
The Algerian natural gas in light of the regional gas markets' developments

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Abstract: The international gas markets have witnessed major developments. Shale gas revolution in the USA is the most important one, in addition to the escalating role of the liquefied natural gas. Since 2004, the rising number of LNG consuming countries as with natural gas prices increased, which led to significant changes that affected the dealers in those markets. Algeria is one of the most important traders in the gas markets. However, several challenges have been incurred due to the developments in these markets. These challenges put large pressures on the natural gas industry of Algeria, particularly with the rise of domestic consumption of natural gas. Through this paper, we aim to highlight the most important challenges that are faced by the gas industry of Algeria and how to deal with them.

Keywords: regional gas markets; liquefied natural gas; LNG; shale gas; Algerian natural gas.

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1 Introduction

Gas industry has undergone several developments and transformations at different levels. The most important of these changes may be the regional gas markets. Where, there is no single market for natural gas, as the case of oil. There are three main regional markets, European, Asian Pacific, and North American. Each of these markets has its characteristics that make it develop differently from the others.

The most important developments are the exploitation of shale gas in the USA and the escalating role of liquefied gas, which has a major role in increasing the regional markets integration. This produced several results that affected the international and domestic gas exchanges structure and prices structure as well; making traders reconsider their gas strategies in line with the reached developments.

Algeria is a major trader in the gas markets. It is the first country that exported liquefied natural gas (LNG). It also has a large reserve of natural gas. In addition to that, its geographic position qualified it to be one of the most important suppliers of the European market. However, the developments seen in these markets changed the gas map, and increased the competition intensity. These changes have also changed Algeria's position within that map, particularly in light of the following local developments; mainly, the increasing rise of the domestic consumption of natural gas and the conventional resources' depletion possibility in the near terms.

Since Algeria depends heavily on gas and oil, the natural gas issue becomes raising many discussions at all levels; especially, the challenges that face the Algeria's gas industry in light of the rapid developments of gas markets. Therefore, the study problematic revolves around a main question:

- What are the challenges facing gas industry in Algeria, under light the gas markets' developments?

Our goal is achieving a set of objectives:

- Knowing the major movements in gas markets as well as the major expectations regarding demand, i.e., the international trade movements of gas and prices.

- Highlighting of Algeria's profile concerning competition at the regional markets' level in general and European ones in particular.

2 The fuel's theoretical rooting

Energy has a major interest of economic theories. The most important topics were the optimal pricing of energy in light of increasing demand on the one hand and the scarcity problem on the other hand, especially for the fossil fuels. The economic theory has also concerned of the optimal organisation of network industries (gaseous and electrical industries).

2.1 The exhaustible resources and scarcity

The exhaustible resources' scarcity relates to their more widespread exploitation. For classical researchers, who have dealt with the subject in depth, they consider scarcity to be the value's basis. In this context, the optimal pricing attention of these resources is increased. Hotelling (1931) is the most prominent who dealt with the subject, in an article in 1931 in the so-called Hotelling rule, which states that the price of the depleted resource should raise at the same rate as the interest rate (Devarajan and Ficher, 1981). However, these actions got attention only after the first oil shock at the end of 1973 (Percebois, 1999).

The issue of fossil energy resources' scarcity has been currently discussed for many decades under two contradictory assumptions: first, oil production is nearing a peak and a major energy supply crisis is taking place; second, assumption that uninterrupted the resources' availability without interruption due to the technological development (Criqui and Martin-Amouroux, 2012).

Indeed, high prices and technological development have contributed to the development of oil and gas non-conventional resources, which have theoretically supported the international reserves, particularly of shale gas; since the technological development access to gas resource in larger quantities. However, this development will not alter the fact that fossil energies will be depleted. It only delays their depletion. The access to shale gas resources will delay natural gas peak by 20 years [Encel, (2016), p.37]; but they remain unconventional resources that characterised by their exploitation difficulty.

2.2 Gas industries' optimal regulation

The economic theory has largely focused on gas industry's organisational form which is a network industry that includes scope economy and size economy. Therefore, it is subject to natural monopoly regulation. However, this form of regulation has been subjected to many criticisms during the 1980s, particularly in the public monopoly case.

