

COUNTRY NOTES

The following Country Notes on Natural Gas provide a brief account of countries with significant gas resources. They have been compiled by the Editors, drawing upon a wide variety of material, including information received from WEC Member Committees, national and international publications.

The principal published sources consulted were:

- *Annual Statistical Bulletin 2005; 2006; OPEC;*
- *BP Statistical Review of World Energy, 2006;*
- Cedigaz data;
- *Energy Balances of OECD Countries 2003-2004; 2006; International Energy Agency;*
- *Energy Balances of Non-OECD Countries 2003-2004; 2006; International Energy Agency;*
- *Energy Statistics of OECD Countries 2003-2004; 2006; International Energy Agency;*
- *Energy Statistics of Non-OECD Countries 2003-2004; 2006; International Energy Agency;*
- *Oil & Gas Journal, 19 December 2006, PennWell Publishing Co.*

- *Quarterly Statistics, Fourth Quarter 2006; 2007; International Energy Agency;*
- *Secretary-General's 32nd Annual Report, A.H. 1425-1426/A.D. 2005; 2006, OAPEC*
- *World Oil, September 2006, Gulf Publishing Company*

Brief salient data are shown for each country, including the year of first commercial production of natural gas (where it can be ascertained).

Reserves/Production (R/P) ratios have been calculated on the basis of gross production less quantities re-injected.

Algeria

Proved recoverable reserves (bcm)	4 504
Production (net bcm, 2005)	87.3
R/P ratio (years)	42.8
Year of first commercial production	1961

For the purposes of the present *Survey*, the Algerian WEC Member Committee has reported a proved amount in place of 6 080 bcm, of which 4 504 bcm is classified as proved recoverable reserves. Gas reserves non-associated with crude oil account for 80% of proved recoverable reserves. An additional amount in place of 2 000 bcm, of which 960 bcm is deemed to be recoverable, has also been reported by the Algerian Member Committee.

Net production of natural gas in 2005 was the fifth highest in the world, after Russia, the USA,

Canada and Iran. About 45% of gross production was re-injected, while much smaller proportions were flared or abstracted as NGLs. About 74% of net production was exported: 39% of gas exports were in the form of LNG, consigned to France, Spain, Turkey, Belgium, the USA, Italy, Greece, the UK and Japan. Exports by pipeline in 2005 went to Italy, Spain, Portugal, Tunisia and Slovenia. Apart from oil and gas industry use, the main internal markets for Algerian gas are power stations, industrial fuel/feedstock and households.

Argentina

Proved recoverable reserves (bcm)	439
Production (net bcm, 2005)	45.6
R/P ratio (years)	8.7

Information published by the Secretaría de Energía with respect to Argentina's oil and gas reserves situation at end-2005 shows proved reserves of natural gas as 439 bcm, a 19% decrease from the end-2004 level of 542 bcm. The same source states that 'probable reserves', not yet proven but considered to be eventually recoverable, now stand at 249 bcm.

Gas extraction takes place in five sedimentary basins. The greatest production corresponds to the Neuquina Basin which provides 57% of the total, followed by the Austral Basin with 20%, the Northwest Basin with 14% and the Golfo San Jorge with 9%; the contribution of the Cuyana Basin is minimal. About 2.5% of current gross production is re-injected. Marketed production (after relatively small amounts are deducted

through flaring and shrinkage) is the highest in South America.

For many years, gas supplies have been augmented by imports from Bolivia, but this flow ceased in October 1999, as the focus of Bolivia's gas exports shifted to Brazil. In a further re-orientation of the South American gas supply structure, Argentina has become a significant exporter in its own right, with a number of pipelines supplying Chile and others to Uruguay and Brazil.

Consumption of indigenous and imported gas in 2004 was divided between the power generation market (33%), industrial fuel/feedstock (23%), residential/commercial uses (23%) and gas industry own use/loss (14%); about 7% was consumed as CNG in road transport.

Australia

Proved recoverable reserves (bcm)	755
Production (net bcm, 2005)	38.9
R/P ratio (years)	17.1
Year of first commercial production	1969

The level of proved recoverable reserves quoted above corresponds to 'Remaining commercial reserves at 1 January 2005' as given in *Oil and Gas Resources of Australia 2004*, published by Geoscience Australia in 2006. Doubtless due to the adoption of differing definitions of 'proved reserves', other published sources tend to quote substantially higher levels for reserves at end-2005, ranging (in terms of bcm) from *Oil & Gas Journal's* 783 to *World Oil's* 3 384.

Estimated additional reserves recoverable of 3 314 bcm correspond with 'Non-commercial reserves' of sales gas in the Geoscience Australia publication cited above, which also provides an alternative assessment, using the McKelvey classification, resulting in 'Economic Demonstrated Resources' of 2 587 bcm and 'Subeconomic Demonstrated Resources' of 1 482 bcm, giving a grand total of 4 069.

Australia's principal gas reserves are located in the Carnarvon, Gippsland, Browse, Bonaparte and Cooper Basins.

Gross production grew by over 60% between 1990 and 1996, reflecting in part higher domestic demand but more especially a substantial increase in exports of LNG (almost all to Japan) from the North West Shelf fields. Production growth has continued in recent years, but at a slower pace.

The main gas-consuming sectors in Australia are public electricity generation, the non-ferrous metals industry and the residential sector.

Azerbaijan

Proved recoverable reserves (bcm)	1 350
Production (net bcm, 2005)	5.7
R/P ratio (years)	>100

Azerbaijan is one of the world's oldest producers of natural gas. After years of falling production the outlook has been transformed by recent developments. Proved reserves of gas, as quoted by Cedigaz, have edged down from 1 370 to 1 350 bcm. *Oil & Gas Journal* and

OAPEC opt for a lower level (circa 850 bcm). Marketed production in 2005 was 5.7 bcm, of which much the greater part came from offshore fields. About 42% of current gross production is reported to be flared or vented.

Bangladesh

Proved recoverable reserves (bcm)	436
Production (net bcm, 2005)	14.0
R/P ratio (years)	31.1
Year of first commercial production	1961

Whilst the published volumes of proved gas reserves are not particularly large, much of Bangladesh is poorly explored and the potential for further discoveries is thought to be substantial. For the present *Survey*, the Cedigaz assessment of 436 bcm for proved recoverable reserves has been adopted in preference to *Oil & Gas Journal's* reduced level of 142 bcm.

Gas production has followed a rising trend for many years and has reached 14 bcm per annum. Natural gas contributes nearly three-quarters of Bangladesh's commercial energy supplies; its principal outlets are power stations and fertiliser plants. Consumption by the residential/commercial sector is growing rapidly.

Bolivia

Proved recoverable reserves (bcm)	740
Production (net bcm, 2005)	12.4
R/P ratio (years)	57.8
Year of first commercial production	1955

The level adopted for proved reserves at end-2005 reflects the view of Cedigaz: other published sources broadly concur. Assessments of gas reserves as at 1 January 2005, issued by the state hydrocarbons company YPFB and published by the Instituto Nacional de Estadística, show proved reserves as 27 tcf (765 bcm) and probable reserves as 22 tcf (623 bcm).

