Algeria. It is a technical and strategic lever to support the deployment of renewables and foster the emergence of a competitive hydrogen sector.

The analysis of Table (4) below highlights the strategic complementarity between natural gas, renewable energy, and blue hydrogen three fundamental levers of the energy transition in Algeria. It provides an overview of the strengths and limitations specific to each of these vectors, while underlining their potential synergies within an optimized energy mix.

Tab (4): Strategic complementarity between natural gas, renewable energies, and blue hydrogen

Criteria	Natural gas	Renewable energies	Blue hydrogen
Availability	Abundant resource with existing infrastructure	Very high potential (solar, wind)	Depends on natural gas and carbon capture capabilities
Operational flexibility	Very high (flexible combined-cycle power plants)	Low (intermittent, requires storage or backup)	Medium (possible continuous production with planning)
Initial investment	Moderate (existing or depreciated infrastructure)	High (new facilities and network adaptation required)	Moderate to high (cost of CCS and transport)
Carbon impact	Less polluting than coal and oil, but not carbon neutral	No direct emissions	Reduced emissions if CCS is properly deployed
Export Capacity	Historical export via pipelines or LNG	Limited export (local electrification needed first)	Strong potential for export to Europe and the Mediterranean

Sources: Prepared by the author based on IEA data (2021a, 2021b)

On the one hand, integrating renewable sources such as solar and wind faces a major obstacle: intermittency. Variations in production due to weather conditions require backup generation systems that are flexible and responsive. Combined-cycle gas-fired plants are ideally suited for this role, as they can quickly respond to demand and maintain grid stability during renewable production shortfalls (IEA, 2021a, p. 12).

On the other hand, Algeria's potential for blue hydrogen produced from natural gas using carbon capture and storage (CCS) technologies represents a strategic opportunity. Requiring less infrastructure than green hydrogen, it would not only allow Algeria to leverage its national gas resources but also position the country as a regional player in future low-carbon energy alliances (Bloomberg NEF, 2023, p. 4).

Thus, the dual role of natural gas supporting renewable integration and forming the foundation for a low-carbon hydrogen sector is clearly illustrated through these synergies.

3.3. Removing structural barriers to make natural gas a driver of the energy transition

For natural gas to fully assume its role as a lever in Algeria's energy transition, several structural obstacles must be removed. Table (5) below summarizes the main barriers and levers related to this transformation pathway. One of the major challenges lies in the rapid growth of domestic consumption, driven by subsidized pricing, low energy efficiency, and increasing urbanization. If this trend continues unchecked, it may compromise export capacity and weaken the country's foreign revenues (IEA, 2021a, p. 23).

In addition, there is a chronic lack of investment in production, transport, and distribution infrastructure. The aging of equipment, technical losses in the network, and delays in pipeline modernization are major obstacles to the sector's performance (Sonatrach, 2022, p. 15).

Moreover, the regulatory environment suffers from legal instability and a lack of incentive clarity, which discourages private investors and limits the introduction of new technologies. Creating a competitive gas market requires a deep reform of the institutional framework, particularly regarding pricing, regulation, and access to infrastructure (Oxford Institute for Energy Studies, 2023, p. 9).

To overcome these obstacles, a systemic and integrated approach is essential. This should combine robust energy efficiency policies, territorial planning tailored to local specificities, transparent and coordinated energy governance, and the strengthening of national capacities human, technical, and institutional.

From this perspective, natural gas should not be seen as an end in itself, but as a strategic vector of transition. It can serve as a bridge between a legacy, carbon-intensive energy model and a more sustainable one based on diversification, energy sobriety, and renewable energies.

Table (5): Key barriers and levers for making natural gas a driver of the energy transition

Categories	Identified barriers	Proposed levers for action
Domestic consumption	Rapid uncontrolled growth, generalized subsidies	Gradual pricing reform, awareness campaigns, energy efficiency standards
Infrastructure	Aging networks, lack of investment, technical losses	Network modernization, targeted public-private investments
Regulatory framework	Legal instability, lack of private sector incentives	Legislative reform, creation of an independent regulatory authority
Governance and skills	Institutional fragmentation, lack of training	Intersectoral coordination, capacity building, international partnerships
Strategic vision	Gas seen as a short-term rent resource	Gas repositioned as a transition vector and enabler of renewables integration

Sources: Prepared by the author based on IEA data (2021a) and Sonatrach documents.

