Over the last thirty years, worldwide consumption of natural gas has grown more rapidly than that of other fossil fuels such as oil or coal. During the period 1970-97, the rate of growth of natural gas consumption reached 2.8% per year, compared to corresponding rates for oil and coal of 1.8% and 1.7% respectively. It is interesting to note that in 1997, these three energy sources represented 90% of world energy consumption, of which oil accounted for a notable 40%, followed by coal (27%) and natural gas (23%).

Natural gas currently accounts for 22% of world energy use, as may be observed in the graph below. In global terms, the more rapid expansion in gas consumption may be explained by the following factors:

- Proven global reserves of natural gas have grown significantly in recent years to reach equivalent levels of oil reserves. Today, these reserves are sufficient to guarantee consumption at present levels for 66 years, compared to 40 years for oil reserves.

- In geographical terms, world reserves of natural gas are more evenly distributed than oil reserves. While 65% of world oil reserves are in the Middle East, the corresponding figure for natural gas is only 34%.

- Technological advances in transport systems for natural gas have made the consumption of large volumes of gas possible, in both technical and economic terms, even when points of production are far from centers of consumption.

- The growing pressures for a reduction in environmental pollution, most notably in the major cities, has favored the use of natural gas as a fuel, given that the products of its combustion pollute less than oil derivatives.

- The energy security policies of OECD countries have been directed towards the reduction of dependency on imported oil, above all, from the Middle East.
SHARE OF NATURAL GAS IN ENERGY CONSUMPTION

**LEGENDA PARA IMAGEM**

<table>
<thead>
<tr>
<th>Português</th>
<th>Inglês</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUA</td>
<td>USA</td>
</tr>
<tr>
<td>México</td>
<td>Mexico</td>
</tr>
<tr>
<td>Argentina</td>
<td>Argentina</td>
</tr>
<tr>
<td>Venezuela</td>
<td>Venezuela</td>
</tr>
<tr>
<td>Japão</td>
<td>Japan</td>
</tr>
<tr>
<td>França</td>
<td>France</td>
</tr>
<tr>
<td>Itália</td>
<td>Italy</td>
</tr>
<tr>
<td>Espanha</td>
<td>Spain</td>
</tr>
<tr>
<td>Inglaterra</td>
<td>England</td>
</tr>
<tr>
<td>Europa</td>
<td>Europe</td>
</tr>
</tbody>
</table>

Within Brazil, consumption of natural gas grew by an average of 14.5% per year over the period 1970-97, from 456,435 m³ per day to 17,531,507 m³ per day. While this behavior apparently reflects the strong growth in domestic consumption, the natural gas industry is still in its infancy, and it is possible to cite a number of reasons for its relative lag. These include: (i) low internal demand, (ii) the structure of Brazil’s energy system, and (iii) the lack of pre-existing distribution infrastructure. It may be observed that the countries that today have a mature natural gas industry are those that had previously developed systems of pipelines for the distribution of coal gas. The most notable cases, the United States and England, have had such infrastructure based on coal gas for public lighting systems since the beginning of the last century. As the option of using natural gas emerged, most notably from the 1960s onwards, such installations were gradually adapted to use the new fuel.

Certain comparative indicators illustrate the size of the natural gas market in Brazil, as well as in other benchmark countries with consolidated industries.