Exports to Argentina used to be the major outlet for Bolivia's natural gas, but the focus of Bolivia's gas export trade shifted towards Brazil following the inauguration of two major export lines, one from Santa Cruz de la Sierra to south-east Brazil in 1999 and another in 2000 from San Miguel to Cuiaba. Exports in 2005 amounted to 10.2 bcm.

Internal consumption of gas is still on a small scale (only about 2 bcm/yr), and confined almost entirely to electricity generation and industrial fuel markets, residential use being minimal at present.

Brazil

Proved recoverable reserves (bcm)	306
Production (net bcm, 2005)	11.2
R/P ratio (years)	20.8
Year of first commercial production	1954

Brazil's natural gas industry is relatively small at present compared with its oil sector. Proved reserves, as reported by the Brazilian WEC Member Committee, amount to 306 bcm and are the fifth largest in South America, having

increased by 29% over the past 3 years. The level of reserves reported corresponds with the category 'measured/indicated/inventoried' in the *Balanço Energético Nacional (BEN) 2006*, published by the Ministério de Minas e Energia. Of the latest assessment of proved recoverable reserves, approximately 25% is non-associated with crude oil. Additional recoverable reserves, not classified as proved, (corresponding with 'inferred/estimated' resources in the BEN) are put at just over 148 bcm.

Nearly one-third of current gross production of natural gas is either re-injected or flared. Marketed production is mostly used as industrial fuel or as feedstock for the production of petrochemicals and fertilisers. As a consequence of Brazil's huge hydroelectric resources, use of natural gas as a power station fuel had been minimal until fairly recently. The consumption picture is now changing as imported gas (from Bolivia and Argentina) fuels the increasing number of gas-fired power plants that are being built in Brazil. The use of CNG by road vehicles is now a significant feature of the gas market.

Brunei

Proved recoverable reserves (bcm)	340
Production (net bcm, 2005)	11.5
R/P ratio (years)	28.8

Natural gas was found in association with oil at Seria and other fields in Brunei. For many years this resource was virtually unexploited, but in the

1960s a realisation of the resource potential, coupled with the availability of new technology for producing and transporting liquefied natural gas, enabled a major gas export scheme to be devised. Since 1972 Brunei has been exporting LNG to Japan, and more recently to the Korean Republic. Occasional spot sales have been made to other destinations.

Despite annual exports approaching 10 bcm, Brunei's proved reserves as published by *Oil & Gas Journal* have remained virtually steady at just under 400 bcm since 1992. For the purpose of the present *Survey*, the somewhat lower level of 340 bcm quoted by Cedigaz, *World Oil* and BP has been adopted.

Nearly 80% of Brunei's marketed production is exported, the balance being mostly used in the liquefaction plant, local power stations and offshore oil and gas installations. Small quantities are used for residential purposes in Seria and Kuala Belait.

Canada

Proved recoverable reserves (bcm)	1 633
Production (net bcm, 2005)	176.2
R/P ratio (years)	7.9

Canada's gas reserves are the third largest in the Western Hemisphere. The proved recoverable reserves correspond with 'remaining established reserves' of marketable natural gas at 31 December, 2005, as assessed by the Canadian Association of Petroleum Producers (CAPP) in its *2006 Statistical Handbook*.

The recoverable established reserves are estimated to be 1 633 bcm. Western Canada is estimated to have an additional 2 700 bcm of natural gas. The provinces with the largest gas resources are Alberta (with 71% of remaining established reserves), British Columbia (21%) and Saskatchewan (6%).

The East Coast Offshore has about 15 bcm of proven reserves, with a potential for a further 500 bcm.

As with crude oil, the National Energy Board (NEB) undertook probabilistic estimates for the Mackenzie-Beaufort region, and it estimates that there could be 255 bcm of marketable natural gas at the mean probability. Additional resources in excess of 3 000 bcm could exist in Canada's north. At this time the Mackenzie Valley gas pipeline project, which would carry approximately 35 million m³/d to southern markets, is in the regulatory hearing phase.

Coal-bed methane has recently received a great deal of interest; production from Alberta was almost 2 million m³/d in 2004. Estimates of the recoverable resource are notoriously difficult to obtain. Figures of up to 7 000 bcm have been published, although there is no consensus.

Gross production of Canadian natural gas is the third highest in the world. Marketed gas output in 2005 was 176 bcm. Over 50% was exported to the United States. The largest users of gas within Canada are the industrial, residential and commercial sectors. A relatively small proportion is consumed in electricity generation.

China

Proved recoverable reserves (bcm)	2 350
Production (net bcm, 2005)	48.0
R/P ratio (years)	49.0
Year of first commercial production	1955

Past gas discoveries have been fewer than those of crude oil, which is reflected in the fairly moderate level of proved reserves. Gas reservoirs have been identified in many parts of China, including in particular the Sichuan Basin in the central region, the Tarim Basin in the north-west and the Yinggehai (South China Sea). China's gas resource base is thought to be enormous: estimates by the Research Institute of Petroleum Exploration and Development, quoted by Cedigaz, put total resources at some 38 000 bcm, of which 21% is located offshore. Most of the onshore gas-bearing basins are in the central and western parts of China.

The level of proved reserves adopted for the present *Survey* has been derived from published sources. Compared with the situation obtaining when the 2004 SER was being compiled, a growing consensus is evident in respect of China's gas reserves. OPEC and BP quote 2 350 bcm, which is also the level given by Cedigaz for 1 January 2005 – its 1 January 2006 level is presently under review; OAPEC has 2 229, while although *Oil & Gas Journal* gave 1 510 for reserves at 31 December 2005, it raised its estimate to 2 265 for end-2006. The only remaining outlier is *World Oil's* figure of

1 575 bcm. For present purposes, a level of 2 350 bcm has been adopted.

The major outlets for natural gas within China are as industrial fuel/feedstock (46%), oil/gas industry own use/loss (21%) and the residential/commercial sector (24%). Natural gas has relatively small shares in the generation of electricity and bulk heat. In January 1996, China began delivering natural gas to the Castle Peak power station in Hong Kong via a pipeline from the offshore Yacheng field; deliveries in 2005 were about 2.2 bcm.

Colombia

Proved recoverable reserves (bcm)	140
Production (net bcm, 2005)	6.7
R/P ratio (years)	18.2

The early gas discoveries were made in the north-west of the country and in the Middle and Upper Magdalena Basins; in more recent times, major gas finds have been made in the Llanos Basin to the east of the Andes. Proved reserves at end-2005 are quoted by the Unidad de Planeación Minero Energético (UPME) of the Ministerio de Minas y Energía, in its *Boletín Estadístico 1999-2005* as 3 994 bcf, plus 937 bcf for own use in the gas fields, giving a total of 4 932 bcf (139.7 bcm). This level compares with a fairly wide range of alternative estimates, extending from BP's 110 to *World Oil's* 190, with Cedigaz and *Oil & Gas Journal* close to the lower end at around 113 bcm.

At present a high proportion of Colombia's gas output (49% in 2005) is re-injected in order to maintain or enhance reservoir pressures. The major outlets for natural gas are own use by the gas industry (31% of total gas consumption in 2004), chemicals, cement and other industrial users (27%) and power plants (25%).

