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# NATURAL GAS RESERVES, DEVELOPMENT & PRODUCTION IN QATAR

Dr Naji ABI-AAD  
OME Senior Advisor

Oil, Gas & Petrochemicals in Qatar  
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Espace Beethoven - Bâtiment 3 - Route des Lucioles - B.P. 248 - 06905 Sophia Antipolis Cédex - France

Tél. (33) 04 92 96 66 96 - Fax. (33) 04 92 96 66 99

e.mail : omesa @iway.fr

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## **Natural Gas Reserves, Development & Production in Qatar**

Qatar entered the club of natural gas exporters in early 1997 when the first shipment of liquefied natural gas (LNG) left the emirate for Japan. Qatar was helped by the discovery in 1971 of the supergiant North Field gas field, the country's suitable location between the established gas consuming markets in Europe and Southeast Asia, and its proximity to developing markets in the Indian subcontinent and in neighbouring countries. All that have combined to make gas export projects from Qatar economically viable and commercially attractive.

In addition to export-oriented development, increased gas production from the North Field is planned for meeting a growing domestic demand for gas as fuel and feedstock for power generation and desalination plants, as well as value-added petrochemical and fertiliser industries.

### **Natural Gas Reserves and Development**

Due to appraisal studies of what is now known as the North Field gas field, official estimates of Qatar's proved gas reserves have risen steadily from 2,265 billion cubic metres (cu m) in 1981 to 6,428 billion cu m in 1992 and 8,500 billion cu m since 1996. In early 1997, Petroconsultants estimated the emirate's remaining gas reserves at a much higher figure of 10,270 billion cu m out of a total discovered of 10,540 billion cu m, representing an exploitation rate of 97.4 per cent only, still the world's highest.

Qatar holds the world's third largest block of natural gas reserves, following those of Russia and Iran. Nevertheless, when the official estimates of gas reserves are compared to the populations and areas those countries, Qatar is by far on the world's top with around 16 million cu

m/inhabitant and 775 million cu m/square kilometre (sq km), compared to about 360,000 cu m/inhabitant and 3 million cu m/sq km for Russia, and some 350,000 cu m/inhabitant and 14 million cu m/sq km for Iran.

**Proved Natural Gas Reserves**  
(Billion cu m)

<b>Year</b>	<b>Volume</b>
1987	4,440
1988	4,440
1989	4,621
1990	4,621
1991	4,615
1992	6,428
1993	7,079
1994	7,079
1995	7,070
1996	8,500
1997	8,500

Sources: OPEC Annual Statistical Bulletin, various issues

In 1997, the Qatari gas reserves represented around 5.6 per cent of the world's total. The reserves to production ratio (R/P) for natural gas in the emirate in 1996 (production equals gross production minus reinjection), a measure often used as an indication of near-term supply capability, was relatively very high, covering around 540 years, compared to 226 years for the Middle East as a whole, and only 59 years world-wide.

Geologically speaking, the Qatari peninsula is occupied by a large, north-south trending, gentle uplift that exposes Eocene beds at the surface. The onshore sedimentary area amounts to some 20,500 sq km. The first petroleum discovery was in 1940 on the west side of the country with the Dukhan field, which has produced crude oil from three Upper Jurassic limestone reservoirs named Arab-III, Arab-IV and Uwainat. The deeper Permian Khuff onshore reservoirs of Dukhan have produced about 45

billion cu m of non-associated gas since 1978. The remaining reserves there are estimated at 14 billion cu m.

Associated gas reserves in Qatar occur in the Dukhan field, that contains about 142 billion cu m in Arab C, Arab D and Uwainat reservoirs, with a gas/oil ratio of some 25.5 cu m/barrel, and in three offshore fields, namely Idd Al-Shargi, Maydan Mahzan and Bul Hanine, which together contain around 127 billion cu m. Those oil fields were discovered between 1960 and 1970 in the offshore areas east and northeast of the Qatari peninsula, producing from the Lower Cretaceous Shuaiba limestone formation, the Upper Jurassic Arab-III and Arab-IV limestones and Uwainat limestone unit of the Middle Jurassic. Their gas/oil ratios range from about 17.5 cu m/barrel in the Bul Hanine and Maydan Mahzan fields to some 33.5 cu m/barrel in Idd Al-Shargi.

Oil and associated gas are also found in the Northwest Dome from the Cretaceous Kharab and the Jurassic Arab formations. That structure was found above the North Field, which is located in the northeastern offshore areas of the Qatari peninsula. More oil and associated gas are contained in the Arab formation of the Qatar Marine B structure, located above the northwest flank of the North Field.

The North Field, the supergiant gas field, was discovered in 1971. It is probably the largest non-associated gas field in the world, with proven reserves of around 6,430 billion cu m, and total gas in place estimated at about 10,800 billion cu m. The field covers an area of some 6,000 sq km in relatively shallow water. The reservoir is the Permian Khuff limestone formation at a depth of around 3,000 metres, containing gas in four layers, one on top of the other. The Khuff gas is sour, with up to 7 per cent CO<sub>2</sub> and 6 per cent H<sub>2</sub>S by volume. The condensate/gas ratio is between 1,050 and 1,400 barrels/1 million cu m, and the condensed water/gas ratio is about 35 barrels/1 million cu m. Depending on the rate of extraction and the final volume of recoverable reserves, the North Field could have a productive life of between 100 and 200 years, compared to around 25 years for oil reserves.

With the aim of making up the increasing shortfall in associated gas needed for domestic demand, including power generation and desalination plants, as well as value-added petrochemical and fertiliser industries, a first phase of the North Field project (Phase I) came on stream in September 1991.