Overall, this section highlights the strategic potential of natural gas as a transitional fuel in Algeria both as a cleaner substitute for heavy fossil fuels and as a support mechanism for integrating renewables and developing a hydrogen economy. These findings align with international perspectives that frame gas as a “bridge fuel” in the energy

transition (IEA, 2021; Medlock, 2021), while also bringing to light structural and institutional barriers that resonate with challenges experienced across the MENA region. By emphasizing Algeria's unique endowments and institutional context, the analysis contributes to the regional literature on low-carbon transitions, underscoring the importance of addressing systemic constraints to fully leverage gas as a transition enabler.

4. Natural gas: A pillar of national energy security

In a global context marked by energy market volatility, geopolitical tensions, and climate transition imperatives, Algeria stands at a strategic crossroads. Natural gas an abundant resource and historically central to the national energy mix remains a key lever for the country's energy security. However, growing dependence on a single resource, without adequate diversification, exposes Algeria to both internal and external vulnerabilities.

4.1. Rapidly growing domestic demand: between stability and pressure on resources

In 2023, domestic consumption of natural gas in Algeria reached approximately 60 billion cubic meters, marking a 12% increase compared to 2020 (Enerdata, 2024). This sustained growth is attributable to several factors, including rapid urbanization, the expansion of housing programs, and increasing industrialization.

Figure (3) below illustrates the sectoral breakdown of this consumption. Electricity generation is the main consuming sector, accounting for 42% of natural gas use, followed by residential and tertiary sectors (24%), industry (19%), and the hydrocarbon sector (15%) (Enerdata, 2024).

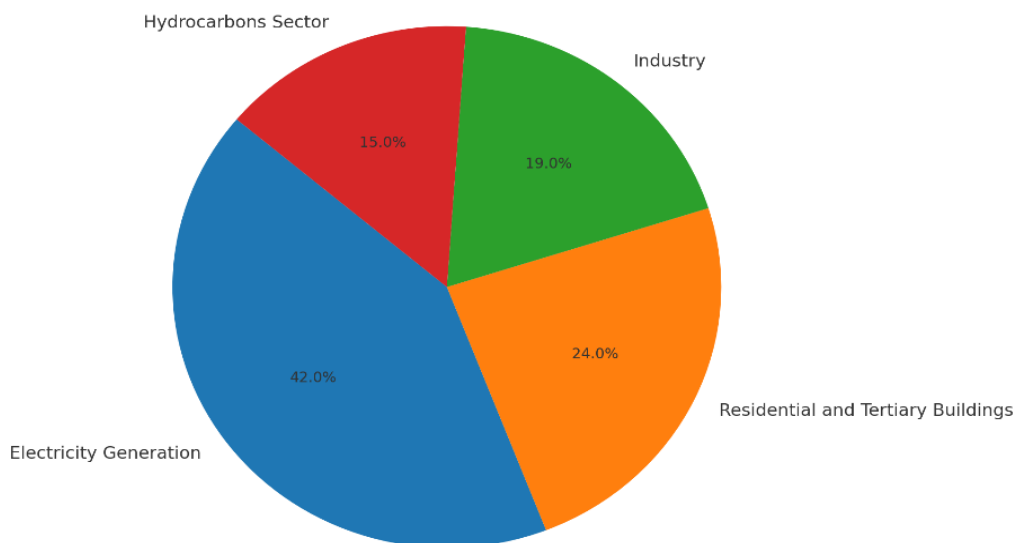
This consumption pattern highlights Algeria's increasing reliance on natural gas to meet its essential energy needs, particularly for electricity generation. While the national gasification program has enabled broad territorial coverage, this dynamic is placing growing pressure on the production and distribution capacities of Sonatrach and Sonelgaz. If this trend continues unchecked, it could compromise the country's ability to fulfill its export commitments, threatening foreign exchange revenues and national economic stability.