Residential/commercial consumers accounted for 14%, while CNG use in road transport is small but growing rapidly.

Denmark

Proved recoverable reserves (bcm)	82
Production (net bcm, 2005)	10.5
R/P ratio (years)	7.7
Year of first commercial production	1984

The Danish WEC Member Committee quotes the Danish Energy Authority (DEA), which does not use the terms proved and additional reserves, but employs the categories 'ongoing', 'approved', 'planned' and 'possible recovery'. The DEA expresses natural gas volumes in *normal cubic metres* (Nm³), measured at 0°C and 1 013 mb. For the purposes of the present Survey, all such data have been converted to *standard cubic metres*, measured at 15°C and 1 013 mb.

The figure for proved recoverable reserves (82 bcm) has been derived from the sum of 'ongoing' and 'approved' reserves (78 billion Nm³), while the figure for additional reserves recoverable (45 bcm) has been derived from the sum of 14 billion Nm³ 'planned' and 29 billion

Nm³ 'possible' reserves. Of the reported proved recoverable reserves, 44% is non-associated with crude oil. The Danish Member Committee also reports the amount of gas in place corresponding to the proved recoverable reserves as 564 bcm and that corresponding to the additional reserves recoverable as 53 bcm.

Egypt (Arab Republic)

Proved recoverable reserves (bcm)	1 894
Production (net bcm, 2005)	42.5
R/P ratio (years)	42.9
Year of first commercial production	1964

Proved reserves are the third largest in Africa, having risen 14% since the 2004 Survey, according to the latest data reported by the Egyptian WEC Member Committee. There is general agreement amongst the standard published sources on a level of around 1 894 bcm, with the exception of *Oil & Gas Journal*, which quotes 1 657 (unchanged at end-2006). Since the end of 2000, Egypt's gas reserves have exceeded those of its neighbour Libya. About 92% of its reported reserves are non-associated with crude oil.

The major producing area is the Mediterranean Sea region (mostly from offshore fields), although output of associated gas from a number of fields in the Western Desert and the Red Sea region is also important.

Marketed production has grown steadily in recent years and is now the second largest in

Africa. The main outlets at present are power stations, fertiliser plants and industrial users such as the iron and steel sector and cement works.

Germany

Proved recoverable reserves (bcm)	178
Production (net bcm, 2005)	16.6
R/P ratio (years)	10.2

Although it is one of Europe's oldest gas producers, Germany's remaining proved reserves are sizeable, and (apart from the Netherlands) they still rank as the largest onshore reserves in Western Europe. The principal producing area is in north Germany, between the rivers Weser and Elbe; westward from the Weser to the Netherlands border lies the other main producing zone, with more mature fields.

The proved recoverable reserves advised by the German WEC Member Committee draw upon a report issued by the Landesamt für Bergbau, Energie und Geologie, Hannover in 2006 and are some 45% lower than the corresponding level reported for the 2004 *Survey*. While Cedigaz, *World Oil* and BP all quote similar levels to that reported to the WEC, *Oil & Gas Journal* and OPEC show about 255 bcm, which may include the additional 64 bcm of 'probable reserves' reported by the Member Committee to be eventually recoverable.

Indigenous production provides only about 20% of Germany's gas supplies; the greater part of

demand is met by imports from the Russian Federation, the Netherlands, Norway, the UK and Denmark.

India

Proved recoverable reserves (bcm)	1 101
Production (net bcm, 2005)	30.4
R/P ratio (years)	34.3
Year of first commercial production	1961

A sizeable natural gas industry has been developed on the basis of the offshore Mumbai gas and oil/gas fields. Proved reserves at 1 April, 2005 have been reported by the Indian WEC Member Committee as 1 101 bcm, an increase of 46.6% on the level advised for the 2004 *Survey*. The revised figure appears to be consistent with the series of 'proved and indicated balance recoverable reserves' published by the Ministry of Petroleum & Natural Gas, which shows 1 075 bcm for such reserves at 1 April 2006.

Strong growth in India's offshore reserves raised them from 584 bcm (63% of total reserves) at 1 April 2004 to 761 bcm (69%) at 1 April 2005.

The Indian WEC Member Committee also reports that the proved amount of gas in place (of which the proved reserves constitute the recoverable portion) is 1 595 bcm.

Marketed production is principally used as feedstock for fertiliser and petrochemical manufacture, for electricity generation and as industrial fuel. The recorded use in the residential and agricultural sectors is very small.

Indonesia

Proved recoverable reserves (bcm)	2 754
Production (net bcm, 2005)	73.8
R/P ratio (years)	33.4

The Indonesian WEC Member Committee reports proved recoverable gas reserves as 97.26 tscf (2 754 bcm), 26% higher than those advised for the 2004 *Survey of Energy Resources*. There has been a noticeable convergence in other published assessments of Indonesia's proved reserves, which at the time of preparation of the 2004 SER varied widely, broadly ranging from 2 100 to 3 800 bcm. End-2005 assessments are all close to the level reported for the present *Survey*.

Indonesia's gas production is the highest in Asia. The main producing areas are in northern Sumatra, Java and eastern Kalimantan.

Exports of LNG from Arun (Sumatra) and Bontang (Kalimantan) to Japan began in 1977-1978. Indonesia has for many years been the world's leading exporter of LNG. Shipments in 2005 were chiefly to Japan (60%) but also to the Republic of Korea (24%) and Taiwan, China (16%). Indonesia exports about half of its marketed production, including (from early 2001) supplies by pipeline to Singapore (4.8 bcm in 2005).

The principal domestic consumers of natural gas (apart from the oil and gas industry) are power stations and fertiliser plants: the residential and commercial sectors have relatively small shares.

Iran (Islamic Republic)

Proved recoverable reserves (bcm)	26 740
Production (net bcm, 2005)	97.9
R/P ratio (years)	> 100
Year of first commercial production	1955

Iran's proved reserves are second only to those of the Russian Federation, (although now closely approached by those of Qatar). They account for 15% of the world total, and exceed the combined proved reserves of North America, South America and Europe (excluding the Russian Federation). The Iranian WEC Member Committee reports that at the end of 2005 proved reserves of natural gas were 26 740 bcm, marginally higher (+0.6%) than the end-2002 level reported for the 2004 *Survey of Energy Resources*.

For many years only minute quantities of associated gas output were utilised as fuel in the oil fields or at Abadan refinery: by far the greater part was flared. Utilisation of gas in the industrial, residential and commercial sectors began in 1962 after the construction of a pipeline from Gach Saran to Shiraz.

In 2005, 64% of Iran's gross production of 153 bcm of gas was marketed; about 21% was re-injected into formations in order to maintain or enhance pressure; about 10% was flared or vented and 5% lost through shrinkage and other factors. The marketed production volume of about 98 bcm was augmented by 5.8 bcm of gas imported from Turkmenistan, whilst 4.3 bcm was

exported to Turkey. Iran's principal gas-consuming sectors are electricity generation (39% of total consumption in 2004), residential users (32%) and industry (19%).

