TIMES-DZA PROSPECTIVE MODELING IN ALGERIA – SHALE GAS DEVELOPMENT STRATEGY AS A WAY OUT OF ENERGY DILEMMA

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Overview

In Algeria, which is considered a substantial energy-dependent country, the oil and natural gas industries are faced with numerous challenges, mainly: excessive external dependency in terms of revenue, steadily declining reserves, and a major energy dilemma that consist of the rapid erosion of the export share of gas and oil, and growing internal natural gas demand[1], [2]. Given these unfavorable circumstances and the continuing drop in oil prices, which worsens the country's economic situation, joining in on the current trend for shale gas development could potentially be Algeria's avenue of escape. Many believe that by becoming a shale producer, Algeria can meet its domestic energy needs and reinforce its export volume to Europe[3].

Endowed with the third-largest shale gas reserves (707tcf of technically recoverable gas, after China and Argentina) [4] (about 20tcm, five times the current gas reserves), as well as a solid foundation of the gas industry and export infrastructure[5], Algeria plays an essential role in the global gas market. The country is the sixth-largest exporter of natural gas globally and is Europe's largest one, and a pioneer in the LNG industry. As for Algeria's significant shale oil resources with an enormous potential of 200bb, of which 10% (20bb) are recoverable, they amount to almost twice as much as the current oil reserves estimated at 12 billion barrels. Therefore, shale gas exploitation is one potential structural measure to curtail the energy dilemma in Algeria and is currently subject to controversy within the government and heated public debates. In this regard, the government aims to achieve an unconventional gas production level of 20bcm in 2030 and 70bcm in 2040[1].

Methods

To identify the economic prospects of shale gas development in Algeria, we employ a multi-scenario analysis based on a partial equilibrium model of Algeria's power and gas system, TIMES-DZA. The main objective of using TIMES-DZA is to provide a range of energy system configurations for Algeria that will deliver projected energy demand requirements optimized to least cost and subject to a set of constraints for the horizon 2070. It provides insight into the scope of energy policy regarding developing shale gas in Algeria, whether this strategy could impact the country's natural gas balance in the future, and test the energy mix and energy dependence on fossil fuels. The TIMES model generator combines two different but complementary systematic approaches to modeling energy: technical engineering and economic approaches. TIMES is a bottom-up, linear programming tool applied to long-term energy systems planning to analyze the effect of different scenarios[6]. It is an energy optimization model generator for local, national, or multi-regional energy systems, which provides a technology-rich basis for estimating energy dynamics over a long-term, multi-period time horizon.

The main objective of this study is to outline the issues that the current power system encounters, investigate opportunities and solutions to avoid natural resources depletion, and address possible strategies that contribute to delivering Algeria from its energy dilemma. The specific objectives of this work are:

1. Assessment of the potential of conventional and unconventional sources to assure resource supply;
2. Identify alternative strategies and responses to shale gas development in Algeria and determine its contribution to the energy mix.

Despite a potentially promising future for shale gas development in Algeria, its exploitation is uncertain. Thus, we base our study on analyzing a series of scenarios where we vary shale gas production and the average shale gas extraction cost. To depict the impact of shale gas development, we construct a reference scenario that allows us to examine the possible trajectories that Algeria's energy system would follow under past trends and current development targets. The table below summarizes the set of hypotheses used in our model TIMES-DZA.

Scenario	**Reference scenario (BAU)**	**Shale gas development scenario**
Common Hypotheses	➢ No Hydropower is planned in Algeria's future energy policy ➢ "Trend scenario-S0" for electricity and gas demand ➢ "Low scenario" for additional LPG demand for the transport sector ➢ Maintain the level of natural gas exports at 50.5bcm ➢ The natural gas export price is exogenously specified at 5.77€/PJ for the considered horizon	
Differnent hypotheses	➢ No shale gas exploitation	➢ Meet the state target of shale production at 20bcm by 2030; ➢ Three scenarios for shale gas production (low-medium and high) ➢ Three extraction cost levels 1€/PJ - 5€/PJ - 10€/PJ

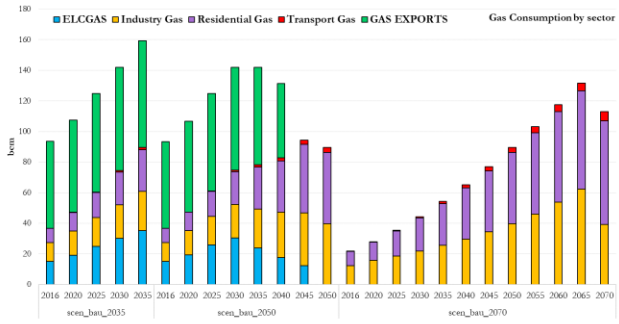
Results

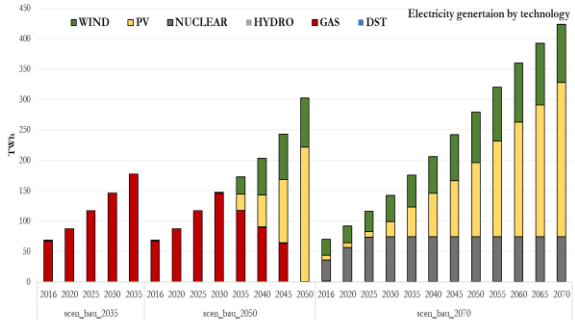
The model outputs of each scenario are analyzed through:

- ✓ The share of each technology in the energy mix;

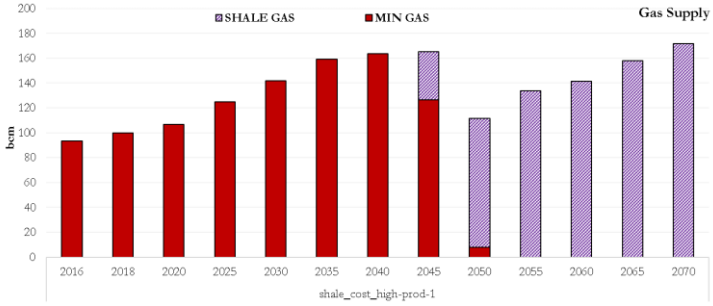
- ✓ The evolution of resource supply trajectories

The outcome of the BAU scenario showed that Algeria can meet its domestic demand in all sectors and exports for natural gas until 2040. Beyond this horizon, Algeria will stop exporting as there won't be enough gas to export and meet the domestic demand at the same time. Thus, the "energy dilemma" becomes a reality in the Algerian case. At the horizon of 2035, the BAU scenario can be called "All Fossil Fuel scenario," all newly installed capacities come from new Combined Cycles. by 2050, the gradual integration of Renewables (Solar and Wind) starts with an additional share of 1.7\% of Pv solar in 2030, to a common share of RE of 93\% by 2050.

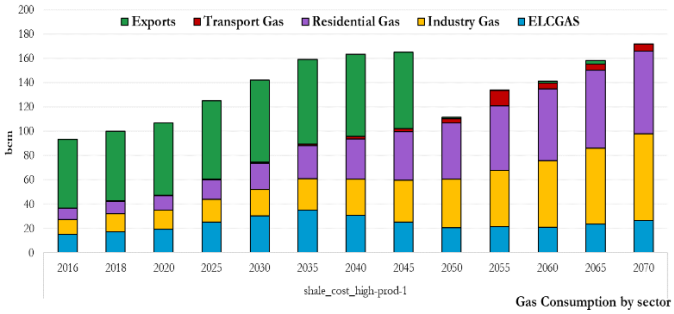




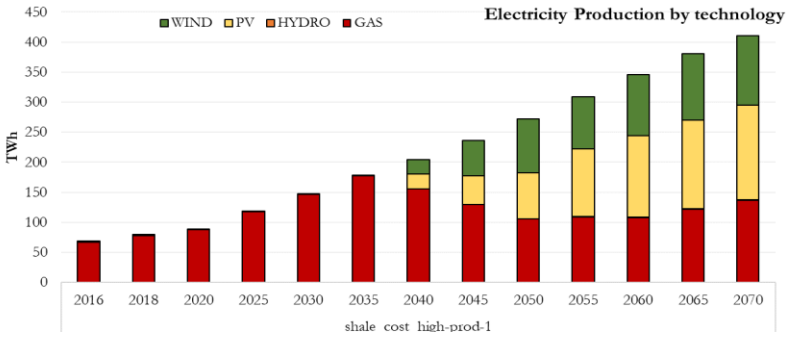
The numerical results for the "Shale gas development scenario" show that Algeria is forced to develop shale gas to meet the gas demand requirements even with a high extraction cost.



Figures below display the disaggregate gas consumption by sector and reveal that Algeria will record a drastic fall by 2050 in its gas exports and stop exporting by 2070, even with a high shale production level and low cost.



In the same scenario, the country will continue to generate electricity using natural gas at 34%; the remaining share comes from renewables, namely solar at 38% and onshore wind at 28%.



Conclusions

Algeria is considering utilizing its shale gas reserves to secure its exports revenues and compensate for the depletion of its natural gas reserves, thus preventing the “energy dilemma.”. the BAU scenario confirms that Algeria will struggle to maintain its exports and fall into a structural impasse by 2050. The shale gas scenario indicates that if shale gas is produced at an accelerated pace of 9% and at a low cost, it can play a significant role in Algeria’s future energy mix. However, it will inevitably reduce exports substantially. Nevertheless, this technological configuration seems very unlikely from today's perspective. Thus, alternative solutions are required to support the country’s energy system in the future.