In this context, transaction costs theory and the competitive markets theory were significantly contributed to the interpretation of the liberalisation of gas markets process through the introduction of competition in gas industry [Percebois, (1999), p.20], which led to the subsequent openness to competition in different ways and degrees from one

country to another. This openness has allowed international gas markets to develop and be more flexible, more than it would be in the USA and UK.

3 The regional gas markets development

Gas industry regulatory environment development and the technological development have led to significant developments in the gas markets, mainly in shale gas and liquefied gas. These developments have been stimulated by the high demand which was accompanied by natural gas high prices during the 2000s.

3.1 The global demand prospects for natural gas

The demand for natural gas has significantly increased following the 1970s oil shock. Where, natural gas has become a strong alternative to oil; partly, because of its low prices and high oil reserves, as well as, of its environmental advantages. Natural gas is considered as the less fossil fuel polluting to the environment.

The demand for natural gas has increased, especially after proving its economic efficiency in the electricity production through the complex cycles' technology. The demand for natural gas increased during the period between 2000 and 2008, at a proportion of 83.8% annually (BP Statistical Review of World Energy, 2011).

It is worth to mention, that there is a key factor, which has greatly enhanced the benefit from these characteristics. This factor is the relatively high prices of natural gas, which stimulated the production of natural gas, characterised by high costs. Natural gas faced significant competition with the renewable energies, particularly in electricity generation; which has led to a decline in the growth rate of natural gas demand over the 2010 to 2016 period to 1.6% per year (BP Statistical Review of World Energy, 2017). This was due to the environmental policies, based on their new able energies use, as well as natural gas high prices during 2011 and 2014, after the Fukushima accident in 2011. According to the British Petroleum (BP) reference case, the demand for the renewable fuels will grow at an annual proportion of 7.1% during 2015 and 2035 [BP Energy Outlook, (2017), p.15], the same trend as OPEC forecasts, at a growth proportion of 6.8% annually during 2015 and 2040 [OPEC, (2017), p.10].

Despite the slowdown in natural gas demand growth rate, natural gas will remain the only fossil fuel on which global demand will increase. For BP predicts, it will be there a demand on the strongest developing gas among all the fossil fuel derivatives until 2035, at a proportion of 1.6%/year [BP Energy Outlook, (2017), p.33]. According to the OPEC report of 2017, it is expected, that natural gas will outperform coal, and it will become the second largest source of primary energy, in terms of primary energy consumption by the proportion of 25% by 2040. This is on the detriment of oil and coal.

Through Paris COP21, held in December 2015, the first agreement to limit coal emissions to reduce the temperature by 2°C, it supports the orientation to the achievement of environmental goals commitment. Where, national contributions from participating countries are determined to reviewing their performance at each five-year summit [Stern, (2017), p.4]. In this regard, by Marrakech Conference in November 2016, The Paris Convention entered into force swiftly. 114 countries out of 197 countries confirmed their commitment to moving towards a carbon-free economy. In this context (Point Climate No. 43, 2016), many countries consider natural gas to be a transit energy,

which can accompany renewable energies in making the energy transition, since it is the least polluting fossil fuel.

However, this growth differs from one market to another, according to consumption policies in regional gas markets, the most important areas of natural gas consumption.

- In European market, the demand for natural gas reached 14% of the world demand for natural gas in 2015. In recent years, the demand for natural gas has stagnated for several reasons; such as the decline in energy demand due to the economic recession experienced by the region. In addition, because of the energy efficiency measures implementation and the development of the renewable energies use. Also, natural gas is facing great competition from coal, because of low prices of this later.

Despite the efforts to reduce energy demand, gas imports will increase due to the continued decline in domestic production. According to BP Energy Outlook (2017), reference case, domestic production will decline by about 3.2% each year, during the period between 2015 and 2035. Therefore, the share of imported gas will reached about 80% from global consumption, in 2035, which reached 50% in 2015.

- For North American gas market, the region's consumption is about 27.3% of global consumption in 2016, the world's largest natural gas consumption in the region. Where, gas demand increased by 2.1% each year during 2005–2015 (BP Statistical Review of World Energy, 2017). While, in the USA, natural gas is supported by the increased supply of shale gas with lower prices, which encouraged natural gas use at the expense of coal. According to the International Energy Agency expectations, gas demand will continue to increase in the USA, but in less proportion than the period between 2010 and 2016, due to the rise prices expectations of natural gas in Henry Hub. This will reduce the gas demand in the coal-to-gas switching process in the electricity production; while, the rise will be due to the gas use in the industry. Where, in North America gas demand will rise to 1,000 billion cubic metres in 2022, which accounting for a quarter of the world's natural gas consumption [International Energy Agency, (2017), p.3].
- For the Asia-Pacific market, Asian Pacific countries are characterised by their high demand for gas, on one hand; and weak resources on the other one. They are also characterised by weak pipes' connection, which led to an increase in their LNG imports that accounted for about 70% of the world's LNG trade. Where, Japan only imports more than a third of the world's liquefied gas; followed by South Korea, as the world's second-largest LNG importer [BP Statistical Review of World Energy, (2017), p.34].