Iraq

Proved recoverable reserves (bcm)	3 170
Production (net bcm, 2005)	2.5
R/P ratio (years)	>100
Year of first commercial production	1955

Gas resources are not particularly large, by Middle East standards: proved reserves (as reported by OAPEC) account for less than 5% of the regional total. Most other published sources quote the same figure, the one exception being *World Oil*, with proved reserves given as 2 379 bcm.

According to data reported by Cedigaz, 70% of Iraq's proved reserves consist of associated gas, whilst cap gas and non-associated gas account for 15% each. A high proportion of gas output is thus associated with oil production: some of the associated gas is flared.

Between 1986 and 1990 Iraq exported gas to Kuwait. Currently all gas usage is internal, as fuel for electricity generation, as a feedstock and fuel for the production of fertilisers and petrochemicals, and as a fuel in oil and gas industry operations.

Kazakhstan

Proved recoverable reserves (bcm)	3 000
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Production (net bcm, 2005)	23.7
R/P ratio (years)	>100

Kazakhstan has substantial resources of natural gas and may well become a major player on the world stage. The chief discovery so far has been the giant Karachaganak field, located in the north of Kazakhstan, near the border with the Russian Federation. Another major field is Tengiz, close to the north-east coast of the Caspian Sea.

The level of proved reserves adopted for the present *Survey* is based upon the figure quoted by the Government of Kazakhstan as 'approved extracting stocks', which could be construed as equivalent to proved recoverable reserves. Lower levels are given by published compilations of reserves data: Cedigaz 1 900 bcm, OAPEC and OGJ 1 841 bcm (although OGJ has raised its assessment to 2 832 bcm as at 1 January 2007).

Kuwait

Proved recoverable reserves (bcm)	1 586
Production (net bcm, 2005)	12.7
R/P ratio (years)	>100
Year of first commercial production	1960

Note: Kuwait data include its share of Neutral Zone.

Gas reserves (as quoted by OAPEC and other published sources) are relatively low in regional terms and represent only about 2% of the Middle East total. All of Kuwait's natural gas production has been associated with crude oil, so that its

availability has been basically dependent on the level of oil output. However, official announcements during 2006 of two major discoveries of non-associated gas have changed the picture. In March it was announced that almost 35 tcf (circa 1 000 bcm) of gas had been discovered in the 'southern north' part of Kuwait; this was followed in June by news of an extractable amount of almost 5 tcf (ca. 140 bcm) in the west of the country. These discoveries are not yet reflected in reserves assessments but, if validated, will have a significant impact in due course.

After allowing for a limited amount of flaring and for shrinkage due to the extraction of NGLs, Kuwait's gas consumption is currently about 13 bcm/yr, one-third of which is used for electricity generation and desalination of seawater.

Libya/GSPLAJ

Proved recoverable reserves (bcm)	1 491
Production (net bcm, 2005)	11.3
R/P ratio (years)	> 100
Year of first commercial production	1970

Proved reserves - the fourth largest in Africa - have been largely unchanged since 1991, according to OAPC and other published sources. Utilisation of the resource is on a comparatively small scale: net production in 2005 was only about a quarter that of Egypt.

Since 1970 Libya has operated a liquefaction plant at Marsa el Brega, but LNG exports (in

recent years, only to Spain) have fallen away to only 0.9 bcm/yr.

Local consumption of gas is largely attributable to petrochemical/fertiliser plants and oil and gas industry use.

Malaysia

Proved recoverable reserves (bcm)	2 480
Production (net bcm, 2005)	63.5
R/P ratio (years)	35.5
Year of first commercial production	1983

Exploration of Malaysia's offshore waters has located numerous fields yielding natural gas or gas/condensates, mainly in the areas east of the peninsula and north of the Sarawak coast. Proved reserves (as quoted by Cedigaz) now stand at 2 480 bcm and rank as the fourth highest in Asia. Other published reserve assessments range from *World Oil's* 1 642 via *Oil & Gas Journal* at 2 124 to OPEC and BP at 2 480 bcm.

Malaysia became a major gas producer in 1983, when it commenced exporting LNG to Japan. This trade has continued ever since, supplemented in recent years by LNG sales to the Republic of Korea and Taiwan, China and by gas supplies via pipeline to Singapore. In 2005, spot sales of LNG were made to Spain and the USA.

Domestic consumption of gas has become significant in recent years, the major market being power generation. The other principal

outlet for natural gas, apart from own use within the oil/gas industry, is as feedstock/fuel for industrial users. Small amounts of CNG are used in transport, reflecting an official programme to promote its use.

Mexico

Proved recoverable reserves (bcm)	412
Production (net bcm, 2005)	39.2
R/P ratio (years)	9.5

The Mexican WEC Member Committee reports that proved recoverable reserves at end-2005 were 14 557 bcf (412 bcm), reflecting the level of 'remaining proved reserves of dry natural gas' stated by *Petróleos Mexicanos (Pemex)* in their *Informe Estadístico de Labores 2005*. Within the total amount of proved reserves, 43% are located in the southern region, 30% in the northern region, 17% in the marine north-east region and 10% in the marine south-west region. Pemex also provides estimates of two further resource categories: 'probable reserves' of 15 246 bcf (432 bcm) and 'possible reserves' of 16 912 bcf (479 bcm).

Production of natural gas has been on a slowly declining trend in recent years. The greater part of Mexico's gas production (66.5% in 2005) is associated with crude oil output, mostly in the southern producing areas, both onshore and offshore.

The Mexican WEC Member Committee reports that Pemex is carrying out a major exploration

programme for natural gas. This has been spurred by the large increase in natural gas utilisation for electricity generation in the last decade. At present, one regasification plant (0.5 bcf/d) is operating in the Gulf of Mexico importing LNG, and another is being built on the Pacific coast near the US border.

The largest outlet for gas is as power station fuel (45% of total inland disposals in 2004); industrial fuel/feedstock 30%; the energy industry consumed about 23%, and households about 2%. Mexico habitually exports relatively small amounts of gas to the USA and imports somewhat larger quantities.

Myanmar

Proved recoverable reserves (bcm)	485
Production (net bcm, 2005)	13.0
R/P ratio (years)	35.1

Myanmar has long been a small-scale producer of natural gas, as of crude oil, but its resource base would support a substantially higher output of gas. There appear to be widely differing views on the level of proved reserves: for the purpose of the present *Survey*, the level of 485 bcm published by Cedigaz has been utilised; *World Oil's* figure equates to 358 bcm and that in *Oil & Gas Journal* to only 283.

Until 2000, gas production tended to oscillate around a slowly rising trend. With the commencement of exports of natural gas to Thailand from two offshore fields, first Yadana

and subsequently Yetagun, Myanmar's gas industry has entered a new phase. As offtake by Thailand's 3 200 MW Ratchaburi Power Plant has built up, gas production in Myanmar has moved onto a significantly higher level than in the past. Domestic consumption of gas is mainly for power generation.

Netherlands

Proved recoverable reserves (bcm)	1 256
Production (net bcm, 2005)	73.1
R/P ratio (years)	16.2

The Netherlands WEC Member Committee, quoting advice from the Netherlands Institute of Applied Geoscience TNO, reports proved recoverable reserves as 1 256 bcm, somewhat below the range of end-2005 volumes given by the standard published sources (1 387-1 756 bcm). However, Dutch reserves still represent one of the largest gas resources in Western Europe. The giant Groningen field in the north-west of the Netherlands accounts for almost two-thirds of the country's proved reserves.

