Outlook for the World Gas Market

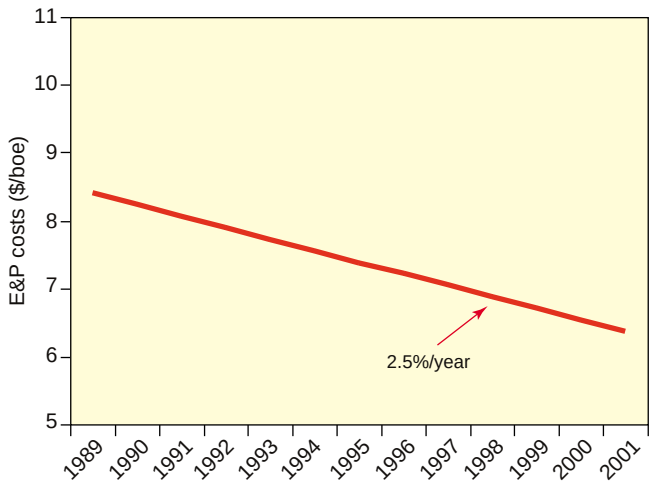
Driven by an economic growth of 3.2%, world energy demand could grow by about 1.7%/year by 2030, according to the IEA (WEO 2004), representing a global increase of almost 60% over 2002. Fossil fuels, which meet more than 80% of world primary energy needs, will continue to play a major role, as they are abundant and well adapted to various uses. Already underway for more than a decade, energy diversification in favour of gas will continue, stimulated by the need for using more environment-friendly sources of energy.

Increasingly energy-efficient economies and growing environmental pressures are gradually modifying not only the rate of development of total energy consumption, but also the growth prospects for each of the primary energies and, consequently, their respective weight in the energy balance.

From 1990 to 2003, the share of natural gas in the world energy balance rose from 22 to 24%. This evolution occurred at the expense of coal (in Europe in particular) and oil, for uses other than the transportation sector. When available at a competitive price, natural gas seized growth opportunities and strengthened its position in the residential and industrial sectors and even more so in the power sector.

The competitiveness of gas prices was maintained by virtue of continued efforts by the industry to reduce costs at all stages of the chain.

Fig. 1 E&P cost reductions (capex & opex)



Source: From bp

The use of advanced technologies in seismic imaging and drilling, as well as improvements in capital expenditures (capex) and operating costs (opex), have been responsible for a 2.5%/year fall in E&P costs, currently estimated at $6.6/boe (3-year average).

Over the past decade, the industry also very significantly improved LNG competitiveness, cutting costs at all stages of the chain. Accordingly, the cost of supplying one ton of liquefied natural gas (LNG), from production to regasification, dropped by about 20% between 1990 and the beginning of this decade.

Table 1
Cost reduction in the LNG chain
(Middle East / Far East LNG project)
($/MBtu)

	Cost estimate Early 1990s	**Cost estimate** Early 2000s
Upstream dev. cost	0.5-0.8	0.5-0.8
Liquefaction	1.3-1.4	1.0-1.1
Shipping (LNG tanker)	1.2-1.3	0.9-1.0
Regasification	0.5-0.6	0.4-0.5
Total cost	**3.5-4.1**	**2.8-3.4**

Source: Valais M., Chabrelie M.F. and Lefeuvre T. (WEC 2001)

The increasingly competitive environment has clearly influenced prices and rates of licensors, contractors and equipment manufacturers.

A variety of factors largely contributed to cutting costs in the LNG industry: tremendously improved overall design of LNG projects, in tandem with the characteristics of gas supply in the upstream sector and those of regasification plant outlets; optimised project construction, from design to start-up, and a systematic attempt to shorten construction deadlines.

The average unit investment for a liquefaction plant has dropped from some $550/t/year (current $) of capacity in the 1960s, to about $350/t/year in the 1970s and 1980s, $250/t/year in the late 1990s, and could be estimated today, for new projects, at slightly under $200/t/year.

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The cost of building LNG tankers has also been falling significantly, from $250 million in 1995-2000 to about $155 million in 2002-2003. The energy self-consumption of the overall LNG chain has also dropped considerably. In the first projects of the 1960s and 1970s, it could represent on average 15 to 20% of the gas input entering the liquefaction chain, against 12 to 15% for the 1980s and, apparently, only 8 to 10% for the latest projects on the most representative routes.

The trends that have been observed during the past few years should continue, with an additional 20 to 25% drop in transportation costs likely by the end of this decade.

The Challenge of Sustainable Gas Development

Natural Gas, a Gateway Towards the Energies of the Future

The future expansion of energy demand will entail a broadening of the portfolio of available sources of energy, with, for instance, a significant role expected in the long-term for nuclear energy and renewable energies.