Emerging economies; mainly India and China are experiencing an increasing demand for energy; which has been reflected in the rising demand for natural gas. China has become a net importer of natural gas since 2007, due to the rapid growth in domestic demand [Encel, (2016), p.41]. Where, its gas consumption increased from 43.4 billion cubic metres in 2005 to 210.3 million tons billion cubic metres in 2016 [BP Statistical Review of World Energy, (2017), p.29]. However, India has started importing gas since 2004 [Howard, (2016), p.40]. BP company expects that China's gas demand will increase during the between 2015 and 2035 to 5.4% annually. Where, the imported gas quota will reach 40% of global consumption by 2035 [BP Energy Outlook, (2017), p.35].

As, the International Energy Agency (2017) expects that natural gas demand in India will rise from 55 billion cubic metres in 2016 to about 80 billion cubic metres by 2022, due to the economic growth and the increase in natural gas use, particularly in electricity production, industry and fertilisers.

Currently, natural gas faces a considerable competition from other types of energy. Coal use is expanding in Asia, especially in India and China; and the renewable energies are rapidly rising in China's energy use. On other hand, the rise of fossil fuel prices during the period between 2011 and 2014 encouraged the return to the nuclear energy in many Asian countries, especially Japan and South Korea. Despite doubts about the number of reactors that will resume their activity, especially under the local opposition to the nuclear energy, the Japanese government expects that the nuclear energy quota in the energy generation will be between 20% and 30% by 2030. Where; Korea plans to add six nuclear reactors to its nuclear energy fleet by 2029. It is expected that the activity in reactors would start at a capacity of 7GW during the period between 2016 and 2021 [International Energy Agency, (2016), p.26]. However, it is also expected, that the lower natural gas' prices will encourage the Asian countries demand for this energy.

Due to shale gas revolution, inevitable changes in natural gas supply will accompany changes in demand.

3.2 Shale gas' impact on the natural gas' global supply development

Although, natural gas proven global reserves have increased from 119.9 trillion cubic feet in 1995 to 157.3 trillion cubic feet in 2005, then they raised to 186.9 trillion cubic feet in 2015; but their growth rate has fallen at 18.31% during the second period, after reaching 31.94% during the first period (BP Statistical Review of World Energy, 2016).

High demand for natural gas has intensified production in many large fields to the depletion state, which led to search who to develop the more geologically complex resources that called non-conventional resources, mainly shale gas. Non-conventional resources have dramatically changed the energy situation in the USA. Where, gas production in the USA increased to 24% during the period between 2007 and 2012, mainly due to shale gas production, which accounts for 34% from the USA gas production, making it the largest natural gas producer in the world since 2009, before Russia [Cornot-Gandolphe, (2013), p.9].

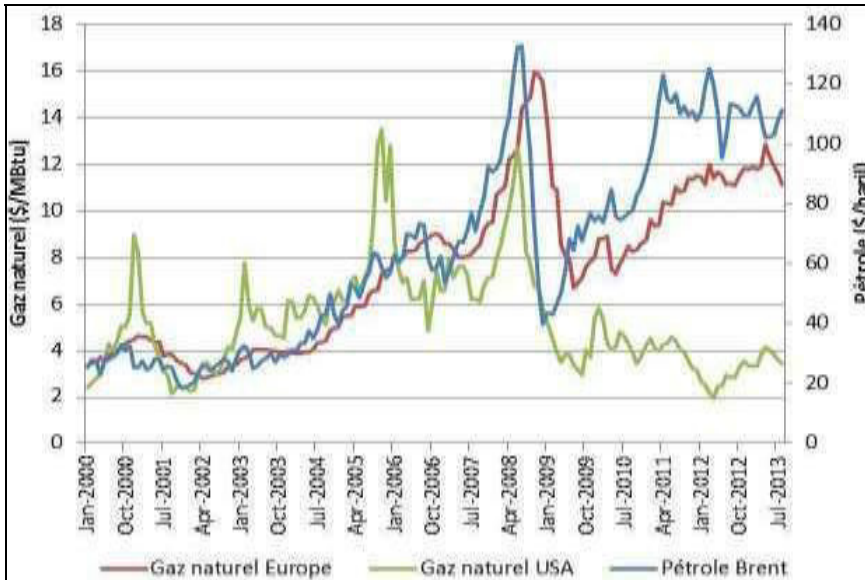
USA based on two main factors in developing these resources, which are the regulatory environment that characterises the US gas market, and the technological developments, represented mainly in the combination of hydraulic cracking and horizontal drilling. However, these two factors were stimulated by natural gas prices' rise during 2000s. This raised shale gas projects 'commercial profitability.