The estimated additional amount in place is given by the Member Committee as ranging from 180 to 440 bcm, but no indications of the volume recoverable were available to report.

Gas production has tended to fluctuate in recent years, depending on weather conditions in Europe, thus demonstrating the flexibility that enables the Netherlands to play the role of a swing producer.

Over half of Netherlands gas output is exported, principally to Germany but also to Italy, Belgium, France, the UK and Switzerland. The principal domestic markets are electricity and heat generation, the residential sector and industrial fuel and feedstock.

New Zealand

Proved recoverable reserves (bcm)	30
Production (net bcm, 2005)	3.9
R/P ratio (years)	7.3
Year of first commercial production	1970

The Maui offshore gas/condensate field (discovered in 1969) is the largest hydrocarbon deposit so far discovered in New Zealand: it presently accounts for 46% of the country's economically recoverable gas reserves. Effective utilisation of its gas resources has been a key factor in New Zealand's energy policy since the early 1980s.

The proved recoverable reserves reported by the New Zealand WEC Member Committee for the present *Survey* correspond with estimates of 'proven and probable reserves' (or P50 values) compiled by the Ministry of Economic Development, on the basis of information provided by field operators. These reserves have been assessed within the context of 'ultimate recoverable reserves' of about 159 bcm. The Member Committee also reports an estimated additional amount in place of 1 144 bcf (approximately 31 bcm), based on reserves in non-producing fields for which Petroleum

Mining Permits have been granted. All fields have been appraised and all final investment decisions concerning development have been made. Five fields (Kupe, Pohokura, Tui, Maari and Turangi) are scheduled to come into production during 2006-2008.

The latest assessment of proved reserves is substantially lower than that for end-2002 (42 bcm), largely due to a major reduction in Maui's reserves. The Maui field came into commercial production in 1979 when a pipeline to the mainland was completed. Three plants were commissioned in the 1980s to use indigenous gas, producing (respectively) methanol, ammonia/urea and synthetic gasoline. Ten gas fields were in production in 2005, with Maui accounting for 57% of total output.

An extensive transmission and distribution network serves industrial, commercial and residential consumers in the North Island. Small (and declining) amounts of CNG are used in motor vehicles.

Nigeria

Proved recoverable reserves (bcm)	5 150
Production (net bcm, 2005)	22.4
R/P ratio (years)	>100
Year of first commercial production	1963

In contrast to the situation reported on in the 2004 *Survey*, published assessments of Nigeria's proved reserves of natural gas at the

end of 2005 all fall within a narrow band (5 150 to 5 230 bcm). The level adopted for the present *Survey* is that quoted by Cedigaz and closely matched by OPEC (5 152), *World Oil* (5 154) and OAPEC/BP/*Oil & Gas Journal* at around 5 230 (note that OGJ quotes 5 151 for gas reserves as at 1 January 2007).

Nigeria's proved reserves on this basis are now the largest in Africa, ahead of those of Algeria, but historically its degree of gas utilisation has been very low. Much of the associated gas produced has had to be flared, in the absence of sufficient market outlets. Efforts are being made to develop gas markets, both locally and internationally, and to reduce flaring to a minimum. There are projects to replace non-associated gas by associated gas in supplies to power stations and industrial users. About 42% of Nigeria's gross gas production of 54.3 bcm in 2005 was flared or vented.

The Bonny LNG plant (commissioned in the second half of 1999) exported 12 bcm of natural gas as LNG during 2005, chiefly to Spain and France, with smaller quantities going to Portugal, Turkey and the USA. A project is under way for the construction of a pipeline to supply Nigerian associated gas to power plants in Benin, Togo and Ghana.

Norway

Proved recoverable reserves (bcm)	2 358
Production (net bcm, 2005)	87.0
R/P ratio (years)	25.9
Year of first commercial production	1977

Resource data have been obtained primarily from the Norwegian Petroleum Directorate (NPD). Proved reserves are the highest in Europe (excluding the Russian Federation). The bulk of reserves is located in the North Sea, the rest having been discovered in the Norwegian Sea and the Barents Sea. The level of proved recoverable reserves reported by the NPD amounted to 2 358 bcm at end-2005; similar levels are quoted by *Oil & Gas Journal*, *World Oil* and BP. On the other hand, Cedigaz, OAEPC and OPEC give higher figures, which appear to include the NPD's 'contingent resources' and 'potential from improved recovery'. At end-2005, contingent resources in fields were put at 156 bcm, those in discoveries at 494 bcm and potential from improved recovery at 100 bcm. In addition, NPD estimated that the recoverable potential of undiscovered gas was 1 900 bcm.

In the NPD's terminology, 'reserves' cover 'remaining recoverable, saleable petroleum resources in petroleum deposits that the licensees have decided to develop, and for which the authorities have approved the PDO³ or granted a PDO exemption'. 'Contingent resources' are defined as 'discovered quantities of petroleum for which no development decision has yet been made'. 'Undiscovered resources' are 'petroleum volumes which are expected to be present in defined exploration models, confirmed and unconfirmed, but which have not yet been proven through drilling'.

Norway's gas production continues to follow a rising trend. A high proportion (30% in 2005) of output is re-injected; nearly 94% of marketed production is exported. In 2005 supplies went to 12 European countries, principally Germany, France, Belgium, Italy, the UK and the Netherlands. Apart from gas industry own use, Norway's internal consumption of gas is still at a very low level, being largely confined to minor feedstock use.

Oman

Proved recoverable reserves (bcm)	829
Production (net bcm, 2005)	16.7
R/P ratio (years)	41.0
Year of first commercial production	1978

Oman is one of the smaller gas producers in the Middle East, with moderate proved reserves which have fallen slightly since 2002, on the basis of OAEPC data. The levels of reserves quoted in other published sources are fairly widely dispersed, ranging from *World Oil's* 766 bcm to BP's 1 000, with OAEPC and *Oil & Gas Journal* at 829 and Cedigaz and OPEC towards the top end at 995. For the sake of consistency with previous editions, the present *Survey* uses the level published by OAEPC.

Oman has developed its utilisation of gas to such an extent that oil has long been displaced as the Sultanate's leading energy supplier. Currently, the principal outlet for marketed gas is the power generation/desalination complex at

³ PDO = Plan for Development and Operation

Ghubrah. Other gas consumers include mining and cement companies.

The Oman LNG project began operating in early 2000, with the first shipment (to the Republic of Korea) taking place in April. Regular shipments of LNG are also being made to Japan, whilst during 2005 additional supplies (including spot cargoes) were delivered to Spain, France, the USA, India and Taiwan, China.

