



THE JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
OF RICE UNIVERSITY

## **CRITICAL ISSUES IN BRAZIL'S ENERGY SECTOR**

BRAZIL'S NATURAL GAS INDUSTRY: MISSED OPPORTUNITIES ON THE ROAD TO  
LIBERALIZING MARKETS

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SUPPORT FOR THIS PROJECT HAS BEEN PROVIDED BY A GENEROUS GRANT FROM  
BP FOUNDATION  
RICE UNIVERSITY - MARCH 2004

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## **Introduction**

The Brazilian energy crisis of 2000-2001 is likely to mark a grand, missed opportunity for needed reforms in the country's energy sector. A bold response to the crisis, initially stimulated by a prolonged, severe drought that curbed the country's hydroelectric supply, might have delivered to Brazil a fresh, transparent, liberalized and competitive national energy industry that would have diversified the nation's energy economy and protected the economy from future drought induced energy shortages. Instead, the country still faces a crippled, dormant industry that may fail to meet the country's needs as economic growth resumes, bringing with it rising demand for energy resources.

When the end of the drought returned reservoirs to normal levels in early 2002, the Brazilian government scrapped its plans to rapidly develop gas-fired power generation, the so-called Emergency Thermal Power Project. As the reservoirs refilled and gas demand plunged, exacerbated by the recent economic downturn, the Brazilian government reversed its focus on gas-fired power generation as soon as power rationing could be suspended in the country. However, this decision may well come back to haunt the country as gas demand recovers as projected and future droughts reappear.

In 2000, Brazil had developed plans to diversify its electricity-generating supply from hydroelectric power and planned to meet rising electricity demand by expanding the country's natural gas industry to supplement hydroelectric supplies. Ambitious plans included construction of 55 new gas-fired power plants over an eight-year period with a combined capacity of 23,000 MW.

But the election of popular opposition leader Luiz Inacio Lula da Silva in 2002 put all plans on hold as the new government took stock of its mandate for change. In its first months in office, the new Lula government has shown its preference for expanded hydroelectric-powered generation despite potential lessons that might have been gleaned from the 2000-2001 crisis, and the stagnation of liberalization programs in the energy sector has resulted in a corresponding

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slowdown in private investment in the more expensive thermal-generated energy projects. Of particular concern to outside investors is the continuing monopoly of state-owned Petroleo Brasileiro S.A. (Petrobras) in nearly all sectors of the natural gas industry, and few government initiatives to enhance competition in the sector. In addition, because of Brazil's anemic economic growth since 2001 and the drop in gas demand, a number of the transnational pipeline projects that were planned in the late 1990s and early 2000 to deliver gas supplies to Brazil from its neighbors have either been scrapped or frozen.

These events have temporarily reduced any ramifications from the new government's decision to increase, rather than reduce, dependence on hydropower. But the loss of demand growth for electricity and natural gas is temporary, and just as Brazil's over reliance on low-cost hydroelectric-powered generation seriously undermined the integrity of the country's power system leading to severe rationing during the latter half of 2001 and a decline in economic growth, similar events could come in the future once the country resumes its growth path.

### **Background: The 2000-2001 Crisis**

With hydroelectric reservoirs at record low levels, inadequate reserve margins, and soaring electricity demand, large areas of the country became subject to California-style rationing, load shedding, and blackouts. The Brazilian energy crisis prompted the former government of President Fernando Henrique Cardoso (1994-2002) to embark on a U.S. \$5 billion countrywide "crash" construction program that called for as many as 55 gas-fired power plants totaling 22,000 MW of capacity. But, only 15 of those 55 proposed projects survived for a combined capacity of 2,982 MW, and Petrobras announced in July 2003 that it was further canceling four gas-fired power projects in which it had equity interest, leaving 11 remaining projects. But, Petrobras also announced at the same time that it was re-evaluating two other projects.

The Lula government has not, however, fully abandoned the natural gas sector. In June 2003, the state-owned Brazilian Development Bank (BNDES) announced that it would finance roughly U.S. \$290 million in mostly private sector investments to expand Brazil's gas distribution network in the Southeast and Northeast, particularly in areas where there are no pipelines and

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consumers use fuel oil for thermal power. The project is expected to require U.S. \$1 billion in direct investment. The Southeast part of the project will involve a new pipeline between Campinas in Sao Paulo and Japeri in Rio De Janeiro state, an extension to the city of Betim in Minas Gerais state, building 10 city gates to transfer custody of gas and a new compression station. The project is meant to bring Bolivian gas to Rio de Janeiro state and ensure adequate supply for thermal power plants in all three Southeastern states. The Northeast portion of the project will require seven new pipelines totaling 962 km, building eight city gates and two compression stations, one in Candeias and the other in Catu. The expansion of this network will increase transport capacity from Bahia to Ceara state to supply power plants in Ceara and Pernambuco states as well as industrial demand. The expansion is expected to increase gas sales to power plants by about 880 MMcf/d by 2010, doubling that market.

Divisions remain within the Brazilian government regarding how to proceed with gas sector reform. In another official move, Brazilian Energy Minister Dilma Rousseff announced in December 2003 the Lula government's intention in 2004 to draw up a master plan to boost the use of natural gas and help the economy grow, following an earlier announcement about a new model for the electricity sector. The new model called for more gas-fired and other thermoelectric plants but made clear that their construction would only be possible at lower natural gas prices. One of the proposed reforms included pooling cheaper hydroelectricity with more expensive thermoelectric plants. By pooling the various sources, the ministry hopes to reduce the electricity tariffs and to ensure power is purchased from the newly constructed thermal plants.

Rousseff said that lower prices for gas sold in Brazil, whether locally produced or imported, would be key to increasing the use of gas in industry, vehicles, and thermoelectric generation. She said that the Lula government had already contracted a consulting firm to study natural gas regulations in other countries that would serve as the basis for the new Brazilian model. Rousseff pointed out that Petrobras might face losing some of its lucrative fuel sales, which will be substituted by the cheaper gas. Petrobras, for its part, announced a week after Rousseff's statement on a new gas model that it would cut the price of gas imports from Bolivia for

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domestic distributors for amounts exceeding normal consumption to boost domestic gas usage and reward consumers with the cost savings, beginning January 1, 2004.

Under the new plan, once distributors import more than 10% of average consumption, the price of the additional amount will be U.S. \$2.70 per Million Btu, instead of the normal price of U.S. \$3.36 per MMBtu. The more the distributors buy, the greater the discounts. With a 40% increase over average consumption, the price of the usual gas volume would also drop with the total discount reaching 7%. If the consumption rises more than 70%, the discount would hit 17%, taking the average price to U.S. \$2.78 per MMBtu. These discounts are fairly typical, giving large volume customers a share in the savings that occur on the fixed costs portion of operating a pipeline at a higher load factor and are an encouragement from Petrobras for domestic gas distributors to help fill the BTB pipeline.

Although Brazil's gas demand has declined in recent years, it is still expected to grow by 41% from 1 Billion cubic feet/day in 2002 to 1.7 Bcf/d in 2007. Thermoelectric power is anticipated to account for 35% of that gas demand in 2007 compared to 19% in 2002. Natural gas currently accounts for only 3% of Brazil's energy consumption, and it is questionable now whether the forecast for gas to grow to about 25% of Brazil's energy matrix by 2010 thanks to thermal power generation will bear out. A number of gas pipelines originating from Bolivia and Argentina that were proposed in the late 1990s to serve concentrated industrial and power generation demand potential in Brazil's Southern or Southeastern states have hit snags, either as a result of the drop in demand or the economic downturn and have either been stalled or cancelled (see Infrastructure Development below).

To spur development of gas-fired power plants and eliminate project risks associated with commodity price volatility, the Ministry of Mines and Energy (MME) under President Cardoso established a fixed gas price of U.S. \$2.47/MMBtu for plants in the Emergency Thermal Power Program. However, even with this guaranteed fuel price, thermal independent power project (IPP) development in Brazil lagged due to the power-pricing regime established by the National Electricity Regulatory Agency (ANEEL). Moreover, with the scaling back of the construction of new gas-fired thermal plants, Brazil is now using only about three-quarters of its daily contract

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supplied by Bolivia but, given take or pay contract terms, still has to pay U.S. \$1.50 per MMBtu for the full volume it agreed to buy from its neighbor. Also, while IPPs pay for their fuel in U.S. dollars, they are forced to sell their power to distributors in Brazilian *reais*. Furthermore, final prices to distributors are capped at a maximum limit. This regulatory policy not only limits IPPs to small fixed margins, but also exposes them to substantial currency risk.<sup>1</sup>

Failure to resolve the disparity between the gas price and generation price cap will continue to inhibit the foreign investment that is essential to the development of sufficient generation capacity to meet future power demand. The consequences are readily apparent, as critical industries, such as aluminum, mining, and chemicals, have cited a lack of generation capacity as a constraint to future production growth.<sup>2</sup> If sufficient reserve thermal generation capacity does not come on line as an insurance against future drought, the country's current and future economic growth could be severely jeopardized.

Brazil faces many choices and obstacles on the way to developing competitive gas and power markets. The failure to privatize fully large power generating companies indicates the difficulties that the country has faced in the transition to a more liberalized and competitive energy market. The growing dominance of a semi-privatized Petrobras in all segments of the gas industry threatens the development of competitive markets and the lack of true support of the new government for pursuing gas-fired power generation over the cheaper, readily abundant hydro-electricity.