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>BRASIL *</th>
<th>ARGENTINA**</th>
<th>INGLAND**</th>
<th>TALY**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proven reserves (billion m³)</td>
<td>225.9</td>
<td>690.0</td>
<td>760.0</td>
<td>300.0</td>
</tr>
<tr>
<td>Gross production (‘000 m³/day)</td>
<td>28,523.7</td>
<td>86,849.3</td>
<td>238,356.2</td>
<td>53,424.6</td>
</tr>
<tr>
<td>Imports (‘000 m³/day)</td>
<td>0</td>
<td>4,931.5</td>
<td>3,835.6</td>
<td>102,191.8</td>
</tr>
<tr>
<td>Consumption (‘000 m³/day)</td>
<td>17,531.5**</td>
<td>90,136.9</td>
<td>235,068.5</td>
<td>147,671.2</td>
</tr>
<tr>
<td>Share of natural gas in total energy use (%)</td>
<td>2.2</td>
<td>48.0</td>
<td>29.5</td>
<td>27.0</td>
</tr>
</tbody>
</table>
The natural gas industry in South and Central America has major growth potential. In general terms, and with the exception of Venezuela and Argentina, South America has yet to develop its natural gas infrastructure, although since reserves in the region are equivalent to those of North America, both South and Central American countries are beginning to exploit their production potential. Bolivia, Argentina, Peru, Venezuela, Trinidad & Tobago and Colombia are transforming themselves into important producers/exporters of natural gas. Brazil, Chile, Uruguay and Paraguay are natural markets for Argentine, Bolivian and Peruvian production, and for this reason, a number of international pipeline projects to interconnect these markets are currently underway, or planned over the next decade.

Confirming this growth potential for the natural gas industry, the U.S. Energy Information Administration – EIA (iii), in its most recent report on the sector, highlights this fuel as the primary energy source that is likely to grow at the highest rate over the next 22 years. According to the EIA’s base scenario, world consumption of natural gas will grow at an average rate of 3.3% per year until 2020, while oil and coal consumption will grow at annual rates of 1.8% and 1.7% respectively.

The EIA study forecasts that world natural gas consumption will reach 4.93 trillion m$^3$ by 2020. This growth is in large part due to its use as a fuel for thermoelectric generation, although its availability, cost and environmental considerations will contribute to the growth of its use in the business, industrial and residential sectors.

A large number of projects for the construction of natural gas transport and distribution systems are currently in progress throughout the world. According to a 1997 survey by the International Pipeline and Offshore Contractors Association, it is expected that 34,000 km of new gas pipelines will be built between 1998-2000. Indeed, this survey only includes firm projects with guaranteed financing, and does not cover projects within China and the former Soviet Union.

The EIA also expects that demand for natural gas in Central and South America will grow at a faster pace than on other continents. The average annual growth rate for this region over the next 22 years is thus expected to reach 7.6%, compared with 2.9% in Western Europe, 2.7% in Africa, 1.7% in North America, 2.0% in the former Soviet Union and 5.9% in Asia.

In order to meet this growing demand, the Southern Cone countries are developing gas transport infrastructure projects that will lead to the formation of an intricate network of pipelines, principally to link the producer regions of Argentina and Bolivia with the Brazilian and Chilean markets.

Within the region, Argentina intends to consolidate its position as an exporter of natural gas, especially to Chile and Brazil. As part of this plan, a further link between the Argentine and Chilean markets was inaugurated in August 1997, namely the 463 km GasAndes pipeline that can transport up to 9 million m$^3$ per day.

Three other pipelines between Argentina and Chile are currently under construction: the 925 km GasAtacama pipeline, with maximum capacity of 8 million m$^3$ per day, the 875 km NorAndino pipeline, with maximum capacity of 7 million m$^3$ per day, and the 537 km GasPacifico pipeline, with maximum capacity of 9 million m$^3$ per day. These three links should begin operating before the end of 1999, and will absorb investments of some US$ 2 billion.

The core demand for two of these three natural gas projects comes from thermoelectric generation. The GasAtacama project is intended to promote generation and transmission of
electricity in the North of Chile, and includes the construction of a combined cycle thermal plant (two units) with installed capacity of 740 MW. The NorAndino project is in turn associated with the installation of two combined cycle thermal plants: a 380 MW plant belonging to Electroandina and a 240 MW plant belonging to Edelnor.

The Brazilian Government aims to raise the share of overall energy use represented by natural gas from the current 2.2% to 12% in 2010, with importing of gas the most rapid way of achieving its objective. To this end, three gas pipelines linking Brazil with neighboring countries are currently under construction, with three more in the planning stage.