Pakistan

Proved recoverable reserves (bcm)	807
Production (net bcm, 2005)	30.8
R/P ratio (years)	23.9
Year of first commercial production	1955

The levels of natural gas resources and reserves quoted in the present *Survey* have been derived from the *Pakistan Energy Yearbook 2006*, published by the Hydrocarbon Development Institute of Pakistan, Ministry of Petroleum and Natural Resources. Proved recoverable reserves have been taken as equivalent to 28.5 tcf of 'Balance Recoverable Reserves' at 30 June 2006, expressed in normalised tcf at 900 Btu/cf. The *Yearbook* shows this figure as being derived from 'Original Recoverable Reserves' of 49.0 tcf (1 388 bcm) by subtracting cumulative production of 20.5 tcf (581 bcm). The resulting level is marginally higher than that reported for end-2002 by the WEC Member Committee (28 288 bcf, equivalent to 801 bcm). It is perhaps illustrative of the uncertainties of resource assessment that only two of the standard published sources

consulted in the course of the present *Survey* are agreed upon a level for Pakistan's gas reserves (*Cedigaz* and *World Oil*: 852 bcm).

Currently, the major gas-producing fields are Sui in Balochistan and Qadirpur and Mari in Sindh. Only 4% of natural gas output is associated with oil production.

Production of natural gas increased by 60% over the 5 years to 2005-06. The major markets for gas (excluding own use) in that year were power generation (40%), industrial users (24%), fertiliser plants (16%) and households and commercial consumers (16%). Rapidly growing quantities of CNG are consumed as a transport fuel.

Papua New Guinea

Proved recoverable reserves (bcm)	428
Production (net bcm, 2005)	0.1
R/P ratio (years)	> 100
Year of first commercial production	1991

The Hides gas field was discovered in 1987 and brought into production in December 1991. Other resources of non-associated gas have been located in PNG, both on land and offshore. Published assessments of proved reserves range between *Oil & Gas Journal's* 345 bcm and the 430 quoted by BP, with *World Oil* positioned midway at 388 bcm. For the present *Survey*, the (unchanged) level of 428 bcm given by *Cedigaz* and OPEC has been retained.

Up to the present, the only marketing outlet for Hides gas has been a 42 MW gas-turbine power

plant serving the Porgera gold mine; offtake averages 14-15 million cubic feet/day. Associated gas produced in the Kutubu area is mostly re-injected into the formation.

The PNG Gas Project for a gas export pipeline to Australia is progressing slowly. The proposed pipeline includes a 500 km undersea section across the Torres Strait and 2 100 km of line following a route southwards close to the coastline of Queensland. ExxonMobil, which has a 26% working interest, reported in its 2006 *Financial and Operating Review* that it was advancing the project. The Australian pipeline consortium had withdrawn from the scheme following the completion of front-end engineering and design. ExxonMobil also reported that 'multiple development options', including an LNG project, were being explored.

Peru

Proved recoverable reserves (bcm)	338
Production (net bcm, 2005)	1.5
R/P ratio (years)	>100

In terms of natural gas reserves, Peru is placed in the middle rank of South American countries, alongside Argentina, Bolivia and Brazil. The Peruvian WEC Member Committee reports proved recoverable reserves as 11 927 660 million cubic feet (337.7 bcm) at end-2005. Some published sources (Cedigaz, BP) concur, but OGJ and *World Oil* specify a lower figure (247 bcm) which probably reflects the end-2003 level.

The WEC Member Committee also reports that 97.4% of Peru's 'proved reserves' are non-associated and that reserves recoverable, in addition to the proved amount, are some 193 bcm – this reflects the level of 'probable reserves' published by the Ministerio de Energía y Minas, which also quotes 'possible reserves' of 11 612 bcf (329 bcm) in its *Anuario Estadístico de Hidrocarburos 2005*.

Gas output used to be mostly associated with oil production, but the coming on-stream of Pluspetrol's non-associated gas production in the Selva Sur has radically altered the situation, such that less than 17% of gross production in 2005 was associated with oil production. An appreciable proportion of production (68% in 2005) is re-injected. Flaring and shrinkage are reported to be on a small scale.

Marketed production of gas averaged about 0.4 bcm/yr from around 1990 until 2003 but rose sharply in 2004 and 2005, with Pluspetrol's new output. Electricity generation accounts for about 80% of Peru's gas consumption.

Qatar

Proved recoverable reserves (bcm)	25 633
Production (net bcm, 2005)	45.8
R/P ratio (years)	>100
Year of first commercial production	1963

Qatar's gas resources far outweigh its oil endowment: its proved reserves of gas of almost 26 trillion m³ are only exceeded within the Middle East by those reported by Iran, and

account for nearly 15% of global gas reserves. The WEC Member Committee for Qatar reports that remaining proved recoverable reserves (here defined as 'proven ultimate recovery minus cumulative production') were 905.24 tcf (25 633 bcm) at end-2005. Published sources are all closely in line with this level.

Although associated gas has been discovered in oil fields both on land and offshore, the key factor in Qatar's gas situation is non-associated gas, particularly that in the offshore North Field, one of the largest gas reservoirs in the world. The WEC Member Committee reports that non-associated gas accounts for almost 99% of Qatar's gas reserves.

Production of North Field gas began in 1991 and by 2005 Qatar's total annual gross production had risen to about 58 bcm; 3.5% was re-injected and around 10% lost through shrinkage. The gas consumed locally is principally for power generation/desalination, fertiliser and petrochemical production and gas industry own use.

Since the end of 1996, Qatar has become a substantial exporter of LNG; in 2005, shipments exceeded 27 bcm of gas, of which 31% was consigned to Japan, 31% to the Republic of Korea, 21% to India, 17% to Spain and a small amount to the USA.

Romania

Proved recoverable reserves (bcm)	121
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Production (net bcm, 2005)	12.4
R/P ratio (years)	9.6

The Romanian WEC Member Committee reports proved recoverable reserves of 120.9 bcm, a further reduction on the 163.3 bcm reported for the 2004 *Survey* and the 405.6 bcm advised for the 2001 edition. Published assessments of Romania's gas reserves vary widely, ranging from *Oil & Gas Journal's* 101 bcm (reduced to only 63 at end-2006) to Cedigaz and BP at around 630 bcm. The proportion of proved recoverable reserves that is non-associated with crude oil is reported to be 90.4%.

The reported additional amount of 'unproved' gas in place has fallen again, from 100.6 to 70.7 bcm, of which approximately 32% is considered to be recoverable.

After peaking in the mid-1980s, Romania's natural gas output has been in gradual secular decline, falling to around 12 bcm in recent years, only about one-third of its peak level. Indigenous production currently supplies about two-thirds of Romania's gas demand; the principal users are power stations, CHP and district heating plants, the steel and chemical industries and the residential/commercial sector.

Russian Federation

Proved recoverable reserves (bcm)	47 820
Production (net bcm, 2005)	640.6
R/P ratio (years)	71.5

The gas resource base is by far the largest in the world: Russia's proved reserves are quoted as 47 820 bcm by Cedigaz. Other major published sources quote figures very similar to this level.

However, there is some evidence to suggest that the generally quoted quantification of Russia's gas reserves may overstate their magnitude in relation to the proved recoverable reserves reported for certain other countries. While the Russian WEC Member Committee was unable to provide a figure for proved recoverable reserves, it has reported the 'proved amount in place' as 8 425.61 bcm and the 'estimated additional amount in place' as 39.4 tcm, of which 9.037 tcm is stated to be recoverable. This is not to belittle the extent of Russian gas resources, but simply to advocate caution in drawing precise comparisons with reserve estimates for other parts of the world.