This dependence creates a double effect. On the one hand, it reinforces short-term national energy stability by supplying households, social infrastructure, and industrial units. On the other hand, it strains the production and distribution capacities of Algeria's two energy system pillars: Sonatrach, responsible for upstream gas activities, and Sonelgaz, in charge of distribution and electricity production.

If this trend continues without structural adaptation, Algeria may reach a tipping point where domestic demand exceeds supply capacity. Such a scenario would significantly restrict export volumes, endangering Algeria's contractual commitments to foreign particularly European partners. This would not only undermine vital foreign currency revenues, essential for maintaining the balance of payments, but also damage the country's energy credibility on the international stage.

This situation calls for an urgent strategic reassessment, combining improved energy efficiency, diversification of the energy mix, and massive investment in gas transport and storage infrastructure. Only under these conditions can natural gas continue to play its role as a stabilizer without becoming a source of medium-term vulnerability.

Fig (3). Sectoral breakdown of domestic natural gas consumption in Algeria in 2023



Source: Prepared by the author based on Enerdata (2024).

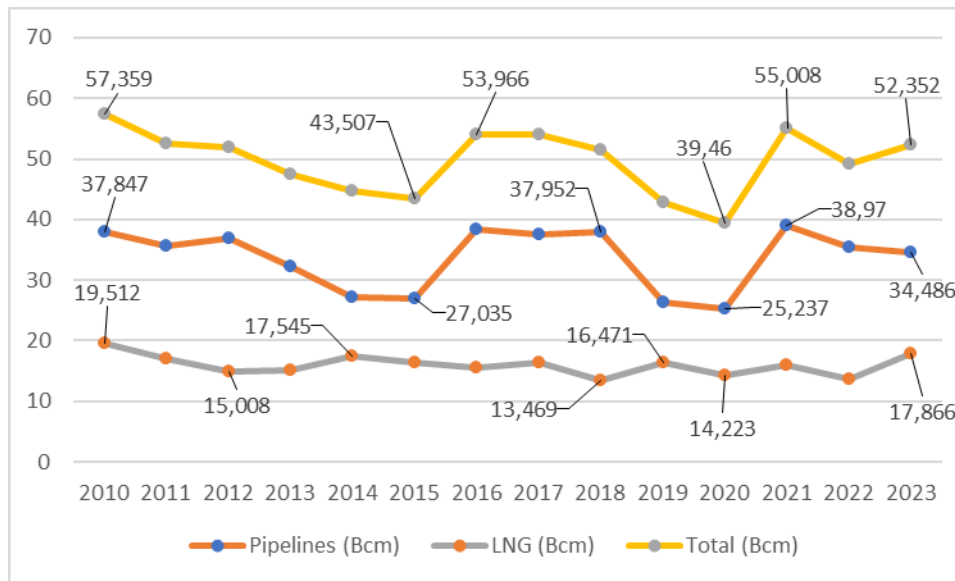
4.2. A Strategic Export Capacity Under Pressure

Algeria retains a key position in the global natural gas market, ranking as the 7th largest exporter in 2023, with a total volume of 52.352 billion cubic meters (bcm). This volume is divided between 34.486 bcm delivered via pipelines mainly to Europe and 17.866 bcm exported as liquefied natural gas (International Gas Union, 2024, p. 15). This performance reinforces Algeria's strategic role in Europe's energy supply, especially in a geopolitical context shaped by the war in Ukraine, which has prompted the European Union to seek alternatives to Russian gas (Fitch Solutions, 2024, p. 2).

However, this export capacity remains fragile, as it is under increasing pressure from domestic demand. Forecasts indicate a steady rise in domestic natural gas consumption, growing from 52.4 bcm in 2024 to 57.3 bcm by 2033, driven by demographic growth, rapid urbanization, and the increasing energy needs of industrial sectors (ISPI, 2024, p. 4). This dynamic tends to reduce the volume available for export, especially in a context where national production is stagnating, affected by aging gas infrastructure and insufficient investment in exploration and capacity renewal (IEA, 2023, p. 79).