Petrobras, which is 51% owned by the central government, is Brazil's largest vertically-integrated energy company and largest natural gas producer. Petrobras played a leading role in the development of Bolivia's gas fields, and is a majority stakeholder in several transnational pipelines. On top of this, the company has assumed a major role in the development of gas-fired power generation projects and has substantial holdings in many of Brazil's local distribution companies. The continued dominance of Petrobras in all aspects of the gas industry in Brazil

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<sup>1</sup> The currency risk is underscored by the recent steep drop in the value of the *reia* against the dollar.

<sup>2</sup> "Abal: Generation Limits Aluminum Growth" Business News Americas 11/30/2000

and the Southern Cone has given outside investors pause for thought, as the majority state-owned giant continues to consolidate and strengthen its already formidable position.

This paper examines recent developments in Brazil's gas industry from several perspectives, including access to resources, infrastructure development, the demand for natural gas, and power generation's key role in driving future natural gas consumption. It also looks at pricing, evolving industry structure, privatization, and regulatory reforms -- all essential elements to developing a vibrant and competitive gas market.

### **Brazilian Energy in Perspective and the Role of Natural Gas**

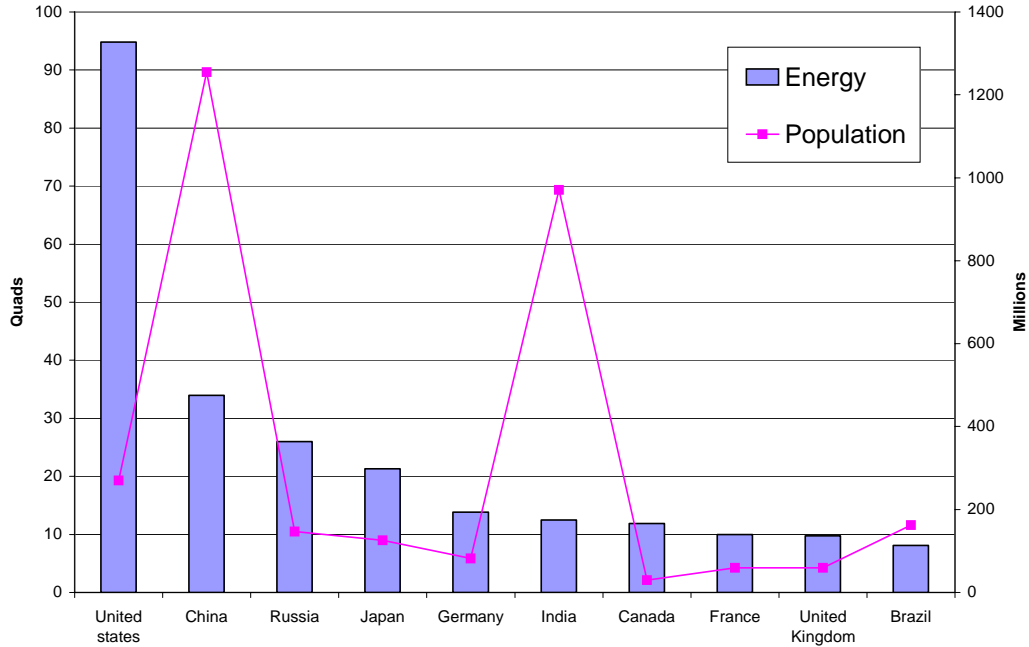
Brazil has a population of 179 million, GDP of approximately U.S. \$650 billion, and ranks fifth in global population and ninth in economic output. With total primary energy consumption of just over 8 quadrillion Btus (quads), Brazil is the world's tenth largest consumer of energy, just behind France and the U.K. Despite its size and population, Brazil's energy consumption is dwarfed by major energy consumers, such as the U.S. (97 quads), China (39 quads), Russia (28 quads), and Japan (22 quads).<sup>3</sup>

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<sup>3</sup> With a quarter of the world's population, China's energy consumption reflects its sheer size. This has obvious implications for global energy consumption as China pursues rapid economic growth.



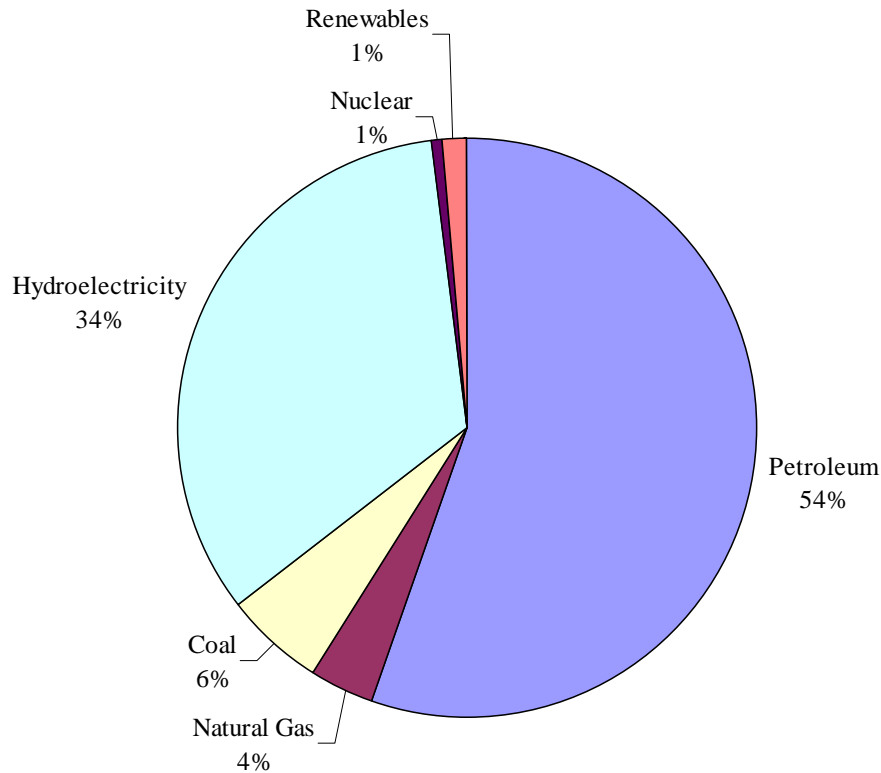
**Exhibit 1: Top Ten Global Energy Consumers and Population (Quadrillion Btu)**



Petroleum is Brazil's largest source of energy, providing 53% of Brazil's primary energy consumption and is used mainly as a transportation fuel and in industry. Hydroelectricity provides 33% of Brazil's primary energy needs and over 90% of power generating capacity. Coal, used mainly in Brazil's steel foundries, accounts for just 6%, while natural gas provides a mere 4% of Brazil's primary energy consumption, which is little more than peripheral renewable sources such as wind, wood, and solar energy.

**Exhibit 2: Primary Energy in Brazil, 2001**

(9.03 Quads)



Source: Energy Information Association

The relatively small role natural gas plays in Brazil's energy matrix stands in stark contrast to other regions of the world and is a sign of the industry's relative immaturity. Natural gas accounts for 23% (26 quads) of total primary energy demand in North America, 19% (13 quads) in Western Europe, and 40% (20 quads) in the Former Soviet Union and Eastern Europe. Brazil also lags behind the rest of Central and South America, which consumes 3.4 quads of natural gas, 17% of total primary energy consumption of 19.7 quads.<sup>4</sup>

<sup>4</sup> The majority of South America's gas (2.4 quads) is consumed in Argentina and Venezuela, where it accounts for over 40% of primary energy consumption.

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Natural gas' share of primary energy consumption is forecast to grow in all countries, including Brazil, which is seeing rapid development of surrounding resources and delivery infrastructure. The U.S. Energy Information Administration forecasts that by 2015, primary energy consumption will grow to 147 quads in North America, 77 quads in Western Europe, 67 quads in the FSU-EE, and 36 quads in Central and South America.<sup>5</sup>

Brazil's primary energy use is expected to grow to 13.5 quads by 2015. As in many other countries anticipating rapid growth in gas consumption, Brazil's rising gas consumption is driven largely by the need to diversify its power generation from hydroelectricity. Although the push for building more gas-fired power plants has faded recently, President Lula is committed to boosting demand for natural gas. Brazil has pledged to expand its gas market as part of negotiations with Bolivia. The government intends to support about U.S. \$290 million in mostly private investment to expand distribution networks in the southeast and northeast in less industrialized areas currently relying on fuel oil.

*Relying on Neighbors' Supplies: A Change in Policy?*

Brazil will continue to meet projected gas consumption from a combination of domestic production and imports in the short term, though the massive gas find in the Santos Basin in 2003 could certainly have a great impact on Brazilian imports in the medium- to long-term, depending on the commercialization of the find and the development time lag. Changes in government policy and Petrobras' business strategy to promote natural gas production increased domestic gas production from approximately 140 Bcf in 1988 to a peak of 257 Bcf in 2000, with a subsequent decline of 18% in 2001 due to the economic downturn in the country. Domestic consumption rose to an estimated 339 Bcf in 2001. With 58 years of reserves currently in the ground, production could readily be increased to more than 1 trillion cubic feet (Tcf) a year.