The greater part (77%) of the Federation's reserves are located in West Siberia, where the existence of many giant, and a number of super-giant, gas fields has been proved.

The Federation's net natural gas production of 640.6 bcm in 2005 accounted for almost 23% of the world total.

Russia is easily the largest exporter of natural gas in the world: in 2005, according to Cedigaz, its exports reached just over 240 bcm, of which about 145 bcm went to European countries and

the balance to former republics of the Soviet Union.

Saudi Arabia

Proved recoverable reserves (bcm)	6 848
Production (net bcm, 2005)	71.2
R/P ratio (years)	84.3
Year of first commercial production	1961

Note: Saudi Arabia data include its share of Neutral Zone.

Most of Saudi Arabia's proved reserves and production of natural gas are in the form of associated gas derived from oil fields, although a number of sources of non-associated gas have been discovered. In total, proved reserves of gas (6 848 bcm, according to OAPEC) rank as the third largest in the Middle East. Other published sources quote essentially the same level.

Output of natural gas has advanced fairly steadily for more than twenty years. A significant factor in increasing the utilisation of Saudi Arabia's gas resources has been the operation of the gas-processing plants set up under the Master Gas System, which was inaugurated in the mid-1980s. These plants produce large quantities of ethane and LPG, which are used within the country as petrochemical feedstock; a high proportion of LPGs is exported. The main consumers of dry natural gas (apart from the gas industry itself) are power stations, desalination plants and petrochemical complexes.

Thailand

Proved recoverable reserves (bcm)	304
Production (net bcm, 2005)	23.7
R/P ratio (years)	11.6
Year of first commercial production	1981

Thailand's WEC Member Committee reports proved recoverable reserves at end-2005 as 10 743 bcf (equivalent to 304.2 bcm), implying a 31% reduction on the level advised for the 2004 SER. Other published assessments of Thailand's proved gas reserves are all higher than the level reported for the *Survey*, but cover a wide range, from Cedigaz at 305 bcm, to *World Oil* at 648, with BP (350) and *Oil & Gas Journal* (418) in between.

Since its inception 20 years ago, Thailand's natural gas output has grown almost unremittingly year after year. Much the greater part of Thailand's gas output is used for electricity generation; industrial use for fuel or chemical feedstock is relatively small, whilst transport use (CNG) is increasing rapidly.

Thailand began to import natural gas from Myanmar in 1999; in 2005 the volume involved was 8.9 bcm.

Trinidad & Tobago

Proved recoverable reserves (bcm)	532
Production (net bcm, 2005)	30.6
R/P ratio (years)	16.5

Trinidad's WEC Member Committee reports proved reserves of natural gas as 18.78 tcf (531.8 bcm). Most published sources quote very similar levels, the only exception being *Oil & Gas Journal*, which gave the equivalent of 733 bcm for end-2005, although subsequently it has quoted 532 for end-2006.

Marketed production of gas has increased rapidly during recent years, as exports from the Atlantic LNG plant (inaugurated in 1999) have built up. Local consumption is also on the increase, reflecting a government policy of promoting the utilisation of indigenous gas through the establishment of major gas-based industries: fertilisers, methanol, urea and steel. In 2004 the chemical and petrochemical industries accounted for about 63% of Trinidad's gas consumption, power stations for 20% and other industry (including iron and steel) for 9%; the balance of consumption is accounted for by use/loss within the gas supply industry.

Turkmenistan

Proved recoverable reserves (bcm)	2 860
Production (net bcm, 2005)	63.0
R/P ratio (years)	45.4

Apart from the Russian Federation, Turkmenistan has the largest proved reserves of any of the former Soviet republics: for the present *Survey*, the level of 2 860 bcm quoted by Cedigaz has been adopted, in preference to the lower figure (2 010 bcm) given by *Oil & Gas Journal* and OAPEC. (It may be noted that OGI

has subsequently raised its figure to 2 832 bcm as at end-2006).

Cedigaz has stated that Turkmenistan's total gas resources have been evaluated at 22.9 trillion cubic metres. Many gas fields have been discovered in the west of the republic, near the Caspian Sea, but the most significant resources have been located in the Amu-Darya Basin, in the east.

Gas deposits were first discovered in 1951 and by 1980 production had reached 70 bcm/yr. It continued to rise throughout the 1980s, but by 1992 a serious contraction of the republic's export markets had set in and output fell sharply. Natural gas output recovered in 1999, and has since advanced to 63 bcm in 2005. Exports to countries outside the CIS amounted to 8.6 bcm in 2005, of which Iran accounted for 5.8 bcm.

Ukraine

Proved recoverable reserves (bcm)	787
Production (net bcm, 2005)	20.5
R/P ratio (years)	38.4

The Ukrainian WEC Member Committee reports that proved recoverable reserves were 787 bcm at end-2005, within a proved amount in place of 1 021 bcm. The available published sources (Cedigaz, *Oil & Gas Journal* and BP) all show proved recoverable reserves between 1 100 and 1 121 bcm, appreciably higher than the latest reported figure. Gas associated with crude oil was stated to account for only about 3% of the proved reserves.

Over and above the proved quantities, the WEC Member Committee estimates that there was about 357 bcm of gas in place, of which around 169 bcm was likely to be recoverable.

Ukraine's output of natural gas has been virtually flat since 1994, although production in 2004-2005 was on a somewhat higher level. The republic is one of the world's largest consumers of natural gas: demand reached 137 bcm in 1990. Although consumption had fallen back to about 76 bcm by 2005, indigenous production met only 27% of local needs; the balance was imported from Russia and Turkmenistan. The principal areas of consumption are households, industry and the generation of electricity and bulk heat.

United Arab Emirates

Proved recoverable reserves (bcm)	6 071
Production (net bcm, 2005)	47.0
R/P ratio (years)	> 100
Year of first commercial production	1967

Four of the seven emirates possess proved reserves of natural gas, with Abu Dhabi accounting for by far the largest share. Dubai, Ras-al-Khaimah and Sharjah are relatively insignificant in regional or global terms. Overall, the UAE accounts for about 8% of Middle East proved gas reserves.

OAPEC's published level of UAE gas reserves (6 071 bcm) is little changed from that quoted in the 2001 and 2004 *Surveys*. Apart from *World*

Oil, which gives a figure of 5 820 bcm, the other main published sources (Cedigaz, *Oil & Gas Journal*, OPEC and BP), all quote UAE reserves within a very narrow band (6 040 - 6 071 bcm).

Two major facilities - a gas liquefaction plant on Das Island (brought on-stream in 1977) and a gas-processing plant at Ruwais (in operation from 1981) - transformed the utilisation of Abu Dhabi's gas resources. Most of the plants' output (LNG and NGLs, respectively) is shipped to Japan. In 2005, other LNG customers comprised Spain and the Republic of Korea.

Within the UAE, gas is used mainly for electricity generation/desalination, and in plants producing aluminium, cement, fertilisers and chemicals.