An analysis of the evolution of Algerian gas exports from 2010 to 2023 (see Figure (4)) reveals significant fluctuations. After peaking at 57.359 bcm in 2010, volumes have shown a generally declining trend, reaching a low of 39.460 bcm in 2020, partly due to the combined effects of falling international prices and the COVID-19 crisis. Although exports rebounded to 52.352 bcm in 2023, this level remains below that of the early 2010s. This underscores the structural tension between rising domestic demand and constrained exportable supply.

Fig (4): Evolution of Algeria's natural gas exports (2010–2023)



Source: Compiled by the author based on data from the ministry of energy and mines

Finally, Algeria's structural dependence on hydrocarbon revenues is an aggravating factor. For several decades, over 90% of the country's export earnings have come from the energy sector (ISPI, 2024, p. 2). A reduction in exportable volumes, combined with the volatility of global prices, can seriously impact macroeconomic balances, reduce foreign exchange reserves, and hinder the financing of the energy transition particularly in the still underdeveloped solar and wind sectors (IEA, 2023, p. 115).

4.3. The Limits of a Hydrocarbon-Centered Energy Model

Algeria's energy model, based on the extensive exploitation of hydrocarbons, is now showing signs of structural vulnerability. This near-exclusive dependence on oil and natural gas which account for over 93% of the country's primary energy production (MEM, 2023, p. 12) raises multiple economic, environmental, and geostrategic concerns.

One of the primary limitations of this model lies in the progressive saturation of the domestic market. National energy consumption has been growing steadily, at an estimated rate of about 3% per year for more than a decade (IEA, 2022, p. 54), due to demographic pressure, widespread subsidies, and the energy-intensive nature of the economic structure. This trend poses a risk to Algeria's ability to meet its export commitments, especially amid stagnating or even declining natural gas production.

Moreover, the national economy's vulnerability to fluctuations in international hydrocarbon prices remains a recurring source of fragility. The drop in oil prices between 2014 and 2020 led to a decline of more than 50% in export revenues, severely affecting budgetary balances and highlighting the country's excessive reliance on external income (IMF, 2021, p. 23).

Algeria's delay in implementing a genuine energy transition further exacerbates this fragility. While many hydrocarbon-producing countries are heavily investing in renewable energy and low-carbon technologies, the share of renewables in Algeria's energy consumption remains marginal below 2% in 2023 (IEA, 2023, p. 47). This situation increases the risk of the country being sidelined in the global energy transition.

From an environmental standpoint, maintaining a fossil fuel-based model complicates Algeria's ability to meet its international commitments under the Paris Agreement. The country has pledged to reduce its carbon intensity by 7% to 22% by 2030, but the lack of a clear decarbonization strategy may jeopardize these goals (Ministry of Environment, 2021, p. 8). In addition, there is a growing risk of international pressure, particularly through mechanisms like the European Union's carbon border adjustment.

In response to these limitations, Algeria has initiated certain reforms aimed at shifting its energy model. The creation in 2020 of a Ministry of Energy Transition and Renewable Energies marked an important step in the institutional recognition of these issues (U.S. International Trade Administration, 2020). The national program notably plans to install 3,200 megawatts of solar capacity by 2025 and 15,000 megawatts by 2035 (Agenzia Nova, 2025).

At the same time, initiatives are emerging around hydrogen development particularly green and blue hydrogen seen as strategic levers for diversifying the energy supply and positioning Algeria in low-carbon export markets. The launch of a national hydrogen roadmap in 2023 reflects this direction (Green Hydrogen Organization, 2023, p. 6).

However, despite these positive signals, the transition remains slow, fragmented, and faces major challenges in terms of financing, governance, and policy coordination. An integrated and coherent energy strategy is necessary to break the rentier dependency, ensure national energy security, and align Algeria with global sustainability dynamics.

4.4. Toward a strategic repositioning of Algeria's energy model

Given the structural limitations of a hydrocarbon-based energy model, Algeria is at a strategic crossroads. A deep transformation of its energy system has become urgent, centered around three fundamental pillars: diversifying the energy mix, improving energy efficiency, and gradually integrating clean technologies.