The most important effect of shale gas exploitation in the USA is the prices' fall in the main pricing axis 'Henry Hub'.

Figure 1 shows the natural gas prices' collapse in the USA since 2009. It shows also the separation of its prices from the crude oil price, because of the development of shale gas production. Thus, natural gas prices are determined at 100% through axes; is through the competition mechanism gas-gas. While, gas prices in other markets are still linked to oil prices, which led to a widening difference between gas prices in the USA and Europe after 2010. This difference was about \$10 per million; British thermal units in 2012. In comparison to gas prices in Asia pacific, the difference was greater. After that, the

difference between prices in the three gas markets fell following the oil prices fall in 2014.

Figure 1 Impact of gas development in the USA on European petrochemicals (see online version for colours)



Source: Cornot-Gandolphe (2013, p.16)

The USA’s energy transition, resulted from shale gas exploitation is a model for countries with significant resources of shale gas that aspire to energy security. According to the US Energy Information Administration Report of 2013, 41 countries have around 7,795 trillion cubic feet of shale gas resources that are technically available for exploitation [US Energy Information Administration, (2013), p.4].

According to BP’s reference case, shale gas production will grow by 5.2% a year, during the period between 2015 and 2035. At the same period, shale gas will account for about 60% of the shale gas production global increase. Where, the US production will rise more than the double; as, China will appear as the second largest shale gas’ producer. Thus, shale gas will account for about a quarter of the global natural gas production by 2035 [BP Energy Outlook, (2017), p.33]. However, there are many doubts about China’s ability to replicate the US experience of shale gas production, due to several challenges, mainly: the geological nature, high costs, gas industry immaturity, the lack of water, and the population transfer problem (Cedigaz, 2015).

Other countries as Argentina, Algeria, Mexico, Australia and South Africa have considerable resources of shale gas. However, shale gas production in these countries faces several challenges. So far, most countries do not accept the development of this energy. If some countries as USA, Canada, Poland and China have authorised such activity, other countries as Great Britain have setup commissions to conduct investigations before they grant licenses. Even the countries that have supported this activity continue to work on the investigation [Meyer, (2013), p.10]. In the USA, they created a site; called FRAFOCUS, to disseminate information about chemicals’ quality

and quantity, used in hydraulic fracturing in each well. Two US bodies manage this site to protect the environment, viewing to disseminating information to the public in a transparent and impartial ways. As in Europe, they are organising the chemicals' use strictly through REACH regulation [Charlez and Baylocq, (2014), pp.77–78].

This new dynamic in demand as well as in supply for natural gas needs to grow and expand the natural gas international trade, and it is expected that LNG will play a major role in achieving balance in light of these data and transformations.

3.3 The escalating role of LNG

Because of the increasing demand for natural gas and the difference of the consumption areas from the production ones, natural gas trade have witnessed a significant growth in the recent years. LNG trade has constituted the bulk of the growth in the natural gas trade. Where, many countries have chosen LPG as an alternative, because of its flexibility compared with pipe option that may be hampered by geographical or economic conditions.

Table 1 Exporting and importing LNG countries number evolution between 1965 and 2016

<i>Year</i>	<i>1965</i>	<i>1974</i>	<i>1984</i>	<i>1994</i>	<i>2004</i>	<i>2014</i>	<i>2016</i>
Exporting countries	1	4	7	8	12	19	19
Importing countries	2	5	6	9	14	30	39

Source: Algerian Ministry of Energy (2015, p.20) and International Union of Gas (2017, p.3)

Table 1 shows the rise of exporters and importers' number of LNG between 1965 and 2016, particularly for the importing countries. Where, 16 countries were added to the LNG importers' list, during ten years (2004–2014) and nine countries, during two years only (2014–2016).