United Kingdom

Proved recoverable reserves (bcm)	481
Production (net bcm, 2005)	85.7
R/P ratio (years)	5.2
Year of first commercial production	1955

The UK is no longer Europe's leading offshore gas producer, having been overtaken by Norway in 2006. The data on gas resources and reserves adopted for the present *Survey* are based on those reported by the British Energy Association, the UK Member Committee of the WEC, on the basis of advice from the Department of Trade and Industry.

Proved recoverable reserves at end-2005 are reported to be 481 bcm, being the sum of 'gas from dry gas fields' (191 bcm), 'gas from

condensate fields' (186) and 'associated gas from oil fields' (104). In this context the DTI defines 'proven reserves' as those 'which on the available evidence are virtually certain to be technically and economically producible, i.e. have a better than 90% chance of being produced'.

'Probable' reserves (with a better than 50% chance of being technically and economically producible) are put at 247 bcm, whilst 'possible' reserves (with a significant, but less than 50% chance) are estimated as 278 bcm.

It may be noted that Cedigaz quotes UK proved reserves of natural gas as 728 bcm, i.e. the sum of 'proved' and 'probable' reserves in DTI parlance, whereas most of the other standard published sources report them as 531 bcm, reflecting DTI proved reserves as at end-2004, being the latest available at the time of their compilation.

Potential additional reserves exist in discoveries for which there are no current plans for development and which are currently not technically or commercially producible. The DTI states that, on the basis of information gathered during the first quarter of 2006, these reserves are considered to lie within a range of 68 to 282 bcm, with a central estimate of 141 bcm. In the course of time, as additional data become available and development plans evolve, some of the 'potential additional reserves' gas is likely to be transferred to 'reserves'.

The DTI has also produced estimates of 'undiscovered recoverable resources', based for the most part on an analysis of mapped leads.

The latest update has produced a range of undiscovered gas resources from 226 to 1 035 bcm, with a central estimate of 421 bcm. It is pointed out by the DTI that such figures provide only a broad indication of the ultimate remaining potential and that the central estimate is not necessarily the volume most likely to be discovered. The figures quoted do not include any estimates of unconventional gas resources such as coal-bed methane.

It should be noted that all UK gas reserves are reported in terms of *recoverable* quantities: the corresponding volumes of gas *in place* do not form part of the published data on gas resources. Moreover, the recoverable quantities exclude any gas that is flared, as well as gas consumed in production operations.

Natural gas production rose year-by-year during the 1990s, reflecting burgeoning consumption in the power generation sector and higher exports at the end of the decade, following the commissioning of the Interconnector pipeline between Bacton in the UK and Zeebrugge in Belgium, in October 1998. Total output peaked in 2000, since when it has followed a downward trend year-by-year.

United States of America

Proved recoverable reserves (bcm)	5 866
Production (net bcm, 2005)	511.8
R/P ratio (years)	10.9

The USA possesses the world's sixth largest proved reserves of natural gas, and accounts for

just over 3% of the global total. Apart from the Russian Federation and the United States, all other countries in the top 10 for gas reserves are members of OPEC.

The figure of 5 866 bcm tabulated above is derived from total proved reserves of dry natural gas at end-2005 (204 385 bcf), as given by the Energy Information Administration in its *U.S. Crude Oil, Natural Gas and Natural Gas Liquids Reserves 2005 Annual Report*. For the purposes of the present *Survey*, the original data in billion cubic feet at 14.73 psia and 60°F have been transformed into standard SER terms (1 013 mb and 15°C) by means of separate adjustments for pressure and temperature.

During the 3 years since the last edition of the *Survey of Energy Resources*, US gas reserves have registered an increase of 17 439 bcf, or about 494 bcm. Total additions to reserves in 2003-2005 were 30.6% greater than the amount of gas produced during the same period.

The 17.4 tcf net increase in reserves during 2003-2005 was due partly to discoveries (field extensions, new field discoveries and new reservoir discoveries in old fields, totalling 62.6 tcf during the three-year period), partly to revisions and adjustments to estimates for old fields (+6.4 tcf) and partly to the net balance of sales and acquisitions (+5.4 tcf). Cumulative production during the three-year period was some 57 tcf.

Total discoveries during 2005 amounted to 23.2 tcf, the largest component comprising field

extensions, notably in Texas, Wyoming, Oklahoma, Colorado and Louisiana. The states with the largest gas reserves at end-2005 were Texas (27.6% of the USA total), Wyoming (11.6%), New Mexico (8.9%) and Oklahoma (8.4%). Reserves in the Federal Offshore areas in the Gulf of Mexico accounted for 8.3% of the total. About 87% of proved reserves consist of non-associated gas.

Uzbekistan

Proved recoverable reserves (bcm)	1 850
Production (net bcm, 2005)	59.4
R/P ratio (years)	31.0

The republic's first major gas discovery (the Gazlinskoye field) was made in 1956 in the Amu-Darya Basin in western Uzbekistan. Subsequently, other large fields were found in the same area, as well as smaller deposits in the Fergana Valley in the east.

For the present *Survey*, the level of 1 850 bcm quoted by Cedigaz has been adopted for proved recoverable reserves.

Uzbekistan is a major producer of natural gas: its 2005 net output was, for example, greater than that of Egypt or Qatar. It exports gas to some of its neighbouring republics.

The principal internal markets for natural gas are the residential/commercial sector, power stations, CHP and district heating plants, and

fuel/feedstock for industrial users. Some use is made of CNG in road transport.

Venezuela

Proved recoverable reserves (bcm)	4 315
Production (net bcm, 2005)	23.6
R/P ratio (years)	>100

Venezuela has by far the biggest natural gas industry in South America, possessing two-thirds of regional proved reserves and accounting for 23% of its marketed production in 2005.

In the absence of any reserves data released by the Ministerio de Energía y Minas later than 151 479 bcf (4 289 bcm) at end-2004, the level for end-2005 quoted by Cedigaz and OPEC (4 315 bcm) has been adopted for the present *Survey*. Other published sources tell much the same story: *Oil & Gas Journal* and OAPEC 4 287 bcm, *World Oil* 4 273 and BP 4 320.

Substantial quantities of Venezuela's natural gas (amounting to around 46% of gross output in 2005) are re-injected in order to boost or maintain reservoir pressures, while smaller amounts (8%) are vented or flared; about 7% of production volumes are subject to shrinkage as a result of the extraction of NGLs.

The principal outlets for Venezuelan gas are power stations, petrochemical plants and industrial users, notably the iron and steel and cement industries. Residential use is on a relatively small scale.

Yemen

Proved recoverable reserves (bcm)	479
Production (net bcm, 2005)	-
R/P ratio (years)	>100

Yemen has appreciable reserves of natural gas - currently quoted by OAPEC as 479 bcm - but no commercial utilisation has so far been established. Cedigaz, *Oil & Gas Journal*, *World Oil* and BP all quote the same level of proved reserves, within +/- 2 bcm.

Commercialisation of Yemen's gas will soon become a reality. An LNG plant is under construction at Balhaf, with its start-up scheduled for end-2008. The plant will consist of two trains, and be capable of delivering 6.7 million tonnes/yr of LNG. Natural gas will be supplied from two gas-processing plants in the Marib gas field via a 320 km pipeline.