

Natural Gas of Yemen The Challenge of Growth in the World's Gas Markets

Abdulkarim Ali Dahan*

The objective of this research is to analyze the growth of oil and gas sector in Yemen and to study the possibilities of exploiting Yemen's gas for both, domestic use and international export. Finding buyers is a major challenge that Yemen had to face in the future, so it was important to study the international gas trade, especially Liquefied Natural Gas (LNG) trade, to secure footholds in the markets in the future. The analysis shows that power generation, cement industry and residential sector are the potential users of natural gas domestically. The analysis also shows that the expansion in gas power generations will drive the growth in natural gas and LNG higher worldwide. Advances in liquefactions and technologies have driven the cost of LNG down by 30%; this will encourage new producers to enter into the markets in order to fulfill the world requiring demands. The analysis gives an indication that Yemen has the potential to compete in the gas markets in the coming years. To guarantee this, Yemen should relay on a new foreign policy and relationships allowing and even encouraging the prospects of gas exports to the targeted markets.

Field of Research: Energy Economics

1. Introduction

Oil has proved to be the world's primary source of energy and was expected to keep this characteristic for more years to come in the future, especially for the next two decades. Even though, economists agree on this oil characteristic, but reality shows that natural gas is the fastest growing source of energy in the last four decades and it is expected to increase further in the future as demands are projected to increase in all regions worldwide. Because of its economical advantages, natural gas is an increasingly attractive source of energy in many countries and it was expected to reach 28% of all energy use by the year 2025 growing at an average yearly rate of 2.3%.

Based on the discoveries of oil and gas in the Republic of Yemen, which proved to be economically viable, I felt it is necessary to study the possibilities of exploiting Yemen's gas for both domestic use and international export.

The objective of this research is to analyze the growth potential of oil and gas sector in Yemen, and also to study the possibilities of exploiting Yemen's gas for both, domestic use and international export. Finally, the study will analyze the growth of international gas trade, especially Liquefied Natural Gas (LNG) trade and its demand in the future. This would give an indication of where LNG trade is heading to, so that Yemen can secure footholds in the LNG markets in the coming years.

*Dr Abdulkarim Ali Dahan, Faculty of Business, Ajman University of Science & Technology
email: a.dahan@ajman.ac.ae

2. Hypothesis and Methodology of the Study

To test the hypothesis that the government of Yemen will be able to exploit its gas domestically and to secure footholds in the world's liquefied natural gas markets, a descriptive economic analysis will be conducted. The methodology of the study will include, analyzing the oil and gas industries and their growth potential in Yemen, the liquefied natural gas project in Yemen, international gas trade, and finally the demand for gas in the future.

3. Oil and Gas as Sources of Energy in Yemen

3.1 Oil Production

It was not until 1984 when oil was discovered for the first time in the northern part of the country. Since then, oil exploration licenses were increased dramatically, especially in the 1990s when numbers of new oil fields were discovered in Masila region (east of the country), which was granted to Canadian Occidental petroleum. Oil production from the discovered fields had increased gradually from 7,356 barrel per day in 1986 to 457,000 barrel per day in 2002, before it start declining to reach 280,000 barrel per day in 2008.

On average, 58 % of the total production is for government share, whereas 42 % for companies shares. About 63 % of government's share goes for export, whereas 37 % goes for domestic use.

3.2 Refining Sector

Yemen has two refineries with total capacity of 180,000 barrel per day. Aden refinery, owned by Aden Refinery Company, came on stream in July 1954 with total capacity of 170,000 barrel per day and two 85,000 barrel per day distillation units. Marib refinery, owned by the Yemen Refinery Company, which came on stream in April 1986, comprises of a 10,000 and 2500 barrel per day distillation unit and reforming unit respectively. Both refineries, subsidiaries of the General Oil & Gas Cooperation, a government body, are producing diesel oil, gasoline, liquefied petroleum gas (LPG), residual, and other products.

Output from the two refineries averaged 4132 thousand metric ton per year. Marib's refined products are planned for the domestic use while Aden's products are for domestic use and contracted deals, especially with Iran, Oman, and Malaysia. The two refineries are processing crude from Marib/Al-Jawf region.

Crude oil that are used by Aden refinery is firstly transferred through a 450 km pipeline from the producing fields to Ras-Issa terminal, on the Red Sea, then carried to Aden refinery using tanker trucks.