The significant growth of LNG trading over the last ten years has been accompanied a rapid development of LNG short-term markets and the spot markets. While, the rapid and short-term LNG trade accounted for less than 5% of the gas trade volume in 2000 [US Energy Information Administration, (2013), p.50], the proportion increased to 28% in 2016 [International Gas Union, (2017), p.15].

This development is due to several factors: the flexibility introduction in the destination items of the LNG contracts, and the differences between natural gas prices in the three regional markets, which provides arbitration opportunities. As well as, the technological development has played an important role in the LPG industry development, especially through the floating units that have a great flexibility. This has clearly affected the development of the exporters and the importers number.

During the period between 2008 and 2014, 12 countries have become liquefied gas importers: four in Asia, three in South America, three in the Middle East and two in Europe (Netherlands and Lithuania). Most of these countries have small markets, and their demand for gas is periodic. Therefore, they have chosen floating gasification units.

The countries' number with floating units reached a total of 13 countries, until the end of 2016. Whether several countries have announced the establishment of floating units for regasification in 2018, namely, the Paraguay, the Philippines, Bangladesh and Ivory Coast [International Gas Union, (2017), p.51]. According to the International Federation of Gas, the Floating units number will be 50 units by 2025, with a capacity of

200 million tons/year. Where, the number of floating platform projects is estimated at 24 projects under development in 2016. Seven of them are under construction and 17 are under planning. These units can produce about 72 million TEU on the long-term [Brian, (2016), p.24], which will lead to a liquefaction possibility increase of about 160 billion cubic metres by 2022. This increase will be mainly by Australia of about 30 billion cubic metres and the USA of about 90 billion cubic metres, which will increase liquefied gas supply in the markets.

Considering given developments, the regional gas trade volume will increase from 444 billion cubic metres in 2015 to 836 billion cubic metres in 2035, and the role of the LNG trade will increase too. As, the LNG quota will rise to 55% of the inter-regional gas trade, in 2035. Before, this proportion was estimated at 44% in 2015 [Cedigaz, (2017), p.10].

LNG growth will be one of the main factors that will make gas markets more connected, because of the markets homogeneity in terms of the supply commodity subject. Where, LNG can be re-exported from one market to another, according to supply and demand. This will have an impact on the prices convergence between the regional markets. However, the oil and natural gas prices' falling will affect the projects profitability of LNG. In addition, the natural gas prices convergence in the regional markets, due to the low oil prices, will reduce the arbitration chances that exporters of liquefied gas can do.

To predict what can happen in the future remains difficult, under light the rapid developments that the gaseous markets are experiencing, but it is necessary for traders in these markets to be able to outline their gaseous policy.

4 Algerian natural gas under light the gaseous markets developments

Algeria is one of the most important dealers in gas markets, considering its reserves and geographical location. As well as, the long experience that it has in gas industry field. However, gas map changing and the markets' development put Algeria in front of great challenges, particularly with regard competition in the liquefied gas markets and gas exploitation issue. This is in light of the conventional resources depletion possibility and the domestic consumption rising of natural gas.

4.1 Natural gas production and consumption in Algeria

Algeria has considerable potentials in natural gas field, with an estimated reserve of 4,500 billion cubic metres, which constitutes about 2.4% of the world's reserves. It is considered the first producer in Africa and ranks the tenth in the world. However, natural gas production has been declining since it reached the peak in 2005. Where, the estimated production was 88.2 billion m³ and it increased only in 2016 (BP Energy Outlook, 2017).

On the other hand, natural gas consumption continuously increased between 2003 and 2015 of about 82.24%. Natural gas represents the largest national energy consumption quota of 37.2% in 2016 [Algerian Ministry of Energy, (2016), p.16]. Electricity production consumes a half of this rate. Therefore, natural gas shares in the electricity production, of about 92 to 95%, that is considered as the largest proportion over the world. This rise is due to the local lower prices, rather than the subsidised prices from the

government. Where, this later spends about \$7 billion a year to subsidise gas and electricity to the end-users [Layachi, (2013), p.27].