By then, natural gas should be the leading energy, continuing to strengthen its position in the world energy balance. Several factors underlie the assumption that there will be strong growth in demand for gas on the order of 2.7 to 3%/year over the next twenty-five years.

Gas is a flexible energy that is well adapted to current uses, and notably has the advantage of being environmentally friendly, particularly with respect to its growing use in the electrical power sector.

The abundance of gas reserves already discovered (180 10^{12} m^3) and prospects for the potential of large finds in the future give natural gas a lifetime probably far in excess of 150 years, at current consumption rates. Because interest in natural gas was very late in developing, many areas have not been fully explored, if at all.

In addition to conventional resources, one has to take into account the large potential of unconventional gas. Even without hydrates, whose potential and production technology are still very uncertain, coal-bed methane resources represent an additional volume estimated at 250 10^{12} m^3. Gas shales and tight gas sands resources also contain a very high potential, which largely remains to be identified.

In the United States, coal-bed methane already provides part of the country's energy supplies. Whereas production of conventional gas, both onshore and offshore, still accounts for 68% of the total, the most promising producing sources of the future are located in the Rocky Mountains, and their potential for unconventional gas could represent, according to the Energy Information Administration, about 43% of production by 2020-2025 out of a total in the United States of about 600 10^9 m^3/year.

Technology, the Main Driver of Gas Sector Development

At all stages of the gas chain, technological progress will play a major role in continued development of the industry.

Technology will make it possible to access the potential of stranded gas, located very far from consuming areas, onshore or offshore, which is currently estimated at 30-35 10^{12} m^3, making it available to the market at a competitive price.

Offshore gas reserves, which represent a bit less than 40% of the world's proven reserves, will have a major impact on future supplies. By 2020, about a third of gas production could come from offshore areas, or about 1100 10^9 m^3, compared to the current 700 10^9 m^3. Producing these reserves, which are sometimes located in deep waters, will require the construction of purpose-built floating infrastructures, which are well adapted to this environment.

Thanks to efficiencies in excess of 60%, combined-cycle power plants are certain to keep a leading position in the power sector for many years to come. Besides the rapid development of smaller-size gas-fuelled power plants (10 MW), which are highly efficient for producing distributed electricity (for urban areas), technological advances in micro-turbines, fuel cells and combined heat and power (CHP) systems provide many alternatives which will enable gas to strengthen its position in this sector.

The LNG industry is establishing new benchmarks and continuing to improve the economics of the production chain, through economies of scale, giving rise to a new generation of projects.

While RasGas in Qatar set a new record last March in the size of liquefaction trains, starting production on its third train with a capacity of 4.7 million tons/year (Mt/year), new developments are under way. Trains with a 7.8 Mt/year capacity are due to start producing in RasGas and Qatargas plants before the end of this decade.

By 2008, a new generation of LNG vessels will go into service, as Qatargas recently ordered two 216,000 m^3 ships. While the current standard size for LNG vessels is 140,000 m^3, shipyards will probably receive orders for 250,000 m^3 vessels by the end of this decade. Improved insulation systems and the adoption of more efficient propulsion modes are among the major technological improvements expected.

This trend towards the construction of plants with larger capacities also applies to receiving terminals. Although

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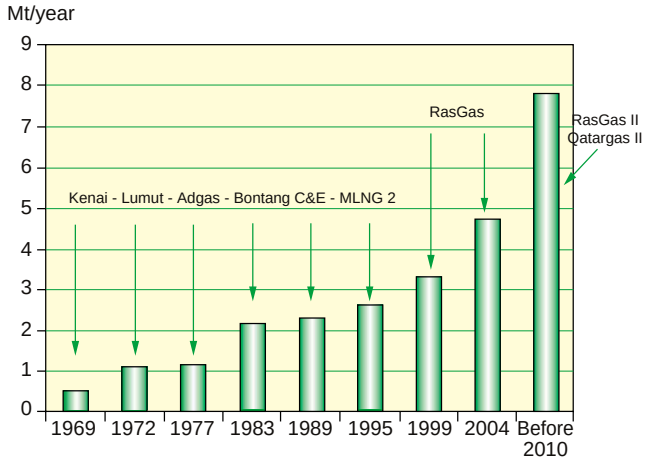
Fig. 2 Evolution of the unit capacity of liquefaction trains



increasingly strict environmental constraints oblige project promoters to consider building regasification plants offshore (United States, Italy), requiring the development of new concepts (single point mooring, gravity-based structures, floating storage regasification unit, floating converted carrier), planned capacities are getting larger (8 to 12 Mt/year).