3.3 Oil Consumption

Since its unity in 1990, Yemen has gone through significant structural changes in its economy. These changes, have included rapid increases in the

Dahan

use of energy domestically, which have increased to almost 155,000 barrel per day in 2009. Factors such as rising incomes, population growth, and cheap energy prices were the main driving engine for such increases.

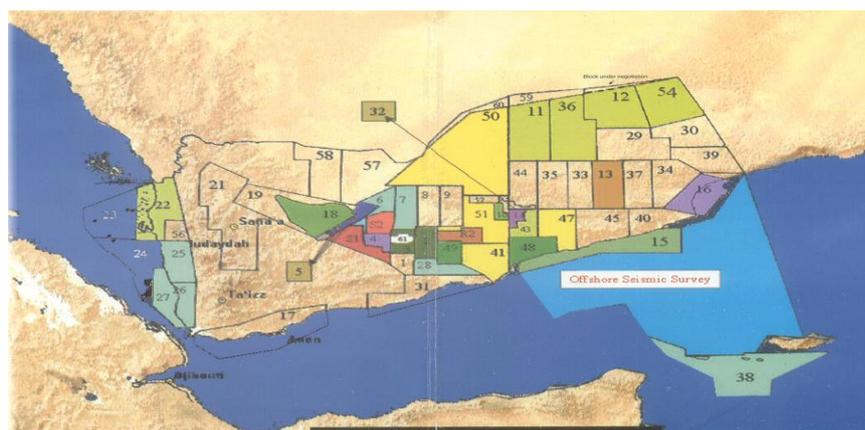
It was reported that Yemen consumed about 24,600 barrel of condensate per day in 2010. Liquefied Petroleum Gas, which has been growing dramatically in Yemen since the early 1970s, considered as the fastest growing source of energy in the last twenty years and the highest used after gasoline. Residential sector is the main consumer of liquefied petroleum gas, which accounts for 87% of total consumption, especially for cooking purposes. Other sectors such as transportation, agriculture, hospitals, restaurant and hotels account for the rest.

4. Natural Gas in Yemen

4.1 Natural Gas Discovery

After signing an oil exploration agreement with the government of Yemen in 1981, Hunt Oil Company, an American oil company, started its oil exploration activities in its concession area in Marib (Block 18), east of the country, figure (4-1). With its first wild cat (Alif NO 1), Hunt oil discovered its first discovery of oil in 1984 and within 30 km radius of that field, two gas reservoirs were discovered which then followed by the discovery of three additional gas/condensate fields between 1989 and 1991. The French company TotalFinaElf made other major discoveries yielding a flow of 12.36 million cubic feet per day in 1991 and 1992 in Janah block, east of the country. Third major gas discovery was made in 2000 in block S-1 by the joint venture of U.S Vintage and Canadian Trans Globe. When this discovery was tested, it yielded 47.7 million cubic feet per day of natural gas, which then followed by another discovery obtaining a flow of 27.7 million cubic feet per day.

Figure (4-1) Oil and Gas Blocks



Source: Ministry of Oil and Minerals, Yemen

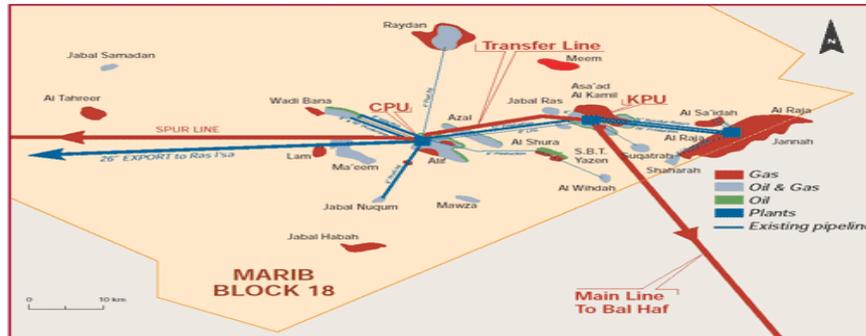
4.2 Reserves of Natural Gas

Yemen's proven gas reserves, mostly associated with oil, stands at 16.9 trillion cubic feet (tcf) by the end of 2007. 89% of the reserves are located in Block 18 (Marib fields), figure (4-2).