In this regard, criticism has been increasing about energy subsidies in Algeria, after the energy consumption increasing that threatens fuel exports. This could lead to falling into the so-called ‘Egyptian gas disease’. As the Egyptian Government suddenly found itself facing the fact that natural gas production would not suffice to meet the growing demand, due to the massive subsidies (Arab Petroleum Investments Corporation, 2013). Therefore, Egypt became a gas importer in 2013, making the export potential of LNG, which is 16 billion m³ unused. This is a possible case for Algeria (Arab Petroleum Investments Corporation, 2016), if price subsidies continue to contribute significantly to higher consumption.

Indeed, the exports decline cannot be attributed, alone to the consumption rise; while the competition in the gaseous markets is another cause that pressures the Algeria’s exports, especially the European market.

4.2 Algerian gas exports under light the gaseous markets’ competition: exclusive to the European market

Europe is the primary market of the Algerian gas exports. Where, it imported more than 80% of the Algerian gas through three pipelines to this market. While, the Algerian gas quota in the European market is for only 7%, of the pipeline gas supplied to Europe. The most important competitors of the Algerian gas, is Russia and Norway, which contributes successively 40% and 37% of the Europe’s imports volume of gas pipe (European Commission, 2016).

In terms of liquefied gas, European market is a secondary market on the international level; its imports represent only the liquefied gas quota of about 13%, from the imported gas in 2015. However, the European market is the primary market of the Algerian LNG exports. More than 93% of LNG was exported to Europe and Eurasia in 2016 (BP Statistical Review of World Energy, 2017).

Algerian gas faces a considerable pressure in the European market; due to gas market’s liberalisation procedures. These later has led to changes in the exchange and pricing structures. Besides the long-term gas contracts, marked by oil prices, currently the pricing is according to gas-gas in the gas platforms (where there is an instant trade of gas). Where, the European gas market’s liberalisation procedures led to the development of gas pricing cording to the gaseous platforms, after the domination of the gas pricing that based on oil, for a long time. In 2005, the price proportion of gas-gas was about 15% of the global natural gas trade. This ratio rose to 66% in 2016 [International Gas Union, (2017), p.9].

Several factors caused this development, such as the reduction in the imported gas volume under long-term oil-price contracts, for the instant gas markets. The re-negotiation also includes the hybrid pricing formulas introduction, where the mark-up under oil is partly. However, it is worth to note that there is a wide variation in pricing between different regions in Europe.

Because of the prices decrease in the gaseous platforms, in comparison with the oil prices during the period that characterised by high oil prices, the conventional traders faced considerable pressures, to modify the long-term contracts.

In the recent years, the Italian company *ENIE* has been negotiating with *SONATRACH* to reduce the commitments of ‘take or pay’, and make the oil referenced

prices aligning with the platforms prices. Where, 'take or pay' item has been significantly modified; but the price formula, referenced to oil has not been abandoned. That is why; *SONATRACH* and the Italian company 'ENIE' have modified their long-term contracts in 2013 and at the end of 2015. Nevertheless, *SONATRACH* has shown its commitment to the oil referenced prices. However, *Gazprom*, *GasTerra* and *Statoil* have shown a greater flexibility in pricing. As, they have focused in their strategies on the exported quantities, which is based on pumping additional quantities of gas to compensate the shortfall in revenues [Aissaoui, (2016), pp.16–17], resulting from lower prices. In this case, large quantities of gas are available for export, which is an obstacle to the implementation of this strategy in Algeria.

The Norwegian company 'Statoil' reduced gas prices in its contracts of 30% in 2009 and in 2010. At the end of 2014, the large quota of the Norwegian company's contracts was made on the instant notification [Aoun and Cornot-Gandolphe, (2015), p.18]. As, the Norwegian quota of gas, priced on platforms, increased from 16.1% in 2013 to 21.5%, of the global Europe's natural gas trade in 2014. While, the Norwegian quota of gas decreased from 16.1% in 2013 to 10.8% in 2014 [Komlev, (2015), p.17].

At the same time, the Russian company *Gazprom* has succumbed to the competition pressures in the European market. It has reviewed about 60 contracts with its European customers during the period (2009–2014) by reducing prices, modifying 'destination items' and 'take or pay' obligations. The reduction rate was 16% in 2013 and 20% in 2014 compared to the prices of long-term contracts marked by oil prices before 2008 [Aoun and Cornot-Gandolphe, (2015), pp.18–19], a strategy adopted by Russia in the short-term to conduct the price war.