Among the projects under construction, the most advanced is the Bolivia-Brazil (Gasbol) pipeline, the first 1,970 km section of which, between Rio Grande in Santa Cruz de la Sierra, and Paulinia in the state of São Paulo, is in a pre-operational phase. When fully completed, in October of this year, the pipeline will have a length of 3,150 km, a
maximum transport capacity of 30 million m$^3$ per day, and will stretch as far as Porto Alegre in the state of Rio Grande do Sul, crossing five states, and 135 municipalities. Its supply area accounts for 82% of Brazilian industrial production, 75% of the country’s GDP, and 71% of national energy consumption.

The second gas pipeline under construction is the Transportadora de Gas del Mercosur (TGM) pipeline, that runs from Aldea Brasilera in Argentina to Uruguai in Brazil. This pipeline will supply the thermoelectric plant at Uruguai (600 MW) that is currently under construction.

In addition to these two projects, the pipeline that transports gas from fields in the Northeast of Argentina to Cuiabá will be completed in the first half of 2000, with capacity of 4 million m$^3$ per day. The link will allow Enron to purchase 2.5 million m$^3$ per day of gas sold by YPF (Argentina), that will be used to power its 480 MW thermoelectric plant. The first stage of the Cuiabá thermal plant (150 MW) has been completed and will use heating oil until the gas arrives.

A further three gas pipeline links to Argentina are planned: the 3,100 km Mercosul pipeline, with maximum capacity of 25 million m$^3$ per day, that will run from the gas fields in Salta across the Northeast of Argentina to the Southeast of Brazil; the 815 km Cruz del Sur pipeline, with maximum capacity of 15 million m$^3$ per day; and the 615 km Uruguaia/Porto Alegre pipeline, with maximum capacity of 9 million m$^3$ per day, that is in fact an extension of the TGM pipeline.

### GAS PIPELINES FOR IMPORTS

<table>
<thead>
<tr>
<th>Pipeline</th>
<th>Origin/Destination</th>
<th>Status</th>
<th>Start-up Date</th>
<th>Length km</th>
<th>Maximum Capacity 10$^6$ m$^3$/dia</th>
<th>Investment US$ million</th>
<th>Origin of Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivia-Brazil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolivia-Brazil Pipeline</td>
<td>Rio Grande (Br) / São Paulo (Br) / Porto Alegre (Br)</td>
<td>In Progress</td>
<td>Oct 99</td>
<td>3,150</td>
<td>30.0</td>
<td>2,000</td>
<td>Bolivia</td>
</tr>
<tr>
<td>Enron Pipeline</td>
<td>Roboré (Br) / Cuiabá (Br)</td>
<td>In Progress</td>
<td>Oct 99</td>
<td>626</td>
<td>4.0</td>
<td>270</td>
<td>NW Fields (Arg)</td>
</tr>
<tr>
<td>Argentina-Brazil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGM</td>
<td>Aldea Brasilera (Arg) / Uruguai (Br)</td>
<td>In Progress</td>
<td>Jun 00</td>
<td>440</td>
<td>18.0</td>
<td>140</td>
<td>Neuquén (Arg)</td>
</tr>
<tr>
<td>Mercosul Pipeline</td>
<td>Salta (Arg) / Santa Catarina / Paraná / São Paulo</td>
<td>Planned</td>
<td></td>
<td>3,100</td>
<td>25.0</td>
<td>1,800</td>
<td>NW Fields (Arg)</td>
</tr>
<tr>
<td>Argentina-Uruguay-Brazil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cruz del Sur</td>
<td>Buenos Aires (Arg) / Colônia (Uru) / Montevideo (Uru)</td>
<td>In Progress</td>
<td>2000</td>
<td>215</td>
<td>6.0</td>
<td>135</td>
<td>Neuquén (Arg)</td>
</tr>
<tr>
<td>Cruz del Sur</td>
<td>Colônia (Uru) / Porto Alegre (Br)</td>
<td>Planned</td>
<td></td>
<td>815</td>
<td>15.0</td>
<td>350</td>
<td>Neuquén (Arg)</td>
</tr>
</tbody>
</table>

Source: BNDES.