Dahan

Although, the government has not granted any gas concessions yet, to explore non-associated gas, non-associated gas was discovered on block S-1 (Damis track) in 2000. The remaining 11% are distributed between two other blocks, Jannah (block 5) and Damis (block S1), 8% and 3% respectively.

Figure (4-2) Reserves of Natural Gas



Source: Ministry of Oil and Minerals, Yemen.

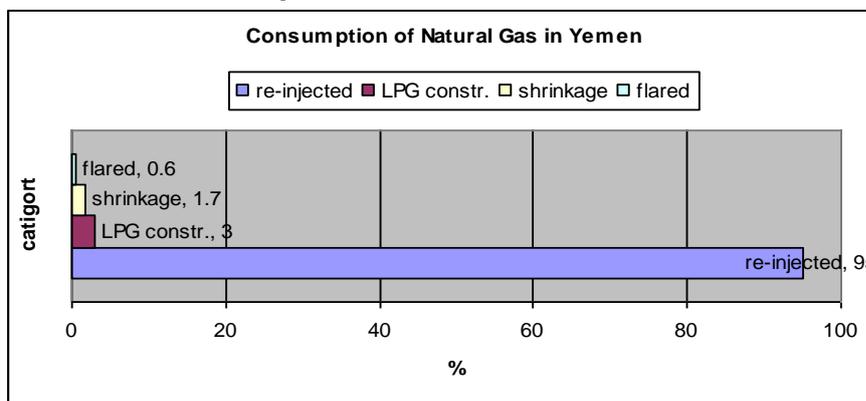
4.3 Production of Natural Gas in the Last Two Decades

Three international companies, Hunt, Nixon, and Vintage have conducted gas production in Yemen, mainly associated gas. Production has been increasing during the last twenty years and expected to continue further in the future. Whereas production of gas reached 13.35 billion cubic meter (bcm) in 1995, it reached 30 billion cubic meter in 2002, with an average production of 2.9 million cubic feet per day.

4.4 Consumption of Natural Gas

Since the discovery of oil and gas, the use of natural gas is limited to the operation process of oil production only, where natural gas re-injected to increase the pressures of reservoirs. About 30 billion cubic meter of associated gas is put back in reservoirs annually to increase the pressure of the existing oil reservoirs and to store gas for future use. In 2002, about 95 % of the total gas produced was re-injected, whereas 0.6% was flared, 1.7% shrinkage gas, and 3% was used for the extraction of the liquefied petroleum gas and condensate, figure (4-3).

**Figure (4-3)
Consumption of Natural Gas in Yemen**



Source: A report made by the Oil & Gas Policy Division, World Bank, Yemen.

Dahan

Yemen consumed 24,600 barrel of condensate per day in 2010. The block 18 supplied 22,000 barrel per day and the Aden refinery supplied 2,600 barrel per day and seasonal imports amounted to some 250,000 barrel each year. The Yemen liquefied natural gas project also delivers 100 million cubic feet per day of domestic gas to the Public Electricity Company (PEC) for power generation.

4.5 Potential Consumers of Natural Gas in Yemen

4.5.1 The Power Generation

Generally speaking, the huge amounts of gas that always utilized in power generation plants turn this sector to be the number one gas consumers in countries where hydroelectricity resources is low or do not exist.

In Yemen, no doubt, power generation would be the strongest candidate to use natural gas. Factors such as the rapid growing demand for electricity, and the current shortage in generating capacity would permit for such use and extensions.

4.5.2 The Cement Industry

Cement industry in Yemen is among the strongest and typically energy intensive which likely to make it a good candidate for gas utilization in the coming years. Comparing to international standard, Yemen consumes a total of 1.5 million tons of cement each year with per capita consumption of 90 kg. This low per capita consumption makes the industry exposure to potential development in the coming years. Cement production is mainly concentrated in areas such as Amran, Bajil, and Mafrak with total capacity of about 1.5 million tons. This quantity is not enough to satisfy the growing demand, which had been expected to grow from 90 kg per capita in 1997 to almost 160 kg per capita in 2010 and 190 kg in 2020. This growing demand will have no problem finding the needed raw materials of lime stone and sand clay since Yemen has abundant raw materials in many areas specially Amran area which will have sufficient reserves for such expansion.