Developments in the European market have placed considerable pressure on Algerian gas exports. After pipeline exports reached a peak of about 39 billion cubic metres in 2005, they decreased by about 10 billion cubic metres during the period of 2012–2015. This rate raised in 2016 to about 37.1 billion m³, due to the increase in exports to Italy after the amendment of the Algerian-Italian contracts of natural gas in 2016, which explains the impact of the competition pressure on Algeria's exports, especially towards Italy.

In terms of liquefied gas, the developments impact on the Algerian gas has been even greater. Algeria's LNG exports have dropped significantly during the period 2005–2016. After reaching more than 22 billion m³ in 2005, they have fallen to less than 15 billion m³ since 2012. Since, the rise in the Algerian gas prices, compared to the prices of Norway, Qatar and Nigeria, has led to the development of the Nigeria's exports to the Spanish market, surpassing Algeria and becoming the first source of Spain in 2016. Qatar has become the first supplier of LNG to Italy; Qatar LNG has covered more than 90% of gas imports in Italy during the period 2013–2016, which is making liquefaction potential use only 46% in 2016. Thus, Algeria ranked the seventh among the LNG exporters in the world.

On the other hand, US exports are a significant threat to the conventional traders in the European market. Where, the US began exporting the first shipment of LNG in 2016 and became one of the dealers competing in the LNG markets. According to the American Energy Administration, US exports will reach about 70 billion m³ per a year in 2020. The US LNG export contracts are flexible (there is no final destination item) and they are priced according to Henry Hub prices [Boussena and Locatelli, (2017), p.7].

Most of the Algerian gas contracts will end during the period 2019–2021. This will put it under a great pressure, especially in light of the continued decline of the oil prices and the lower gas prices in the platforms. These challenges require Algeria to look into all available opportunities, specifically to take advantage of the European strategy to diversify gas supplies, particularly the LG, to reduce the link to the Russian pipelines.

For Algeria, the possibility of exports markets diversification appears to be weak. Since its increase of LNG exports to Asia Pacific in 2011, due to the Asian demand for the Algerian gas because the Fukushima incident; they have subsequently fallen to 0.7 billion m³ in 2016. This was explained by the gas prices' decline, as well as due to the large competition from Qatar and Australia, whose LPG exports have increased to more than 23 billion m³ compared to 2015. In addition, the potential competition of Russia that aims to diversify its markets towards Asia. In 2014, Russia and China signed a contract to transport 38 billion m³ per a year through a Russian pipeline [Milov, (2015), p.7]. In light of these data, it will be difficulties for Algeria to have a large share in Asian market. This enhances and emphasises the need to rely on its long experience in the LNG field and to strengthen the infrastructure with new technologies, as well as the openness as much as possible on other energies such as shale gas.

5 Shale gas in Algeria

The increasing domestic consumption of natural gas and the warning of experts about the depletion of conventional resources have put the public authorities in front of the inevitability of shale gas exploitation, especially that Algeria has significant resources of it. According to the US Energy Information Agency 'EIA' 2013 Report, in Algeria, shale gas is founded seven tanks: Ghadames (Berkin), Ilizi, Timimoun, Ahnat, Muidir, Ragan and Tindouf. The estimated resources of the shale gas exploitation in Algeria, is about 707 trillion cubic feet, and these tanks contain 507 billion m³ of shale oil. This makes Algeria ranked the fourth place in the world, in terms of the size of technically recoverable resources for the exploitation of shale gas.

Shale gas exploitation by hydraulic cracking technology poses a problem in Algeria. This is because of the aquifers contamination risk due to the materials in the used liquid. In addition to the problem of water consumption in large quantities that will affect the water resource in Algeria.

Behind the economic aspects, the period of extraction from the fields of unconventional gas rarely exceed five years, and so far the cost of drilling is still unclear regarding the exploitation of shale gas in Algeria, as it has not yet begun the exploitation process.

The agency 'alnaft' affirmed that \$300 billion must be invested to produce 60 billion m³ of shale gas annually [Pereira and Talus, (2015), p.46]. Where some estimates suggests that rock gas cost in Algeria may reach the \$15 per million British thermal units that is much higher (Algerian Portal of Renewable Energies), than its counterpart in USA, which ranged between \$2.8 and \$3.6/million BTUs in 2015 (Mistré, 2017). This raises many questions about Sonatrach's ability to acquire the necessary machinery and technologies to develop its resources. It will also be difficult to collect rents from the shale gas exploitation in light of the low gas prices in the regional markets.