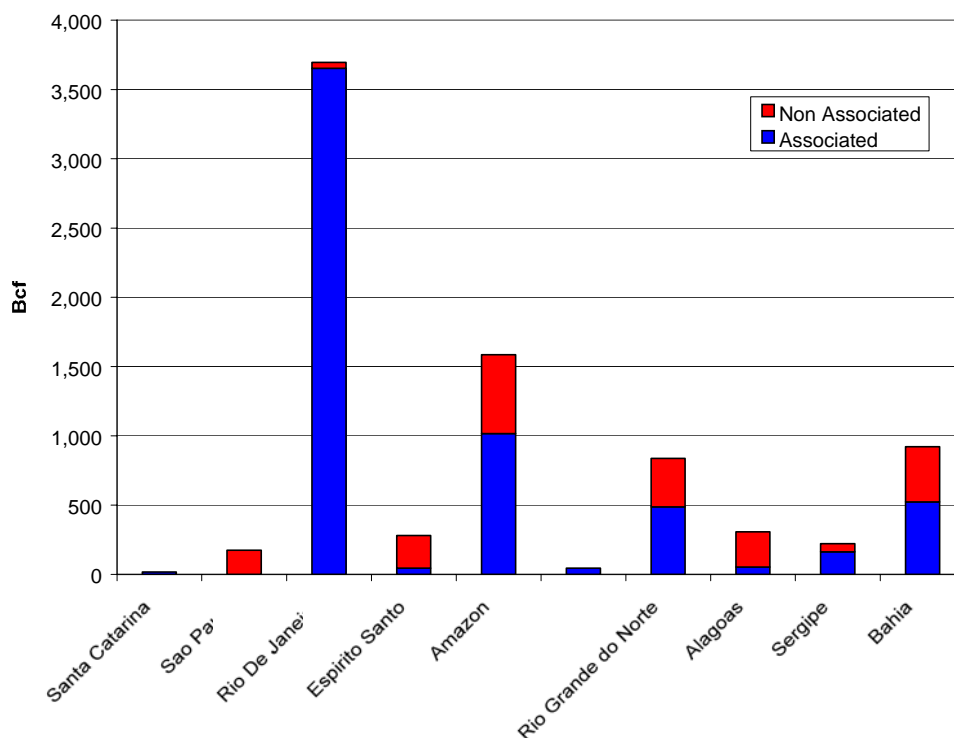
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<sup>5</sup> U.S. Energy Information Administration, "International Energy Outlook, 2001."

***Domestic Reserves and Production***

As of January 2003, Brazil's natural gas reserves stood at 8.1 Tcf of natural gas reserves, the fifth largest in South America behind Venezuela, Argentina, Bolivia, and Peru. The Southeast contains approximately 4.2 Tcf of proved reserves, with 88% of those located in the state of Rio de Janeiro. The Northeast contains gas reserves of approximately 2.3 Tcf, with most of those concentrated in the states of Bahia, Rio Grande do Norte, and Alagoas. Finally, the state of Amazonia holds over 1.6 Tcf of proved gas reserves (Exhibit 3). Petrobras enjoys exclusive rights to all the natural gas reserves in Brazil.

**Exhibit 3: Natural Gas Reserves by State**  
(Bcf)



Source: Petrobras

The major discovery by Petrobras in May 2003 in Block BS-400 in the Santos Basin could dramatically change Brazil's gas supply/demand picture in the medium- to long-term and could have a profound impact on Southern Cone energy mix as well. Petrobras had initially estimated

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the discovery to be the largest it had had to date, at 2.47 Tcf, but subsequent testing prompted the state energy firm to announce in September 2003 that its estimates for the find had been boosted to a whopping 14.8 Tcf. Potentially tripling national gas reserves, the Santos find has sweeping implications for Brazil's ability to meet its own burgeoning gas demand and reduce heavy reliance upon its neighbors. The find may affect its commitment to a number of pipeline projects.

However, Petrobras is remaining guarded about the impact of the revised estimates, noting that it will take time to determine whether the discovery is commercially viable. Guilherme Estrella, Petrobras' director of exploration and production, noted on September 4<sup>th</sup>, 2003 that it should take between eight to 10 years for the new gas discovered in the Santos Basin off the coast of Sao Paulo to reach Brazilian consumers, between two to four years to access the actual reserves and four years to begin to develop and distribute the gas. Estrella pointed out that the Santos volumes lie near large consumption centers – the Rio-Sao Paulo circuit – in the country's most industrialized region, the Southeast, which currently consumes much of Brazil's diesel fuel production, and which could be replaced by the new gas.

Brazil's major producing regions are located in the Southeast, the Northeast, and the Amazonas basin. Exhibit 4 shows the producing basins of Argentina and Bolivia, the most important gas producing regions in the Southern Cone<sup>6</sup>, and the key to Brazil's gas supply security.

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<sup>6</sup> The Southern Cone consists of Argentina, Brazil, Chile, Uruguay, and Paraguay.

**Exhibit 4: Brazil's Producing Basins**



Source: ANP

Brazil's three main producing regions include the following basins:

- ***Southeast Production Basins.*** The Campos basin, located off the coast of Rio de Janeiro, is the largest producing basin in Brazil, supplying approximately 247 million cubic feet per day (MMcf/d) to Rio de Janeiro and Sao Paulo states. The offshore Espirito Santo basin, located north of the Campos basin, supplies almost 140 MMcf/d to markets in the state of Espirito Santo.
- ***Northeast Production Basins.*** The Reconcavo basin is the largest basin in Northeastern Brazil, with proved and probable reserves of almost 1.8 Tcf. Next in size is the Potiguar basin, with reserves of 0.7 Tcf, followed by the Alagoas basin, with onshore and offshore reserves of just over 500 Bcf. The Northeast currently produces approximately 345 MMcf/d

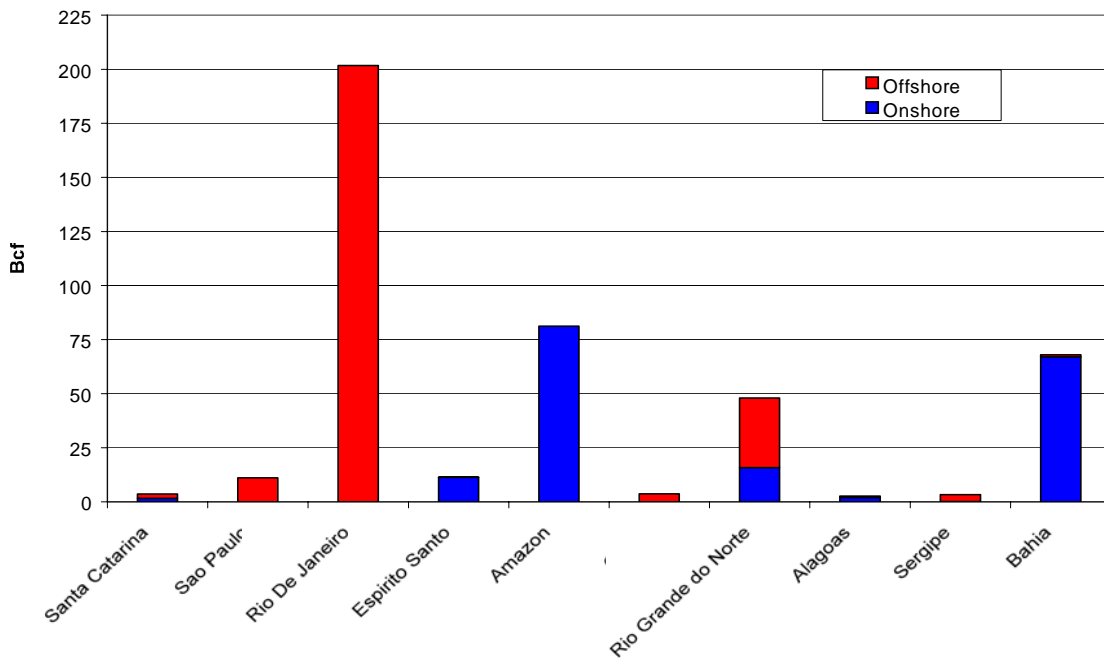
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of gas, with 183 MMcf/d originating from onshore Bahia, while the Ceara basin in offshore Rio Grande do Norte produces 88 MMcf/d.

- **Amazon Production Basin.** The Amazon is isolated from the major producing and consuming areas of Northeastern and Southeastern Brazil and encompasses a 'closed' natural gas system. Production amounts to approximately 222 MMcf/d.

Exhibit 5 shows Brazil's leading producing states, with Rio de Janeiro producing over 200 Bcf annually.

**Exhibit 5: Natural Gas Production by State**  
(Billion Cubic Feet)



Source: Petrobras

A lack of infrastructure and pipeline deliverability has limited the outlets for natural gas production to local gas markets. This is beginning to change as the Southeast, in particular, develops a flexible pipeline delivery system capable of transporting domestic gas to new load pockets. But, curbed demand and fiscal problems have resulted in a number of proposed transnational pipelines, linking Brazil to Bolivia and Argentina, to be suspended or cancelled.

## **Argentina and Bolivia: Key Resources in Brazil's Gas Development**

### ***Bolivia***

Bolivia's natural gas potential is exceptionally high and is becoming increasingly important to the South American energy trade arena. Bolivia has proved and probable reserves of 44 Tcf that, following an aggressive exploration and development program, are expected to grow substantially in the near term. Recent exploration efforts, focused in the southern and eastern areas of the country, have been so successful that analysts now believe that Bolivia's natural gas reserves may be second only to Venezuela in South America. In fact, the discovery of several large gas fields has slowed the pace of upstream activity as new gas discoveries await the development of suitable markets.