With regard to the supply of natural gas to the South, Southeast and Center-West of Brazil, these options for importing from Bolivia and Argentina will, when added to domestic production, most notably from the Campos Basin, provide an important safety net for the development of markets in these regions. With regard to the Northeast, the most promising medium-term supply solution is the import of liquefied natural gas (LNG) from Nigeria or Trinidad & Tobago, both of which are countries with large reserves and small internal markets, in which the major oil companies have already invested in export plants for LNG. The National Petroleum Agency (ANP) has thus issued authorizations for each of Shell Brasil S.A. and Petrobrás to import quantities of LNG equivalent to 7.6 million m$^3$ of gas per day from Nigeria, that will be delivered to the port of Suape in the state of Pernambuco.
As little as two years ago, an assessment of the degree of development of the natural gas market in Brazil would have taken note of the existence of a market with significant potential that was nevertheless limited by insufficient supply. Today, this situation has been reversed. In cumulative terms, taking a conservative measure of the current domestically available reserves of natural gas, as well as of projects for gas imports, either in the form of pipelines or in the form of LNG, the potential supply in ten years time should reach 94 million m$^3$ per day, equivalent to a fivefold increase from the current market size.

It should nevertheless be noted that the estimate for imports of Argentine gas are based not on the capacities of pipelines that are already under construction or planned, but on the Argentine government’s own assessment of possible exports to Brazil and Chile by 2010$^9$.

<table>
<thead>
<tr>
<th>ORIGIN</th>
<th>VOLUME (million m$^3$/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>17.5</td>
</tr>
<tr>
<td>Imports</td>
<td></td>
</tr>
<tr>
<td>• Argentina</td>
<td>38.9</td>
</tr>
<tr>
<td>• Bolivia</td>
<td>30.0</td>
</tr>
<tr>
<td>• LNG*</td>
<td>7.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>94.0</td>
</tr>
</tbody>
</table>

*Despite the ANP’s authorization for LNG imports to the Northeast of 15.2 million m$^3$ per day, the table considers only half of this amount.

Of this total potential supply, some 38 million m$^3$ per day should be absorbed by thermoelectric generation. In the “Ten-Year Expansion Plan: 1999-2008”, the electrical sector indicates the need to install 9,380 MW of gas-fired generating capacity, split over 25 projects. Excluding this amount from the total projected supply, some 56 million m$^3$ per day will be available to the industrial, residential, commercial and automotive markets, amounting to a volume over three times the current consumption figure.

In this way, the recent maturation of projects that increase the range of natural gas sources indicates that at least from the point of view of supply, the government’s goal of increasing the share of overall energy consumption represented by natural gas is a viable one. In fact, the development of a suitable consumer market will depend on large-scale investment in the expansion of the natural gas transport and distribution network in a relatively short space of time, together with the formulation of a fuel pricing policy that allows natural gas to compete with other alternative fuels.

With the exception of the cities of Rio de Janeiro and São Paulo, distribution infrastructure in Brazilian cities is either non-existent, or of extremely limited extent. On the other hand, use by the industrial, residential and commercial sectors will not be immediate. Within the industrial segment, the decision to use natural gas is linked to the relative price structure of alternative fuels, to the greater or lesser gain in productivity at the level of the final product, to the demands of environmental controls on the productive process, to the cost of converting existing installations, as well as the availability of funding for such investments.

At the same time, within the residential and commercial sectors, given the low average density of consumption and the need for broad distribution networks, the emergence of this market will rest on questions of scale, with such networks depending for their feasibility on much higher consumption densities, or proximity to industrial areas with high unit consumption.
Natural gas requires more sophisticated and expensive transport than is the case for oil (a liquid) or coal (a solid). Gas pipelines are the most common means of transport, but are ruled out over long distances (greater than 6,000 km), or when it necessary to cross seas. In such cases, the transport of liquefied natural gas (LNG) becomes the most cost effective option.

These totals do not include reinjected or unused (burnt in flares) natural gas.

The report of the Gas Commission, which was created in July 1991 with the objective of proposing directives and indicating the actions to be taken in order to promote more widespread use of natural gas. The report was approved by the President of Brazil in March 1993, and includes the objective of raising the share of total national energy consumption represented by natural gas to 12% by 2010.