Algeria is suffering from a shortage of qualified labour in this field, which requires accurate technologies possessed by large foreign companies. It is therefore necessary to

use foreign investment to benefit from expertise and technology, particularly as Annual Report Ministry of Energy (2016) oversees more than 80% of the hydrocarbon activities.

The hydrocarbons law of 2013 includes the basic rules for the non-conventional hydrocarbons exploitation in terms of their definition, as well as the tax incentives provided to the companies that exploit them. The law also includes additional obligations to adjust and to control the hydraulic cracking process, in view of the potential environmental effects of this technology use.

The major challenge facing the shale gas exploitation is the ability to attract foreign investment. Despite the incentives provided by the new hydrocarbons law, it did not have much effect, as demonstrated by the tender in 2014, where 17 offers of unconventional hydrocarbons out of 31 offers. Four contracts were signed, including one license to explore shale gas by 'Statoil' with 'Shell' company. In addition to two licenses for 'Enel' and 'Dragonoil' companies, while the other was granted to 'Repsol' and 'Shell' companies (Nahkle, 2015). Currently, the shale gas exploitation in Algeria faces a set of limitations and restrictions on access to this unexploited resource in Algeria, which can be summarised as follows:

- Shale gas exploitation needs accurate techniques, which will be more expensive in Algeria due to the lack of experience.
- If the American experience has achieved some of the advantages through the shale gas exploitation, it is not possible to determine easily the possibility of repeating the experiment in Algeria. This is because of the different geological nature, as the shale gas exploitation in USA is located in areas far from the population.
- The above economic conditions that hinder this exploitation, which are mainly the popular rejection, especially in the area of Ain Saleh, through the holding of large demonstrations to express the absolute rejection of this resource exploitation.

6 Conclusions

Energy demand will continue to rise for several decades, particularly on natural gas, due to the rise of the demographic growth rate and the rising growth rates in the emerging economies, which has encouraged gas markets development, despite the large competition of coal and renewable energies.

The most prominent developments in the gas markets is shell gas revolution in USA, which has changed many of the gas map features, and which has revived the chances of some countries to have energy resources. As well as, LNG plays an important role in achieving great mobility in natural gas trade, in light of a sharp competition between many traders.

Under light all these developments, gas industry in Algeria faces great challenges, because of the fierce competition known in the gaseous markets. Although European market has been long considered a natural market for Algeria, it is now more open to dealers, which increased competition. The spot prices drop has also put a pressure Algeria for long-term contracts, particularly which Algeria is not very much in the downstream activities in Europe. While, Asian market is the most difficult and most competitive for Algeria, due to the current control of Qatar in meeting the Asian demand,

and the expectations about the huge resources of Australia that directly targeting this market.

The increasing domestic consumption of natural gas, especially in the electricity sector, will increase the pressure on the demand for natural gas in light of the available possibilities of the conventional resources. Therefore, shale gas has become an option; rather it is the inevitable, especially in light of the large reserves estimated by the international bodies. However, the obstacles are many and large, due to doubts about the environmental influences of this type of resources exploitation. In addition, the lack of technology and labour resources that Algeria suffers in this area.

These challenges call for a clear strategy based on objective principles, some of them, which can be summarised in the following:

- The need to strengthen the partnership with foreign companies in order to benefit from the expertise and technology; so as Sonatrach do not bear alone the investment risks, and to improve the fields' productivity. Where, the foreign partners' importance highlights, especially, in acquiring technologies for the shale gas exploitation.
- The need of an energy transfer; Algeria have to move towards an energy economy, and to more rely on renewable energies, in order to achieve a sustainable development and to reduce the pressure on the natural gas use.
- To discuss the outstanding issues seriously, especially, the shale gas exploitation, the energy consumption model, and the energy resources pricing. This should be based on the consultation of experts in each field and in light of a long-term expectation.
- Algeria should benefit from its long experience in the gas industry field, especially its ability to manage the negotiations. This is in order to consolidate its quota in the European market and to find outlets in the Asian market, which requires Sonatrach to take part in downstream activities in these markets.

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