Gas pipeline transportation should also show substantial development in the coming years, with high-pressure, high-grade (X100, X120) steel pipelines. While Japanese and European steel makers have already achieved significant advances in this field, the Majors, which are involved in very large projects (Trans-Alaska Pipeline, Mackenzie Valley Project) state that the use of high-strength line-pipe can generate investment cost savings of 5 to 15%.

A Major Challenge: The Need for Huge Investments

The pace of growth of the markets remains very closely conditioned by the industry's ability to invest massively in the short and medium term. Many traditional supply sources, which have been producing for several decades, are now declining. By 2020, the anticipated gap between demand and these sources could exceed $1\ 10^{12}$ m^3/year (25% of total forecast demand).

Gradually, producing zones will shift towards new provinces within traditional supplying areas. In Russia, for instance, Gazprom, the world's leading gas producer, currently provides about 93% of the country's marketed gas production ($616.5\ 10^9$ m^3). 62% of its output comes from the oldest giant fields in Western Siberia (Medveze, Urengoy and Yamburg). Accordingly, in the years to come, new fields (Bovanenkovo, Petsovoy, Eastern Siberia), some of which are located in difficult areas (Schtockman, Yamal Peninsula), will have to take over and secure a major share of production.

Growing volumes of gas will also come from the areas most well endowed with gas resources, but whose huge potential has only been partially developed, such as the Middle East. Iran, in partnership with many international companies, plans to invest some $8 billion to develop the first ten phases of the South Pars field. Producing reserves in Central Asia, Africa (Algeria, Nigeria, Libya, Egypt) or Asia also requires huge investments.

Besides the development of new fields, the transportation of gas reserves, at the centre of the gas problematic, is the most capital-intensive.

From exploration-production all the way to regasification, an LNG project involves huge investments in the range of $6 to $10 billion. The construction of a large-diameter, long-distance pipeline requires an investment of about one billion dollars per 1,000 km. The growing dependence of major consuming areas (North America, Europe, Asia) will necessitate the construction of additional transportation infrastructures, most often to deliver the resources over long distances, accordingly accelerating investment needs.

According to Cedigaz, over the next ten years, the industry will have to invest $1000 to 1200 billion to meet gas market growth.

LNG: The Driver for the Expansion of the World Gas Market

While the mismatch between producing areas and major consuming centres becomes further accentuated, LNG is set to become the key driver for the world gas balance. Given the flexibility in supply this option provides, both in terms of volumes and the wide range of suppliers, the share of LNG in world gas trade is set to grow faster than that of pipelines.

The prospect of very strong demand for LNG on the American market is the basis for the expected rapid growth.

LNG flows are accordingly anticipated to grow by about 7%/year by 2020, boosting the share of LNG in worldwide trade to about 38% (22% in 2003). By then, total international flows could reach $1350\ 10^9$ m^3, accounting for a third of marketed production.

The liberalisation of the electric and gas sectors offers LNG new opportunities for growth. The setting up of new, more competitive, more responsive market operations, in which emerging and traditional buyers favour the LNG option, will play a major role.

The convergence developing between the electric and gas sectors also results in the diversification of assets of electric companies towards LNG infrastructures, as pipelines establish a too tight link with traditional gas operators. The LNG option

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also makes it possible to overcome political problems, which are often more difficult to solve than that of distance.

Dynamic Markets

All markets — both traditional and emerging — show strong potential for growth, which should continue at the rate of about 7%/year through 2020.

Table 2
Prospects for LNG demand (Mt)

Country	2003	2010 Low	2010 High	2020 Low	2020 High
North America	**11.37**	**36.2**	**47.4**	**82.6**	**108.8**
Canada	–	–	3.0	7.5	12.0
Dominican Republic	0.22	0.5	0.6	0.7	0.8
Mexico	–	–	3.0	7.5	10.0
Puerto Rico	0.55	0.7	0.8	0.9	1.0
United-States	10.60	35.0	40.0	66.0	85.0
South America	**–**	**–**	**2.0**	**4.0**	**7.0**
Brazil	–	–	–	1.0	2.0
Chile	–	–	2.0	3.0	5.0
Europe	**29.62**	**56.0**	**67.8**	**86.5**	**100.6**
Belgium	2.30	3.5	4.2	5.0	5.5
France	7.30	10.5	11.5	12.5	14.5
Greece	0.39	0.5	0.6	0.5	0.6
Italy	4.10	11.0	13.0	16.0	18.0
Portugal	0.63	3.0	3.5	4.0	4.5
Spain	11.20	18.5	20.5	24.0	26.0
Turkey	3.70	4.0	4.5	4.5	5.5
United Kingdom	–	5.0	10.0	20.0	25.0
Other*	–	–	–	–	1.0
Asia-Oceania	**84.05**	**109.0**	**117.0**	**147.0**	**164.0**
China	–	6.0	8.0	13.5	15.5
India	–	9.0	11.0	15.0	20.0
Japan	59.0	63.0	64.0	73.0	75.0
South Korea	19.5	22.5	23.5	30.0	33.0
Taiwan	5.55	8.5	9.5	12.0	13.5
Others*	–	–	1.0	3.5	7.0
World total	**125.04**	**201.2**	**234.2**	**320.1**	**380.4**