Bolivia has four gas fields with estimated reserves larger than 5 Tcf each: San Alberto, San Antonio, Itau, and Margarita. Petrobras holds stakes in all four fields, with 35% of the San Alberto and San Antonio fields. Bolivian gas discoveries far exceed domestic demand and further discoveries are unlikely to be developed in the near term. With current production of 1.2 Bcf/d, and almost no domestic consumption, most of the gas is slated for export via pipelines to Argentina and Brazil, LNG to the West Coast of the U.S., and the remainder re-injected, flared, or vented at the wellhead.<sup>7</sup>

Plans to export gas as LNG to the West Coast of Mexico or the U.S. were scuttled after indigenous opposition to exporting through Chile -- with which Bolivia has a centuries-old border dispute -- forced President Gonzalo Sanchez de Lozada to quit on October 18<sup>th</sup>, 2003. The new president, Carlos Mesa, promised to hold a referendum on the plan, but this may be irrelevant, since west coast LNG developers already have their eyes on probably cheaper sources in places such as Australia and Indonesia. De Lozada's resignation came after month-long protests of his free-market reform policies by Indian farmers, labor and opposition political groups led to more than 80 deaths after the beleaguered president used military force to try to quell the protests.



The trigger for the demonstrations was de Lozada's backing of a plan to build a U.S. \$5 billion pipeline through the Chilean port of Patillos to deliver gas to the U.S. and Mexico. Not only did protestors argue that Bolivia – the poorest country in South America – would only receive 18 % of the profits from the project, but the plan opened up old wounds in that Patillos was part of Bolivia until it was lost in a war with Chile in 1879. The opposition seized upon the pipeline project to raise a series of grievances against the president, in particular, his free-market economic policies. Despite calling for a referendum on the project, de Lozada was forced to resign after he lost support from a key coalition partner, the center-right New Republican Force party, his vice president Mesa and his economic development minister.

### ***Argentina***

In contrast to Brazil and Bolivia, natural gas is Argentina's most important energy source. In 2001, domestic gas consumption was at 1.1 Tcf and, based on projected economic growth, is expected to double over the next twelve years, to over 2 Tcf.

Argentina has 23 Tcf of proved and probable reserves, and in 2000 produced more than 4 Bcf/d<sup>8</sup>. With consumption of just under 3 Bcf/d, this leaves a little more than 1 Bcf/d available for export. The largest producing basins in Argentina are Neuquen, Austral, and Noroeste. The Neuquen basin, located in Northwestern Argentina, accounts for more than 60% of Argentine gas production.

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<sup>7</sup> There are a number of potential LNG projects in the planning stages that would involve pipeline transport of Bolivian gas to Chile for conversion to LNG that would be exported to the U.S. In addition, there are also several gas to liquids (GTL) projects that are being considered for both domestic consumption and export.

<sup>8</sup> Petrobras: Presentation at the *II Seminario Internacional das Rotas de Integracao do Cone Sul*

**Exhibit 6: Argentina's Natural Gas Reserves and Production by Basin**

<b>Basin</b>	<b>2002 Reserves (Bcf)</b>	<b>2000 Production (Bcf)</b>
Neuquina	12,170	732
Austral	5,250	256
Noroeste	4,570	201
Golfo San Jorge	1,420	80
Cuyana	20	2
<b>Total</b>	<b>23,100</b>	<b>1,269</b>

*Source: Secretaria de Energia y Minería de Argentina*

### **Power Generation: The Former Driver of Gas Consumption Growth**

In the late 1990s, the expected growth in regional and Brazilian gas demand was the result of specific government policies that partially deregulated wholesale gas markets, promoted gas as a future source for power generation, and created a favorable environment for the development of gas infrastructure.

Brazil's power sector privatization program has focused heavily on divestiture of distribution assets, and currently about 70% of Brazil's distribution system is in private hands. However, this focus on the sale of distribution companies has come at the expense of generation and transmission assets. Today only 25% of the country's generating capacity has been sold to private investors, and although Brazil is now eager to attract private capital to foundering state-run generation assets, plans to auction off key power companies have been scuttled. For example, the Sao Paulo government called off the auction of its 38.67% interest in CESP Parana, the nation's third largest power company, just one day before the auction date in May 2001, citing the then energy crisis for canceling the sale.

The National Agency for Electricity (ANEEL) is a key agency driving privatization and deregulation. ANEEL created Brazil's Wholesale Energy Market (MAE), which was launched in September 2000. So far, the MAE has been a major disappointment due to a lack of market liquidity and the terms and structure of Power Purchase Agreements (PPAs) between generators

and distributors. Distributors were obligated to purchase 100% of their power supply from generators until 2003. From 2003 forward, distributors are permitted to reduce their volumes under long-term PPAs by 25% annually, which should lead to greater spot market trading and the development of a truly competitive wholesale power market.

Implementation of more investor friendly policies has resulted in some foreign investment in Southern Cone infrastructure development. For example, the Swiss-Swedish electric engineering group Asia Brown Boveri (ABB) signed a contract with Cien (the Brazilian subsidiary of Spain's Endesa) in July 2000 to build a transmission system linking the Brazilian and Argentine electricity grids. Completed on schedule in June 2002, the project brought 1,000 megawatts (MW) over a 310-mile (500-kilometer) transmission line from Argentina to Brazil. This is the second ABB project with such power interconnection between the two countries, as its first line became operational in May 2000.<sup>9</sup>

Additional imports of power to Southern Brazil are envisioned when construction of a 3,000 MW gas-fired thermoelectric plant in Puerto Iguazu, Argentina, is completed in 2004. The project is a joint venture between CTR of Argentina and Tradener of Brazil, and will require over U.S. \$3 billion to construct a gas pipeline between Bolivia and Argentina, and an 815-mile transmission line from Argentina to Brazil.<sup>10</sup>

### **Emergency Thermal Power Plan**

In an effort to head off power shortages and encourage natural gas consumption, the Ministry of Mines and Energy in June 2001 initiated an Emergency Thermal Power Plan with the goal of adding over 15,500 MW of gas fired generation capacity by 2005, equivalent to nearly 2.2 Bcf/d of natural gas consumption (Exhibit 7). In the mean time, with the return of the rains and the reservoirs full, electricity rationing turned into an electricity surplus of as much as 7,500 MW in early 2003. Brazil's push to diversify its electricity generating sources has faltered.

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<sup>9</sup> Brazil's Electrobras is operating the 1,000-MW connection line.

<sup>10</sup> Gazeta Mercantil, 5/17/01

**Exhibit 7: Proposed Natural Gas-Fired Generation 2000-2005**

<b>Region</b>	<b>Projects</b>	<b>Capacity (MW)</b>	<b>Gas Demand (MMcf/d)</b>	<b>Project Completion</b>
North	3	584	82	2001-03
Northeast	7	1,610	227	2001-05
Amazonia	3	1,030	145	2001-04
Southeast	25	9,905	1,398	2002-04
South	6	2,430	343	2002-04
<b>Total Brazil</b>	<b>44</b>	<b>15,559</b>	<b>2,195</b>	<b>2001-05</b>

*Source: Petrobras*

Brazil's failure to create a favorable environment for private investment in power generation has forced government agencies to assume the financing burden for project development. For example, the National Development Bank of Brazil (BNDES) allocated more than U.S. \$3 billion for the development of over 26,000 MW of hydro and thermal power generation capacity by 2003. Given the magnitude of the national power crisis that ran into early 2003, domestic banks such as Sudameris and Banco do Brasil offered special lines of credit to companies looking to purchase their own power generators. However, the current electricity surplus reversed the drive for new power generation capacity and the special lines of credit remain idle.

International energy heavyweights like El Paso, InterGen, Duke, Electricidade do Portugal (EDP), and Iberdrola had either purchased existing generation assets or were developing thermal power plants. However, regulatory impediments, a stalled privatization program, disputes with Petrobras over third party access to gas pipelines, and the lack of international project financing sources caused many foreign investors to reconsider their investments in the country.

U.S. power group AES, for one, announced in 2001 that they would not be bidding on the CESP Parana generation assets, and were going to delay the official inauguration of the 600 MW Uruguaiana plant. They also announced that they have suspended plans to invest over U.S. \$2 billion in thermal power projects in the coming years. Faced with serious financial problems of its own, AES in late 2003 was working with BNDES on a debt rescheduling agreement, after having defaulted on payments to the Brazilian development bank and having failed to transfer its controlling stake in hydroelectric generator AES Tiete to Novacom, a new company being created under the debt-restructuring deal between AES and BNDES. The AES plant, although

operational, faces ongoing transmission problems as a result of the financial problems associated with AES.

With international developers shying away, Petrobras has fortified its leading role in the development of thermal power generation in Brazil with substantial short-term losses. In its first quarter financial results, Petrobras took a U.S. \$236 million provision for financial exposure to thermal generation in 2003. The company has minority equity stakes in nine of the 12 thermal power projects completed in 2001, and is the sole developer for the 602 MW Canoas project in Rio Grande do Sul state and the 466 MW Tres Lagoas project in Mato Grosso do Sul (Exhibit 8). In the ten-year expansion plan for the Brazilian electric sector, Petrobras will have a minority role in 23 thermal power plants.<sup>11</sup> Twelve of these plants will be dedicated to the production of electricity only and will account for 3,705 MW of capacity. The other 11 plants will produce both power and steam, with the electricity allocated for Petrobras' consumption and sales to large industrials. The steam will be completely consumed by Petrobras refineries or petrochemical facilities.