First, a proactive policy to rationalize domestic consumption is essential. The rapid increase in national energy demand is putting growing pressure on production capacity, threatening the balance between domestic consumption and exports. A gradual reform of the subsidy system often criticized for its economic inefficiency and inflationary effects is a crucial step. This must be accompanied by the gradual electrification of uses still dominated by fossil fuels, particularly in the residential and transport sectors, as well as the introduction of stricter energy efficiency standards, especially in industry and construction.

In parallel, the massive development of renewable energy must be based on a coherent strategic vision supported by a transparent and incentivizing regulatory framework. Success in this transition requires strengthening public tender mechanisms, adopting feed-in tariffs, and creating an investment-friendly environment for both domestic and foreign investors. Strengthening the local solar and wind equipment industry could also stimulate the creation of skilled jobs and the emergence of a competitive industrial base.

Finally, in this energy transition trajectory, natural gas still plays a central role but that role must evolve. It can serve as a transitional energy source if integrated into a long-term strategy oriented toward carbon neutrality. This includes the development of carbon capture and storage (CCS) technologies, low-carbon hydrogen production via reforming gas with CO₂ capture or electrolysis powered by renewables and the export of green electricity to European markets.

This strategic repositioning calls for renewed energy governance, centered on intersectoral coordination, the mobilization of financial resources, and the enhancement of technical capacities. The goal is not to abruptly break away from hydrocarbons, but to embed them in a structured, gradual transition aligned with international climate commitments. As the International Energy Agency (IEA, 2023) emphasizes, fossil fuel exporting countries must adapt their energy models to ensure economic resilience in the face of profound changes in global energy markets.

This section confirms the central but fragile role of natural gas in Algeria's current energy security. The tension between rising domestic demand and stagnating export capacity reflects a structural vulnerability that has been widely acknowledged in the literature (OME, 2022; IEA, 2023). Moreover, the persistence of a hydrocarbon-centric model delays the necessary diversification of the energy mix and weakens Algeria's ability to adapt to global market shifts. These findings support recent calls for a more coherent and integrated energy strategy, in line with the long-term sustainability goals identified by both national and international institutions.

Conclusion

At a time when energy security has become both a geopolitical imperative and a developmental challenge, Algeria stands at a pivotal juncture in its energy trajectory. Faced with rising domestic demand, stagnant export capacity, and increasing international pressure to decarbonize, the country must urgently reconsider its rent-based hydrocarbon development model. In this context, natural gas represents a strategic intermediary less carbon-intensive than oil or coal, while still ensuring supply reliability and generating vital export revenues.

This study has demonstrated that natural gas can play a key role in enabling a more sustainable energy transition for Algeria. However, unlocking this potential requires comprehensive structural reforms. These include modernizing gas infrastructure, reducing domestic consumption, enhancing energy efficiency, and fostering a governance framework that facilitates investment and innovation particularly in renewable energy and low-carbon technologies such as hydrogen and carbon capture and storage.

That said, the study has limitations. It relies primarily on secondary data and institutional analysis and does not include original fieldwork or quantitative modeling. Future research could address these gaps through empirical case studies on infrastructure performance, consumer behavior, or the implementation of pilot renewable energy projects. Comparative studies with other hydrocarbon-exporting countries in the MENA region such as Egypt, Qatar, or the United Arab Emirates could also offer valuable policy insights and help assess governance models under transition constraints.

Furthermore, while the article incorporates selected regional academic sources (e.g., Aïssaoui, 2016; Bouznit & Pablo-Romero, 2016; OME, 2022), further efforts are needed to include peer-reviewed literature produced within Algerian academic institutions. This would strengthen the endogenous knowledge base and provide a more nuanced understanding of the national context.

Ultimately, Algeria's energy sovereignty in an increasingly carbon-constrained world will depend not only on using natural gas as a transitional resource, but also on embedding it within a long-term strategic vision built on diversification, institutional resilience, and regional cooperation. The country must seize this critical opportunity to reshape its energy future before structural constraints or external shocks render the transition no longer a strategic choice, but an unavoidable necessity.

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