* Others: Singapore, Philippines, Indonesia, Sweden.

Source: Cedigaz

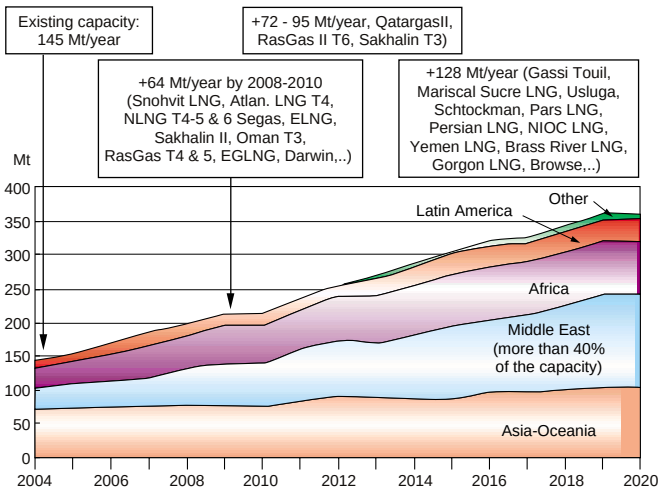
Despite forecast sustained growth, Asia's leading position in worldwide demand for LNG is set to weaken rapidly, accounting for only about 50% of total trade by 2010, compared to 67% in 2003. By 2015, Japan will likely lose to the United States its position as the world's largest LNG consumer.

Abundant Potential LNG Supply

Distributed among a dozen countries, the current liquefaction capacity of 145.1 Mt/year will develop very rapidly. A plethora of projects representing a total potential capacity of 210 to 298 Mt/year is being built or planned.

In the medium-term, the Middle East, where the largest projects are to be located, will overtake Asia, which still hosts 48.5% of current liquefaction capacity. By 2020, more than 40% of the world's liquefaction capacity could be concentrated in the Middle East.

Fig. 3 Evolution of liquefaction capacity worldwide



Source: Cedigaz

The come-back of the United States on the LNG scene, and more generally the prospects for sustained growth in demand in the Atlantic basin will undoubtedly have a strong impact on the overall equilibrium of world LNG supply and demand. The supply of the Pacific Basin could be particularly tight after 2010 because although there are numerous projects worldwide for new LNG plants and others to extend capacity, the additional capacity being planned for Asia is rather limited. The evolution of gas prices on the North American market, which will stimulate to a greater or lesser extent producers and resellers alike, will have a strong influence on the overall liquidity of the market, as will the potential development of terminals on the west coast of the United States or Chile.

Chemical Conversion and Gas by Wire: New Outlets

To date, natural gas has hardly penetrated the transport sector. Only about 1% of the world's vehicle fleet is powered by compressed natural gas. The heavy development of downstream infrastructure limits the expansion of this sector. Its role as a "niche market" is therefore likely to last for many years.

Whereas the industry's major concern is to cut gas transportation costs, the chemical conversion of gas into oil

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products brings a new alternative. According to the IEA, gas demand from this sector could reach about 40 10^9 m^3 as soon as 2010 and 214 10^9 m^3 in 2030.

Some GTL projects are currently progressing. Qatar, which hosts this decade's most advanced projects (Oryx GTL, Pearl GTL and ExxonMobil), is considering achieving a 700,000 b/d capacity by 2014. Low gas production costs in Qatar favour the economics of these projects, which are highly energy and capital-intensive. The development of this option on a large scale will offer gas producers a new way to enhance the value of their gas resources.

The transformation of gas into electricity and its transportation by wire over long distances may, in the longer-term, emerge as another alternative. Although a number of obstacles still remain to be cleared before this option develops significantly, recent advances in semiconductors and insulating materials have in particular resulted in a reduction in transportation costs for direct current (DC).

There is huge growth potential for natural gas, and the industry has high-performance technologies at its disposal. However, the massive investments involved will require ever-closer cooperation between all players in the natural gas chain, including the governments of the countries that host major export projects.

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