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<sup>11</sup> *Plano Decenal de Expansão do Setor Elétrico*

**Exhibit 8: New Thermal Projects**

<b>Project</b>	<b>Location (State)</b>	<b>Capacity (MW)</b>	<b>Petrobras Stake (%)</b>	<b>Gas Demand (mm3/d)</b>	<b>Start up Date</b>
<b>In Operation</b>					
Fafen Energia	Bahia	133	20	0.3	Dec-03
Ibirité	Minas Gerais	240	50	1.1	Jul-03
Canoas		500	100		Expansion
UEG Araucaria	Parana	480	20		Sep-02
Piratininga	Sao Paulo	500	80		Sep-03
Termobahia	Bahia	450	29		Aug-03
<b>Commissioning /Tests</b>					
Temorio	Rio de Janeiro	750	43		May-04
Trés Lagoas	Mato Grosso do Sul	350	100		Expansion
<b>Under Construction</b>					
Termoacu Norte	Rio Grande do Norte	325			Dec-04
Fluminense	Rio de Janeiro	780			Feb-04
<b>On Hold</b>					
CCBS	Sao Paulo	440	27		TBD
Termogaucha	Sao Paulo	500	25		TBD
Termosergipe	Rio Grande do Sule	110			TBD
Termoalagoas	Alagoas	120			TBD
Paraiba		150			TBD
	<b>Total</b>	<b>2,982</b>		<b>18.6</b>	

Source: Petrobras

***Industrial Power Generation***

The economic consequences of power rationing that reduced industrial energy use by 15-25% and levied hefty surcharges for large consumers in 2001-2002, impacted most heavily large energy consuming companies in the mining, aluminum, beverage, and steel sectors. With power use cuts of 20%, the steel sector lost about U.S. \$890 million in revenues in 2001 alone. The aluminum industry association estimated production losses at 94,000 tons, and beverage can makers had to shut down domestic production in favor of imports from plants in neighboring Argentina and Chile.

Eager to avert such future losses, some large Brazilian industrials are striving to improve their energy security. The VBC consortium, comprised of Votarantim, Bradesco, and Camargo Correa, is investing over U.S. \$1.5 billion in power projects and will be responsible for over 7% of Brazil's overall electric power generation capacity by 2006. The Companhia Vale do Rio Doce (CVRD), one of the largest mining companies in the world, will likely partner with VBC on some of the larger generation projects.

### ***Industrial Gas Demand***

Although the industrial sector is the other large source of expected consumption growth, it is unclear whether demand will top 1 Bcf/d by 2005, as forecast. Most of this gas will be used as feedstock in the petrochemical, fertilizer, and steel industries, and as a heat source in other industries. The MME has sought to encourage development of industrial cogeneration by increasing the previous limit of 100 MMcf/d of natural gas consumption and simplifying the approval procedures required by ANEEL. As a further incentive, BNDES is offering special lines of credit for cogeneration projects.

### ***Infrastructure Development***

Most recent infrastructure planning activity was directed towards linking the supply basins of Argentina and Bolivia to demand centers in South and Southeast Brazil. Additionally, Petrobras has entered into a joint venture with Shell to import liquefied natural gas (LNG) into Northeast Brazil through development of a re-gasification facility at Suape, in Pernambuco State.

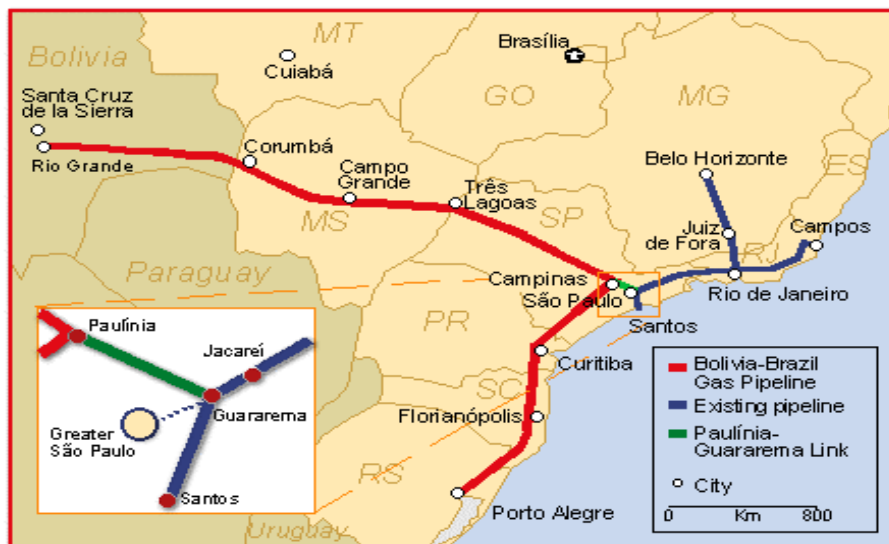
Transnational pipelines, particularly the BTB, are changing Southern Cone energy market dynamics. The BTB provides a major natural gas backbone for Southeast Brazil and sufficient pipeline capacity to serve several large power projects, industrial load, and pockets of residential/commercial demand. Additionally, the pipelines from Argentina offer Brazil access to competing supplies. Other transnational pipelines linking Argentina to Chile, Brazil, and Uruguay, and potentially Peru's giant Camisea gas field to Brazil, offer a tantalizing glimpse of the degree of interconnectivity that could develop among Southern Cone nations.

Competing sources of gas connecting multiple markets via a diversity of pipeline routes suggest that eventually gas could flow along the most efficient and least costly routes, offering future savings to consumers. In addition, free trade among Southern Cone nations and diversity of ownership of both production and pipelines suggests that a truly competitive market could eventually develop. However, for this to occur, regulation and pricing between nations needs to be addressed.

***Bolivia to Brazil Pipeline***

The completion of the 1 Bcf/d BTB transnational pipeline is arguably the most significant recent event in the development of Brazil's natural gas industry. At a total cost of U.S. \$1.8 billion, the 3,100 km pipeline begins in the gas fields near Santa Cruz, Bolivia and serves 29 Brazilian cities, including Sao Paulo, before reaching its terminus at the city of Porto Alegre. It passes through the states of Mato Grosso do Sul, Sao Paulo, Parana, Santa Catarina, and Rio do Sul (Exhibit 9). These states account for 82% of domestic industrial production and 71% of national energy consumption.<sup>12</sup>

**Exhibit 9: Route of the Bolivia to Brazil Pipeline**



Source: Petrobras

<sup>12</sup> “Setor Energético: Destaques em 1999 e Oportunidades de Negócios” p. 8, May 2000.



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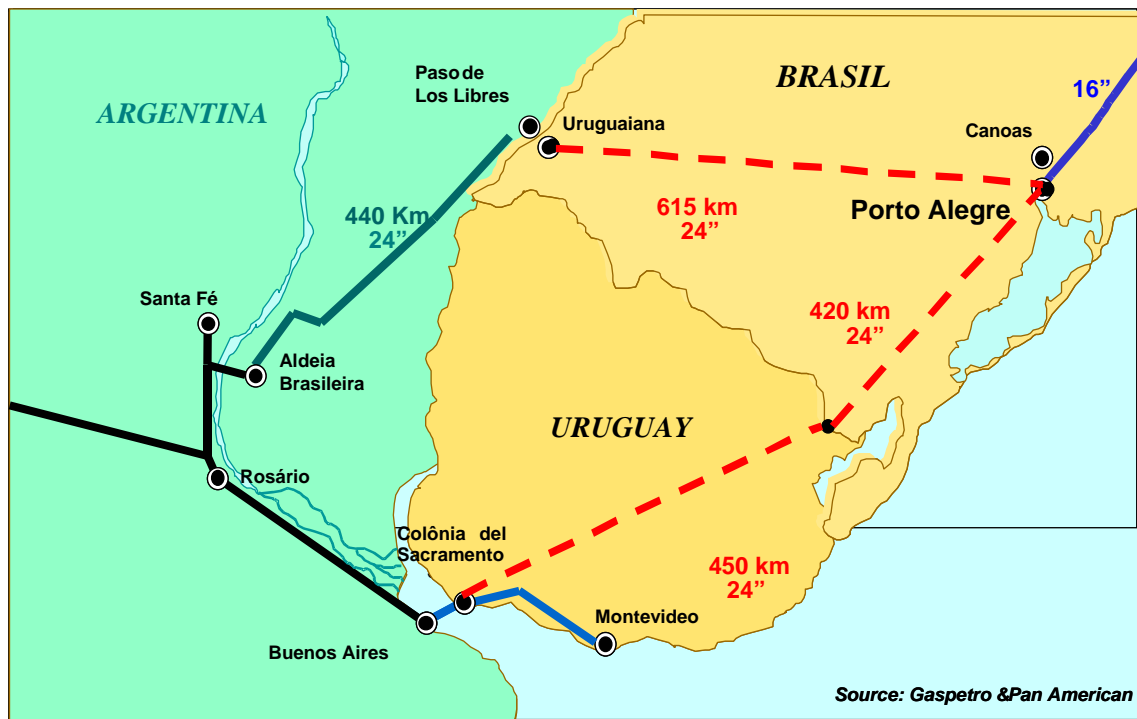
Service to Sao Paulo began in March 1999 at 141 MMcf/d, and was scheduled to increase to 564 MMcf/d by 2006. The original participants in the BTB include: TBG (owned 51% by GasPetro, a subsidiary of Petrobras); a consortium of Enron, Royal Dutch Shell, and Transredes; and the BTB consortium of BHP Petroleum, British Gas, and EL Paso Energy Corp. In February 2003, Enron and El Paso both announced their intentions to sell their stakes in the pipeline, stating that expected revenues from the project have failed to materialize, however to date, no buyers have been forthcoming.