The use of gas is expected to replace fuel oil in existing plants and be the running engine for new ones. Gas utilization in this sector will depends on expected production of cement and the type of process which will be based on modern dry process that use approximately 1 billion cubic feet per day of gas per 100,000 tons of produced cement. Conversion of existing plants to natural gas use will imply new equipment for pressure reduction, internal network, metering, and a pipeline.

4.5.3 The Fertilizer Industry

Fertilizers that Yemen currently uses are imported through companies along with seeds and spare parts. About 30,000 tons of Urea was imported in 1997. Agricultural industry, which accounts for almost 30% of Yemen's GDP, mainly produces cereals (sorghum, millet and wheat), fruits and vegetables with

Dahan

relatively low yield per hectare not exceeding 1.5 tons/ha for wheat and 1.0 ton/ha for sorghum and millet. All types of crops produced in Yemen require primarily nitrogen and phosphate fertilizers which makes it clear that building a plant to provide the country with the needed fertilizers might be economic viable. The ministry of agriculture has made an attempt to study the required nutrients that Yemen may need in the coming years. An estimate of 43,000 tons of Urea was projected by 2005, representing a sizable yearly average growth rate of 15% between 1997 and 2005. This growth rate is expected to increase to reach 6.4% between 1997 and 2010, and 5.5% between 2010 and 2020.

4.5.4 The Industrial Sector

Industrial sector in Yemen, which includes food processing, chemicals, textile and non-metallic production, is still underdevelopment and energy intensive industries are still low, except the oil refineries and cement factories. Fuel oil and diesel oil are the most usable source of energy to run these factories, except factories such as Coca Cola, Canada Dry, and Sanitary Wares are using liquefied petroleum gas instead. Energy utilization by the industries in Sana'a area, for example, has been estimated at 100,000 ton of oil equivalent per year, this figure excludes Amran cement factory. Using gas in this sector will depend on many factors including the size of consumption, the location of plant from the main gas line and the cost of converting existing furnaces or boils to gas. Gas utilization in industries is considered for existing and possible new plants with allowing room for potential development of a few medium scale industries.

4.5.5 The Household/Commercial Sector

Beside households, commercial consumers such as hospitals, hotels, restaurants and small enterprises are included in this sector. A study by the UNDP was conducted to study the possibility of liquefied petroleum gas substitution in this sector since its reserve will become insufficient to meet potential demand, especially after Marib oil fields were projected to dry up in the future.

Gas reserves in Yemen are far greater than quantities of liquefied petroleum gas extracted from oil and gas process. Therefore, replacement of liquefied petroleum gas with gas utilization is essential especially for the long run. A pipeline network could be built first in Sana'a, where about 33% of liquefied petroleum gas is consumed, and then gas networks could be extended to cover some other areas.

Another study by the UNDP in 1998, concluded that if natural gas was available at an attractive price, it could replace 50% of the liquefied petroleum gas and 20% of the diesel demand from the industries. If this happened, this will lead to a natural gas utilization of 25 billion cubic feet per day by 2010.

Dahan

5. Liquefied Natural Gas (LNG) Project in Yemen

5.1 Background

As an alternative option for using natural gas domestically, and after many thoughts of exporting natural gas to get foreign exchange, the government of Yemen has received plans for constructing liquefied natural gas export facilities project in 1993. A total of 3-5 billion dollar was the primary investment for the project with annual capacity of 6.2 million tons per year.

5.2 Location

The project is located in the southern tip of the Arab Peninsula in Bal Haf on the Arabian Sea, approximately 400 km east of Aden. The strategic location of the project also is considered as one of the most suitable port sites in Yemen, which can best be described as the heart of all liquefied natural gas (LNG) markets worldwide. Its output can have an easy access to all markets, the Far East, India, Europe, and America, figure (5-1).

Figure (5-1)
the Location of the LNG project



Source: Yemen Liquefied Natural Gas (YLNG) company.