That phase has brought a capacity to produce some 9.1 billion cu m/year of gas, and around 50,000 b/d of condensates. Its facilities consist of eight interconnected platforms, including two wellhead platforms and a production platform with two 12.5 million cu m/day gas separator trains, linked to the coast by two 85-km submarine pipelines. It also includes the construction of the NGL-III plant at Umm Said, which is now processing up to 21.24 million cu m/day of lean gas and 50,000 b/d of condensates. A gas desulfurisation unit to extract hydrogen sulphide was also built at Umm Said extracting some 60,000-70,000 tons/year of sulphur for export, at the same time as improving the quality of the gas.

The Phase I was followed by the start-up in late 1996 of the Qatar Gas Liquefaction Co. (Qatargas) project, the first LNG export scheme in the emirate, which by May 1998 will be capable of producing some 6 million tons/year of LNG, from around 12.5 billion cu m/year of dry gas.

### North Field LNG Development Projects

Project	Production Starts	Gas Output (bcm/y)	LNG Output (Mt/y)	Liquids Output (b/d)	LPG Output (000 t/y)	Status (April 1998)	Cost (US\$ billion)
Phase I	1991	9.1	-	50,000	450	Onstream	1.3
Qatargas	1996-8	12.5	6	40,000	500	Onstream	6.0
Rasgas I	1999	10.3	5	35,000	415	Underway	4.5
Rasgas II	2001?	10.3	5	35,000	415	Intent letters	6.1
Enron	?	10.3	5	35,000	415	Uncertain	4.0
Elf/Sumi	?	8.3	4	30,000	300	Shelved	5.0
Eurogas	?	12.5	6	44,000	500	Shelved	7.5

Subsequent development phases would include other LNG schemes such as Ras Laffan LNG (Rasgas) which is now going ahead, and may be another project (Enron) that has not yet been finalised, as well as gasline export schemes (to Pakistan, Dubai, Europe, and the Gas Grid of the Gulf Co-operation Council—GCC, among many others).

## **Natural Gas Production**

Until the Phase I of the North Field development project came on stream in September 1991, Qatar's natural gas production consisted mainly of associated gas from both onshore and offshore oil fields, together with some non-associated gas from Khuff reservoirs and onshore gas cap structures. The non-associated Khuff-Dukhan gas production had helped the total output to stay relatively stable, and to be only slightly affected by movements in crude oil production.

Natural gas gross production, that totalled 6.49 billion cu m in 1986, increased slightly to 6.86 billion cu m in 1990 after fluctuating between 6 and 7.3 billion cu m/year. Marketed production of natural gas reached 6.3 billion cu m in 1990, slightly up from 5.8 billion cu m in 1986.

With the completion of the first phase, gross gas production sharply increased in 1991 to 10.13 billion cu m, of which 4.65 billion cu m came from the North Field, then soared in 1992 to 17.05 billion cu m, and jumped further up to between 18.3 and 19 billion cu m in the four following years. With the start-up of the Qatargas scheme in late 1996, gross output grew to an estimated 25 billion cu m in 1997.

Marketed gas production did not follow the sharp jump in production of 1991, rising to only 7.63 billion cu m. It surged, however, to 12.62 billion cu m in 1992, 13.5 billion cu m in 1993-95, and 13.7 billion cu m in 1996. The only losses now in gas production are due to shrinkage since flaring did stop in 1985 (with a minor exception in 1991).

Gas started to be reinjected in 1991, mainly into the ageing onshore Khuff reservoirs of the Dukhan field. The Khuff-Dukhan field is now turned into a strategic emergency reserve that may also be used during times of peak demand for new industrial and export projects, or reinjected into oil reservoirs when needed. Volumes of reinjected gas have risen from 1.2 billion cu m in 1991 to 2.83 billion cu m in 1992, 3.1 billion cu m in 1993-95, and 3.25 billion cu m in 1996. Reinjected gas is expected to keep constant at between 3 and 3.5 billion cu m throughout the first decade of the next century.

**Natural Gas Production**  
(Billion cu m)

Year	Gross Production	Gas Rejected	Gas Flared and Vented	Other Losses	Marketed Production
1986	6.49	0.00	0.00	0.69	5.80
1987	6.44	0.00	0.00	0.83	5.61
1988	6.49	0.00	0.00	0.63	5.86
1989	7.27	0.00	0.00	1.07	6.20
1990	6.86	0.00	0.00	0.56	6.30
1991	10.13	1.20	0.50	0.80	7.63
1992	17.05	2.83	0.00	1.60	12.65
1993	18.40	3.10	0.00	1.80	13.50
1994	18.30	3.00	0.00	1.80	13.50
1995	18.40	3.10	0.00	1.80	13.50
1996	18.95	3.25	0.00	2.00	13.70

Sources: OPEC Annual Statistical Bulletin, various issues

The annual level of production of dry gas from the North Field is now expected to reach between 28.5 and 33.5 billion cu m by the year 2000, and between 33.5 and 43.5 billion cu m in 2010, depending on the implementation of the field's development projects, which in turn rest on the gas export agreements (LNG and pipelines). With the annual output of associated gas expected to stay constant at around 1.5 billion cu m through 2010, the annual total production of gas is forecast to amount to

between 30 and 35 billion cu m by the year 2000, and between 35 and 45 billion cu m in 2010.

In addition to dry gas, the North Field first development phase has produced some 1.2 million tons/year of natural gas liquids (NGLs) for export, consisting mainly of light and heavy naphta, propane and butane. Output of liquid petroleum gas (LPG), which was doubled with the first phase to about 1 million tons/year, is growing further with the start-up of the Qatargas scheme, and is expected to reach some 1.5 million tons by 1999. In addition, the production of condensates which doubled to around 100,000 b/d with the first train of Qatargas, is anticipated to reach about 150,000 b/d in mid-1999.

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