Although the BTB began delivering gas to São Paulo in March 1999, Petrobras and Bolivia began wrangling over contract terms in 2002 when Petrobras found its throughput declined dramatically but was caught in a take-or-pay deal that runs through 2019, resulting in Petrobras being forced to pay higher prices for the Bolivian gas imports. The original 20-year deal in 1999 stipulated a basic price range of U.S. \$0.96- cents-1.50 per thousand cubic feet and maximum volumes of 750-850 MMcf/d, but Petrobras is now importing about one half of that amount and with the Brazilian currency's depreciation against the U.S. dollar, it is stuck paying the equivalent of U.S. \$3.60 per thousand cubic feet. Although a series of negotiations between Petrobras and its Bolivian counterpart on amending the take-or-pay contract to appease Petrobras failed to produce results, a political decision by President Lula in November 2003 to support new Bolivian leader Carlos Mesa indefinitely suspended the price talks. The revised upward estimates of the Santos Basin gas discovery have added a new twist in Brazil's efforts to renegotiate its "take-or-pay" gas import contract with Bolivia. The price of Bolivia's gas imports – fixed in U.S. dollars and based on international market prices – is now roughly 30% more than the cost of the gas that Brazil imports from Argentina or produces itself. With Brazil paying for an obligatory 850 MMcf/d with its consumption requirements from Bolivia currently at 500 MMcf/d, the Santos find is adding more impetus for the country to find more favorable terms for its Bolivian supplies. Under the agreement signed in the early 1990s, Bolivian imports were to steadily increase to a maximum of 1 Bcf/d between 2007 and 2019, when the contract is due to expire.

*Argentina to Brazil*

Various pipelines from Argentina to Brazil offer competitive alternatives to the BTB pipeline (Exhibit 10). The Transportadora Gas do Mercosul (“TGM”) pipeline connects Paraná, Argentina to Uruguaiiana, Brazil, and was the first interconnection between Argentina and Brazil to come on stream, when it was inaugurated in August 2000. The 237-mile pipeline originates in Argentina’s Neuquen basin and currently provides 88 MMcf/d of gas to a 600 MW gas fired plant in Uruguaiiana on the border of Argentina and Brazil.<sup>13</sup>

**Exhibit 10: Pipelines Under Construction from Argentina to Brazil**



Other Argentina to Brazil pipelines are in various stages of development and planning, although recent natural gas discoveries in both Bolivia and Brazil could inhibit further development, and economic and demand contraction in the region have caused delays. Projects under

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consideration include Transportador Sul-Brasileira (TSB), Cruz del Sur, Trans-Iguacu, and Mercosur pipelines.

TSB would be an extension of the existing TGM pipeline and would run from the AES plant at Uruguaiana to Porto Alegre, where it would interconnect with the BTB pipeline. TSB, in fact, fell victim to the economic instability in Argentina and Brazil, with the pipeline developers – Repsol YPF, Total, Ipiringa and Techint – freezing work on the line in 2002. The 500-MW Termogaucha plant was one of the four gas-fired power plants in which Petrobras cancelled its participation in July 2003, effectively dooming the projects.

Cruz del Sur would extend into southern Brazil an Argentina-Uruguayan pipeline that was completed in November 2002, but the extension has experienced delays as Uruguay has been unable to convert its power generators to natural gas, thus making the initial deliveries infeasible. The extension into Argentina is now expected to be completed in mid 2004. The 24-inch, 970 km, pipeline would begin in Punta Lara, near Buenos Aires and end in Porto Alegre, Brazil. The pipeline cost is estimated at U.S. \$420 million, of which U.S. \$150 million would be for crossing the Plata River. Over 600 MMcf/d of the 700 MMcf/d pipeline would be dedicated to Brazilian markets.

The Trans-Iguacu pipeline would cross from northern Argentina's Noroeste basin into southern Brazil. The Mercosur pipeline would bring gas from the Neuquen basin in northwest Argentina to Curitiba, Brazil, and could extend to Sao Paulo. Transiguacu and Mercosur, have projected capacities of over 1,200 MMcf/d and 900 MMcf/d respectively, although market demand is likely to support only one route.

**Exhibit 11: Transnational Pipelines Serving the Brazilian Market**

Project	Origin	Destination	Length (Km)	Capacity (MMcf/d)	Full Capacity Date	Investment (\$MM)
<b>Bolivia to Brazil</b>						
BTB	Santa Cruz, Bolivia	Sao Paulo Brazil	3,000	1,059	Dec-04	1,880
Bolivia to Cuiaba	Rio Grande, Bolivia	Cuiaba, Brazil	626	141		210
<b>Argentina to Brazil</b>						
TGM	TGN's network	Uruguaiana, Brazil	275	135	July-04	250
TSB	Uruguaiana, Brazil	Porto Alegre Brazil	815	424	Dec-06	250
Transiguacu	NW Argentina	SE Brazil		1,235	2005	
Mercosur	NW Argentina	SE, Brazil		880	2005	

*Source: Pace and other public sources*

**Domestic Pipelines and LNG Opportunities**

Brazil's domestic gas pipeline infrastructure is owned and controlled by Petrobras and is relatively limited due to Petrobras' historical focus on upstream oil development. The major pipeline serving the Northeast is the *Nordestão* system, which links producing fields located in the states of Ceara, Rio Grande do Norte, Sergipe, Alagoas, and Bahia to regional markets. The backbone of the Nordestao system is a 12-inch, 424 km pipeline that links the Guamare terminal in Rio Grande do Norte to the city of Cabo, near Recife. Other cities served by *Nordestão* include Natal, Mossoro, Joao Pessoa, and Fortaleza.

Several pipelines have been planned for the Amazon basin to serve thermal power plants in the region. Petrobrás is negotiating with the states of Amazonas and Rondonia to build a 342-mile Urucu to Porto Velho pipeline. The pipeline is expected to supply 80.5 MMcf/d, mainly to power a 404 MW thermoelectric plant owned by El Paso and CS Participacoes. Environmental licensing problems have delayed the construction of the pipeline. In the same region, Petrobrás is proceeding with plans to build a U.S. \$393 million 261-mile Coari to Manaus pipeline to be able to supply gas from the Urucu field to regional industry. El Paso announced its interest in

November 2003 in taking a stake in the Manaus pipeline as the U.S. firm has four plants serving the Manaus market.

The Northeast is the fastest growing region in Brazil, but as indicated above, has limited pipeline infrastructure. Given the lack of indigenous gas production and pipeline infrastructure, power developers are looking to LNG to fuel new plants.

Shell and Petrobras formed a joint venture company in 2000 to build a U.S. \$200 million LNG terminal in Pernambuco state near Recife and has begun work on the facility. With an initial capacity of approximately 140 MMcf/d and a start-up date of 2005, the terminal would import LNG from Trinidad, Nigeria, or Venezuela. It would be the first regassification terminal in South America. A Repsol-YPF and BP Amoco joint venture, Dunas, plans a 250 MW gas-fired plant in Ceará state that would eventually be supplied by LNG.<sup>13</sup>

### **Industry Restructuring and Regulatory Reform**

Restructuring and privatization of Brazil's energy industry is ongoing. Until the early 1990s Brazil's energy industry was centralized and state-owned. To attract private investment to an undercapitalized industry, the government pushed through a series of economic reforms that began to move the industry towards greater liberalization and participation by private capital.

Restructuring and privatization of Brazil's energy industries took place as reforms were implemented in the rest of the economy. Brazil embarked on economic reform in the early 1990s by simultaneously liberalizing trade and developing a framework for privatization of major state owned industries. The cornerstone of these initiatives was the introduction of the *Real Plan* in mid-1994 to reduce inflation and tame inflationary expectations.

The *Real Plan* dramatically reduced inflation through a combination of exchange rate reforms, structural economic reform, and privatization. Brazil's annual rate of inflation was over 2,000% in 1994, but plummeted to less than 3% in 1998. With inflation under control and structural

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<sup>13</sup> Dunas is part of the Atlantic LNG project in Trinidad and Tobago.

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economic reforms in place, Brazil experienced strong growth in the latter half of the 1990s and was able to attract private capital, especially foreign direct investment, to the energy industry.

A key event in energy sector reform was the Brazilian government's approval in July 1997 of the full text of the Brazilian Petroleum Investment Law. The law limits Brazilian treasury holdings in Petrobras and defined a new energy policy. Highlights and key objectives of the law included:

- Creation of the National Council for Energy Policy (CNPE) to set energy industry policy.
- Creation of the Agencia Nacional do Petroleo (ANP) to oversee deregulation and restructuring.
- Increased use of natural gas.
- Free competition in the energy industry
- Domestic and foreign investment in power generation.

Despite the intention to create a more competitive energy market, the Brazilian government still retained monopoly control of key sectors of Brazil's energy complex, including:

- Ownership of oil and natural gas reserves;
- Sole rights to explore for and develop reserves; and
- Gas and oil transportation.

Exhibit 12 shows the major characteristics of Brazil's gas industry today.