5.3 Owners/Stakeholders

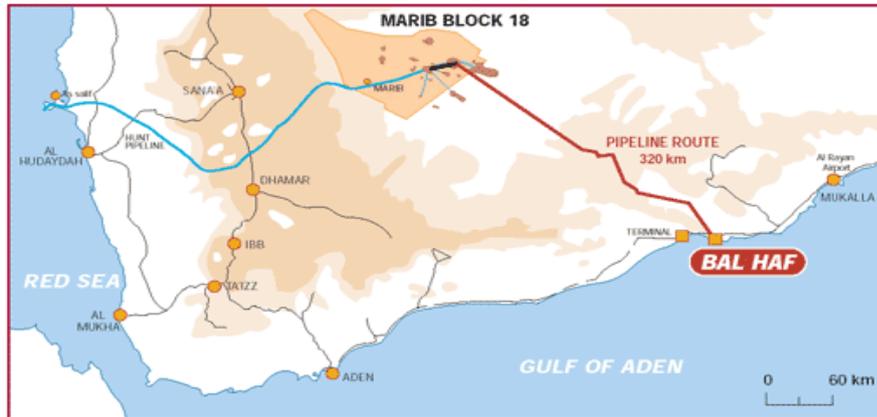
Shareholders of Yemen LNG include France's Total (42.9%), state-owned Yemen Gas (23.1%), US Hunt Oil (18%), and South Korea's SK (10%) and Hyundai (6%).

5.4 Feeding Fields

The feeding stocks for the project, which assumed to reach 830 million cubic feet per day, will come from the producing oilfields in Marib (Block 18) via a pipeline connecting the fields with Bal Haf, the exporting terminal on the Arabian Sea, figure (5-2).

Dahan

Figure (5-2)



Source: Yemen Liquefied Natural Gas (YLNG) company.

5.5 Targeted Markets

Yemen started looking for customers in the mid 90s, especially focusing on India and the Far East like South Korea and Taiwan. New customers such as the United States have been targeted as a potential market in the past few years.

5.6 Status of the Project

The liquefied natural gas project completed its phase 2 construction and is in operation since November 2009 when exported its first load of 149,000 cubic meters to south Korea.

5.7 Components of the Project

The project includes the liquefaction plant, two trains, two storage tanks, the marine terminals and a fleet of methane tankers, figure (5-3). The project also includes the construction of two gas lines. The first line is a 320 km, 34-inch pipeline from Marib (the producing fields) to Bal Haf (the exporting terminals). The second line is a 200 km pipeline, which will carry gas from the producing fields to Sana'a (the capital) for the domestic use then can be expanded to cover different potential areas in the country.

Figure (5-3) LNG Project



Source: Yemen Liquefied Natural Gas (YLNG) company.

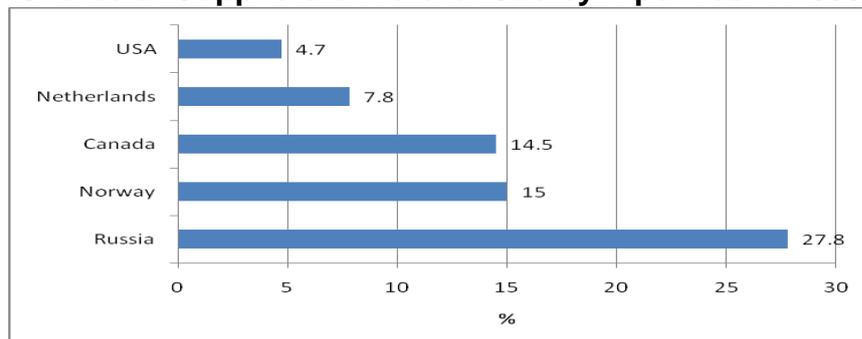
5.8 Current Contracts

Although it faces strong competition from existed sellers in the region, Yemen LNG, in February 2005, announced that it was able to secure the sale of its gas and signed agreements to supply buyers with up to 6.5 million tons of natural gas annually. Two agreements were signed to provide Tractebel EGI, part of the French utility giant Suez, with 2.5 million tons of LNG yearly, while Total, the leading shareholder of Yemen LNG, will purchase 2 million tons annually. Both will ship natural gas to the United States for 20 years. The third agreement was with Kogas (Korea Gas Corp.) as Yemen will supply South Korea between 1.3 million and 2 million tons each year for 20 years.

6. Trade of Natural Gas

Demand for natural gas is highly seasonal, which depends on many factors such as weather, income, demographic trends, and consumer preferences. The expansion in gas power generations has driven the growth in natural gas and LNG higher worldwide. Pipelines transport most of the gas traded in the world, especially in Europe and North America markets. Russia, Norway, Canada, Netherland, and USA are the major pipelines suppliers in these markets; they supplied about 70% of the world total in 2009, figure (6-1).