**Exhibit 12: Profile of Brazil's Natural Gas Industry**

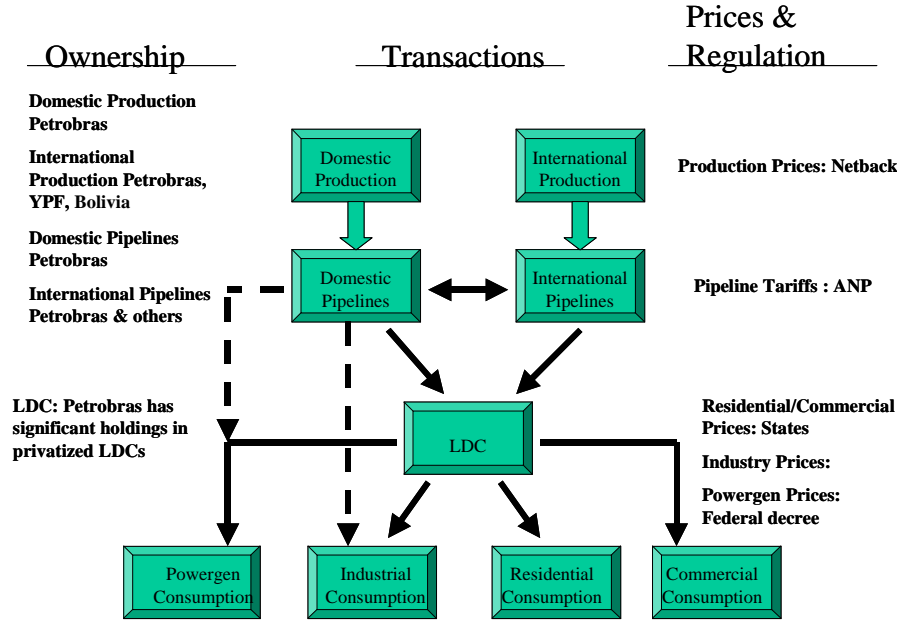
<b>Category</b>	<b>Characteristic</b>
Industry Control	State ownership predominates, with state-owned entities wielding greater power than the private sector.
Industry Structure	Restrictions on private ownership, with reserves and production in Government hands
Privatization	Privatization process stalled in all key sectors.
Pricing and Sales	Retail and wholesale gas prices linked to oil or U.S. gas prices.
Regulation	Regulated by an independent regulator
Trade Restrictions	No restrictions
Fiscal Regime	No special taxes on gas industry

Source: Pace

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Exhibit 13 shows the industry structure and regulatory framework currently in place in Brazil. Under asset ownership, domestic production is firmly in the hands of state-owned Petrobras, which is also involved in an increasing share of production from Argentina and Bolivia. Most domestic pipelines are operated by Petrobras, which also has either controlling shares or significant participation in international pipelines. Petrobras holds significant stakes in local distribution companies, many of which were privatized in recent years, and is also very active in proposed gas-fired power generation.

**Exhibit 13: Industry Structure and Regulatory Framework**



*Source: Pace*

From a transactions and price point of view, producers essentially receive a netback price based upon regulated wholesale prices and regulated pipeline tariffs. Pipeline tariffs are based on cost of service rate-making and are regulated by the ANP, which also sets the domestic gas price by federal decree. Regulation of the retail industry, from local distribution companies to the various end use sectors, is under the jurisdiction of local states.

This model of industry regulation is somewhat similar to the current regulatory structure in the United States, with the wholesale market regulated by the federal government and retail markets regulated by the states. One key difference is that in the United States, gas supplies and prices are competitive and unregulated, while in Brazil production is concentrated in a monopoly, with prices netbacked from regulated wholesale and retail markets.



## **Petrobras' Role in Brazil's Gas Market**

Petrobras is a significant obstacle to the development of a truly competitive market in Brazil. It dominates Brazilian and Bolivian gas production and plays a significant role in gas transportation and retail markets. It is the largest gas producer in Brazil, has played a leading role in the development of Bolivia's gas fields, and is a majority stakeholder in several transnational pipelines. On top of this, Petrobras has taken a leading role in the development of gas-fired power generation projects and has substantial holdings in many of Brazil's local distribution companies.

**Exhibit 14: Petrobras' Equity Stake in Brazil's Gas Distribution Companies**

<b>Distribution Company</b>	<b>State</b>	<b>Petrobras Stake (%)</b>
CEGAS	Ceara	41.5%
POTIGAS	Rio Grande do Norte	41.5%
PBGAS	Paraiba	41.5%
COPERGAS	Pernambuco	41.5%
ALGAS	Alagoas	41.5%
EMSERGAS	Mato Grosso do Sul	41.5%
BAHIAGAS	Bahia	41.5%
BR	Espirito Santo	100.0%
RIOGAS	Rio de Janeiro	25.0%
SCGAS	Santa Catarina	49.0%
COMPAGAS	Parana	24.5%
MSGAS	Mato Grosso do Sul	49.0%
RONGAS	Rondonia	41.5%
<b>Average</b>		<b>44.6%</b>

*Source: Petrobras*

As a pipeline operator, Petrobras is often accused of preferential treatment to Petrobras subsidiaries, of hoarding excess pipeline capacity, and of barring access to other gas shippers.<sup>14</sup>

<sup>14</sup> Pricing of pipeline tariffs is also a contentious and political issue. For example, the majority of state gas distribution companies, which serve as intermediary suppliers of gas to the new power plants, are demanding that postage stamp tariffs be applied along the Bolivia to Brazil pipeline. Rio Grande do Sul State (3,100 km away from the Bolivian gas fields) has lobbied to pay the same tariff as Matto Grosso do Sul State, on Bolivia's border. The ANP has issued a discussion document (Portaria 169), which aims to fix tariffs according to distance and also allow free access to Brazil's gas pipelines. Portaria 169 proposes that any company which controls more than 50% of a line may not have more than a 40% stake in new sections built. It also suggests that rolled in rather than incremental

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Apart from its controlling stake in the Bolivia to Brazil pipeline, Petrobras also owns more than 10 Tcf of natural gas reserves in Bolivia. Under the terms of its Bolivia to Brazil take or pay contract, Petrobras has preferential supply rights and in theory could fill more than 800 MMcf/d of the 1 Bcf/d pipeline. This has effectively blocked other Bolivian producers from accessing the Brazilian market and could potentially drive other producers out of the Bolivian gas industry.

Petrobras is playing a significant role in the development of thermal power generation in Brazil. In the ten-year expansion plan for the electric sector, Petrobras will have a minority role in fifteen thermal power plants.<sup>15</sup> Ten of these plants will be dedicated to the production of electricity only and will account for 2,780 MW of capacity. The other five will produce both power and steam, with the electricity allocated to Petrobras' consumption and sales to large industrials. The steam will be completely consumed by Petrobras.

In comparison to Argentina and Bolivia, Brazil's industry is still monopolistic and state-owned. For decades, the prevailing business model in Brazil was oligopolistic; with major companies in particular sectors cooperating to assure high margins that would otherwise be eroded by competition. As privatization of Brazil's natural gas sector proceeds, Petrobras would appear to be recreating a similar system for Brazil's nascent natural gas industry.

To combat the tendency towards oligopoly, Brazil could well look to Argentina as an example of a gas and power industry model to emulate. Argentina's natural gas industry was privatized in June of 1992. The state monopoly Gas del Estado was split into eight distributors (MetroGas, Gas Natural, Pampeana, Litoral, Sur, Centro, Cuyana, and Noroeste) and two pipeline companies (Transportadora de Gas del Sur SA (TGS) and Transportadora de Gas del Norte SA (TGN)). TGN and most of the distribution operations were privatized in December 1992.

Because the new regulatory system gave companies a "reasonable return" on investments in expansion capacity, and allowed companies to recover costs from future customers, Argentina's gas distribution system grew at a rate of 7% annually from 1992 through 1996. Argentina's

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tariffs be applied, in that, if a pipeline's capacity is increased, then any productivity gains and cost savings would be passed on to all shippers, rather than just incremental ones.

<sup>15</sup> *Plano Decenal de Expansão do Setor Elétrico*

natural gas transportation system operates under a non-discriminatory "open access" policy, with rates set by the state regulatory agency, ENARGAS.

Now, Argentina's natural gas industry -- production, transportation, distribution, and marketing -- is completely in the hands of the private sector and is operated within a competitive market structure, with guaranteed open access to transmission and distribution pipelines, and no restrictions on imports and exports of natural gas. With proper and stringent regulation, Brazil's gas industry could follow the path blazed by Argentina in the 1990s.

### **Brazilian Prices: Inefficiencies and the Benefits of Commoditization**

Brazil's natural gas prices are highly regulated, from upstream production to downstream distribution. Downstream prices are tiered according to customer type and location and are generally capped. For example, commodity prices to existing power plants are based on a formula that links gas to a basket of international crude oil prices, while commodity prices to new plants that are part of the Emergency Thermopower Program are fixed at approximately \$2.58 per MMBtu, with annual adjustments for U.S. inflation.

Despite fixed gas prices, new power developers are exposed to substantial currency risk. Gas is priced in U.S. dollars, while power is priced in Brazilian *reais*. Exchange rate risk has recently increased substantially due to weakness in the *real* and the spread of regional economic instability. Argentina's economic problems and currency weakness has created a "contagion" effect on the Brazilian market and currency, and the energy crisis has only exacerbated weak investor confidence.

Recognizing this, the Government has considered enacting emergency regulations that mitigate some foreign exchange risk by fixing the price of imported gas in *reais* for periods of 12 months. During that period, Petrobras would absorb costs from currency fluctuations, although they would eventually be able to pass the costs on to distributors and consumers.