Figure (6-1)
Shares of Suppliers of Natural Gas by Pipelines in 2009



Source: Data collected from Statistical Review of Energy Report, 2010

Liquefied natural gas (LNG) trade is only complementing the pipeline gas supply in these two markets, whereas most of the gas in the Asian Pacific market is traded in the form of LNG. The share of LNG is increasing overtime, while it was 3.9 % of the total gas traded in the world in 1990, it reached 27.7 % in 2009, growing at an average rate of 10.34 % annually.

The increase in LNG trade is due to the increasing demand globally, the declining domestic natural gas resources in gas-consuming countries, and due to lower transportation costs, advanced liquefactions and technologies which have driven the cost of LNG down by 30%.

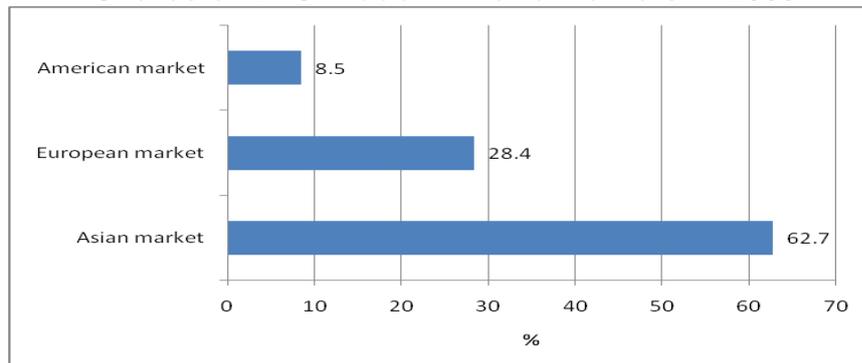
In 2009, 18 exporting countries shipped 242.77 billion cubic meter (bcm) of LNG to 22 LNG importing countries. Qatar, Malaysia, Indonesia, and Australia are major exporting countries accounted for 53.2 % of the total LNG export while Japan, Korea, Spain, and France are considered to be the main importing countries accounted for 66.1 % of the total world imports.

Dahan

In 2009, the shares of traded LNG in the world markets, the Asian, European, and American, are 62.7 %, 28.4 %, and 8.5 %, respectively, figure (6-2). Intra-regional trade in the Asian market accounted for approximately 58.2 % of its total LNG trade in 2009. Malaysia, Australia, and Brunei supplied 41 % of the Asian consumption, whereas 17.2 % was supplied by Indonesia.

Japan is the largest LNG importer in the world; it imported about 35.4% of world total, followed by South Korea 14.1 %, Spain 11.2 %, and France in the fourth place with 5.4 %.

Figure (6-2)
Shares of LNG Trade in World Markets in 2009



Source: Data collected from Statistical Review of Energy Report, 2010

While Algeria, Nigeria, and Egypt supply about 72% of the LNG in the European market, Trinidad and Tobago, Egypt, and Nigeria supply most of the LNG imported by the American market, accounted for 89.6 % of the total market for the same year.

7. The Future of Natural Gas

It was forecasted by the Energy Information Administration (EIA) that world consumption of natural gas will reach 156 tcf by 2025, growing at an average rate of 2.3 % annually between 2002 and 2025. The share of natural gas among energy sources will increase from 23% to 28% for the same period, and about 50 % of the incremental growth will go for electricity generation.

Imports by the Asian market are forecasted to double by the year 2015 whereas imports by the European market is forecasted to increase 40% of demand in 2015 and more than 50% by 2025.

It is also expected that North America's import capacity will continue to expand in the future and more than 50 proposals, to build new re-gasification facilities, have been put forth. The market is expected to counter major growth in LNG trade as new LNG import facilities were expected to operate soon bringing about 20 trillion cubic feet new import capacity to the region.

8. Research Findings

The previous analysis shows that potential gas consumers in Yemen such as power generation, cement industry, and residential sector are the major players that will permit for such gas use and extension, as demand for electricity is expected to increase in the future.

The analysis indicates that the expansion in gas power generation worldwide will drive the growth in natural gas and LNG in the coming decades, and this will require new sources to enter the gas markets.

New LNG import facilities in many countries, especially the north American gas market, were expected to go on line soon. These will bring about new import capacity to all regions in the world.

The analysis also indicates that advances in liquefactions and technologies have driven the cost of LNG down by 30%; this encourages new producers to enter into the markets in order to fulfill the world growing demands.

9. Conclusion and Recommendations

To speed the process of encouraging the use of gas in the domestic use, especially the gas fired power generations, the government of Yemen has the option to invest in gas sector by offering low prices to gas consumers. This, no doubt, would encourage rapid consumption growth and in the replacement of oil products by gas.

The expansion in gas power generation, the large number of new terminals and projects that have been proposed around the world and the expansion of the existing ones, no doubt, will increase competition not only among original suppliers, but among new producers as well.

Advances in liquefactions and technologies which have reduced the cost of LNG during the past decades are also a sign for more competition between producers in the future. The cost and location advantages, however, are likely to persist in the market.

All these facts can prove that Yemen has the ability to secure footholds in the gas markets in the coming years since it has the reserves, the completed gas infrastructures, and the location advantage, which make it one of the potential gas exporters in the region.

Exporting Yemen's natural gas and securing foothold in the gas markets in the future will depend on several factors such as: a) Yemen's foreign policy and relations. There should be a change in Yemen's foreign policy relationships allowing and even encouraging the prospects of gas exports to the targeted markets. b) The skills and abilities of chosen delegates to negotiate gas deals with buyers. c) Encouraging foreign investors to invest in the development of the gas sector. Such MNCs would bring in State-of-the Art technologies and skills.

Dahan

Facing these challenges, Yemen has to develop a special and flexible marketing strategy seeking: a) the reduction in production and processing costs and focusing more in the larger modern tankers to counter for the problem of high transportation costs. b) targeting all importing countries, especially those with no or insufficient resources and huge market potential.

References

- Abdulkarim, A. Dahan 1996, 'Economic Analysis of Energy Consumption in Yemen', Ph.D. thesis, University of Arizona, Tucson.
- Ali, Alzabidy 2000, *Studying Constructing Strategic LPG Storage in Republic of Yemen*, a report prepared by Yemen Consultant House, Sana'a, Yemen.
- Energy Information Administration, *U.S. Natural Gas Markets: Recent Trends and Prospects for the Future*, U. S. Department of Energy.
- Ian, W & Jonathan, S (eds.) 2002, *Natural Gas In Asia: The Challenge of Growth in China, India, Japan and Korea*, Oxford Institute, Oxford , N.Y.
- James, T. Jensen 2003, 'The LNG revolution', *The Energy Journal*, vol. 24, no. 2, pp. 1–45.
- Liquefied Natural Gas (LNG), [http:// www.naturalgas.org](http://www.naturalgas.org)
- Mohammed, Alshami 2000, *An economic analysis of natural gas sector and its use in Yemen*, a report prepared by Resource Development Consultant, Sana'a, Yemen.
- National Petroleum Council 2003, *Balancing natural gas policy: Fueling the demands of a growing economy*, Task group report and LNG subgroup report, National Petroleum Council.
- Organization of Arab Petroleum Exporting Countries, *Prospects for Growth of the Gas Industry, Trends and Challenges*, Issue No.103, Volume 28 of the Oil and Arab Cooperation.
- Statistical Review of Energy Report, 2010.
- Taha, Alahdal 2002 , 'Yemen gas outlook: The Yemen LNG Project' Oil & gas opportunities in west Asia' paper presented to the oil & gas conference in Yemen, Sana'a, April 2002.
- The World Bank 2002, *Economic Growth in the Republic of Yemen, Sources, Constraints, and Potentials*, The World Bank, Sana'a.
- The World Bank 2004, *The Oil & Gas Sector in the Republic of Yemen*, World Bank Oil & Gas Policy Division.
- The Worlds Energy Supply. Past, Present, and Future, [http:// www.abovetopsecret.com](http://www.abovetopsecret.com)
- Tomko, Hosoe 2004, 'Japan will continue to dominate Asian LNG picture', *Oil & Gas Journal Supplement*, viewed 8 March 2004.
- Uses of Natural Gas, [http:// www.naturalgas.org](http://www.naturalgas.org)
- Worldwide gas, LNG demand poised to surpass oil, *Oil & Gas Journal* Sept.22, 2003.
- Yris, Olaya 2006, 'World LNG Trade Model', Ph.D. thesis, Colorado School of Mines, Golden.