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Since Petrobras may eventually recover some of the costs from customers, this pricing structure is better than the regulatory debacle in California, where wholesale power prices were deregulated, while retail prices remained capped -- a scheme that effectively bankrupted the state's two largest utilities. However, Government failure to respond effectively to market conditions and regulatory uncertainty has had a chilling effect on much needed private investment in Brazil's energy infrastructure.

Energy price fixing creates obvious distortions in the market place, and, if set too low, encourage excessive consumption, while discouraging investment. This can and has created energy shortages, and has resulted in rationing in both Brazil and other world economies. For example, wellhead price caps on natural gas in the United States during the 1960s and 70s resulted in under investment in new production, gas shortages, and eventual rationing.

Likewise, California's 2000/01 power crisis provides another compelling example of the unintended outcomes of price caps over the long run. California deregulated wholesale power prices to encourage competition among generators and reduce consumer prices. Unfortunately, years of under investment in power generation left California short of capacity, and, as markets deregulated, power prices shot up. Higher power prices sent a clear signal to consumers to cut back consumption and for producers to invest in new capacity, steps that would eventually bring the market back into balance. The California 'energy crisis' is still unfolding, with the California legislature recently re-imposing price caps.

Under the new price cap scheme, power prices are based upon the cost of the highest cost (marginal) generator. Since this is normally natural gas, power prices are essentially linked to the price of gas. However, this can create new problems, since the cost of gas is not calculated as the actual cost on a day-to-day basis, but as an average monthly cost. If power demand soars and generators cannot recover their daily gas price, generating capacity will not be dispatched, further exacerbating power shortages.

California's regulatory fix is meant to ease the transition to a deregulated market, particularly until new generating capacity comes on-line. However, in the long run, price caps and reduced

generation result in lower gas demand and lower gas prices. Low gas prices will send a signal to pipelines and producers not to add needed production and transportation capacity, and sets the stage for future energy shortages.

Subsidized gas prices for new exploration and production during the late 1970s and early 1980s, created a U.S. “gas bubble” that lasted well into the 1990s. Some might argue that this was intentional since the “gas bubble” and attendant low prices were necessary events for the successful deregulation of the U.S. gas industry. A fact that eluded California, which deregulated power markets during a period of extreme market tightness.

### **Development of Deregulated Gas Prices: The U.S. Experience**

Prior to liberalization of U.S. natural gas prices during the 1980s, wellhead prices were federally controlled and pipelines bought gas from producers under long-term contracts of 30 years or more. LDCs in turn entered into long term, largely fixed price contracts, with pipelines and resold the gas to their customers.

Producers passed a federally regulated natural gas price along to pipelines, which after adding a federally regulated wholesale markup, passed the price on to the LDC. The LDC added a state regulated distribution markup for delivering the gas to its utility, industrial, commercial and residential customers.

The system worked well enough for many years, providing stable gas supplies at a relatively low and stable price. However, years of low price ceilings at the wellhead meant that producers had little incentive to find new gas supplies and shortages began to develop that eventually led to federally mandated gas rationing.<sup>16</sup> The strictly controlled natural gas industry had begun to unravel.

As an incentive for producers to supply more natural gas, the Natural Gas Policy Act (1978) began to increase and ultimately phase out production price caps, the first step towards natural

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<sup>16</sup> The Fuel Use Act forbade the burning of natural gas for power generation and in some industrial processes.

gas commoditization. The decontrol of wellhead price was initially applied to certain categories of 'high cost' gas, such as gas produced from depths greater than 15,000 feet. Soon price decontrol spread to all categories of newly discovered gas, more supplies began to enter the market, and an oversupply of natural gas, termed the 'gas bubble', was developed. Consequently, wellhead prices began to plummet.

During the late 1970s, pipelines and consumers perceived natural gas to be in short supply. To secure supplies, pipelines entered into expensive long term fixed price contracts with producers in which they were required to take gas up to a contracted maximum volume and were subject to stiff penalties if the volumes dropped below a specific amount --"take or pay". However, with wellhead price decontrol, new supplies began to enter a developing 'spot' or 'cash' market and prices began to fall below the cost of the gas written into the contracts. Pipeline companies were left holding long-term contracts for natural gas at prices way above market clearing prices.

This was one of the key events that eventually led to the exit of pipelines from the merchant role altogether. Fulfilling a merchant function, pipelines took ownership of the gas and resold it to the local distribution companies. During the late 1980s and early 1990s, the U.S. Federal Energy Regulatory Commission issued a number of key orders that formalized the transformation of pipelines into common carriers of natural gas -- a transformation that pipelines were already undergoing, following the "take or pay" debacle. Consumers could now purchase gas directly from producers, either under a contract, with lengths varying anywhere from 30 days to 30 years, or in the rapidly developing cash market.

With new supplies entering the market and prices plummeting, among the first consumer groups to buy natural gas in the cash market were industrials and utilities that, after 1987, were again allowed to purchase gas unrestricted.<sup>17</sup> They increasingly by-passed the LDCs' high tariffs to contract directly with producers to supply the gas and pipeline companies to transport it. At the same time, a new market player arose, the natural gas marketer, which made it easier for large consumers to deal with multiple pipelines and producers. The marketer rebundled supply,

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<sup>17</sup> The Power Plant and Fuel Use Act was repealed in 1987.

transmission and other services and offered them competitively to large consumers at a lower cost than the LDC.

In 1989, the U.S. Congress passed the Natural Gas Wellhead Decontrol Act, which completed the phased decontrol of prices on all classes of natural gas. This act effectively fully commoditized natural gas at the wellhead and paved the way for the New York Mercantile Exchange (“NYMEX”) to establish the futures contract at Henry Hub in 1990.

### **Commoditization and its Benefits**

As a U.S. spot market for natural gas grew, so did the need for financial instruments to hedge price volatility. The new NYMEX natural gas futures contract gained rapid market acceptance as a hedging and speculation tool. Now, the U.S. natural gas market is fully commoditized, with prices determined by the interplay of the physical and financial markets, through the actions of producers and consumers on the physical side, and hedgers and speculators on the financial side.

The depth and sophistication of the U.S. gas market has grown by leaps and bounds. Not only has the futures market continued to grow in terms of open interest and daily transaction volumes, but new more exotic financial instruments and strategies have evolved for producers and consumers to manage price volatility and risk.

Price decontrol and the development a functioning competitive market in the U.S. gas market has bestowed significant benefits on the U.S. economy, including generally lower gas prices, greater competition, and more secure supply. It has also created a degree of market transparency that ensures that the market remains competitive and free of manipulation. Open interest and daily transactions on the future market would not remain so high, if participants believed that prices were subject to persistent and ongoing manipulation, and provide a barometer of market competition.

## **Brazil's Natural Gas Industry: Missed Opportunities on the Road to Liberalizing Markets**

Brazil's problem is that natural gas prices are subject to manipulation and uncertainty, whether by government fiat or, even more insidiously, by formerly state-run monopolies. Many potential private investors will require further moves towards liberalization and transparency before they will commit to long-term investments in energy infrastructure projects, which will only prolong undue uncertainty in the Brazilian energy market and feed smoldering economic and political problems. Some industries have already decided they can wait no longer for a government solution and have acted alone. Mining and industrial conglomerates, such as CVRD and Votarantim, have embarked upon ambitious power generation programs utilizing corporate financing (as opposed to project, or debt, financing) to ensure adequate supply. Brazil's third largest individual power consumer, the steel conglomerate CSN, is now entirely self-sufficient in power with a stake in three power plants.

Besides government inaction, perhaps the greatest obstacle to a transparent and competitive market for natural gas in Brazil remains the dominant position of Petrobras. A full break up of the company into competing parts is ultimately the only way to openly solve this problem. Additionally, strong regulatory agencies would enforce price competition and ensure that remaining monopolies (most notably pipeline companies) would be effectively monitored for abuses.

### **Looking Forward: Policy Recommendations to Facilitate Market Development**

Problems and impediments remain to developing a fully functioning competitive natural gas market in Brazil. For this discussion, we assume that Brazil is following a path towards market liberalization not for the "narrow" purpose of attracting private capital to under-funded state enterprises, but for the broader purpose of creating a more vibrant and economically efficient gas sector.

In general, the problems and impediments center around: the legal regulatory framework and property rights, restructuring of dominant monopolies, development of competitive markets and pricing, and the development and strengthening of regulatory agencies with clear responsibilities.



Brazil's government has taken steps to resolve many of these issues, although the pace of change is erratic as it struggles to create competition in a market dominated by Petrobras. Perhaps the greatest danger, as seen in many instances of privatization around the world, is the replacement of a state-run monopoly with a private one. However, this need not be the future, with the implementation of tough anti-trust laws and strong regulatory bodies overseeing the transition.

Impediments specific to the gas industry are considered next under the sub-headings pricing, regulation, and industry structure.

### **Pricing**

- *Integrated Southern Cone gas prices.* A truly regional (Southern Cone) gas market requires the transnational harmonization of natural gas commodity prices between Argentina, Brazil, and Bolivia. Producer gas prices in all three countries are currently based on a netback from regulated wholesale and retail prices, which in turn are tied to a basket of international oil prices. Wellhead prices seen by producers are therefore not market derived, and due to political and regulatory uncertainty, often impede full participation by foreign producers. Assuming that the political will exists to tame the power of state-run monopolies, Brazil and other Southern Cone countries should seek to move away from a gas price linked to oil. Ideally, new market entrants, such as third-party marketers and private producers, would add diversity and competition to the market. This would be a first step towards the creation of a commoditized gas market, with a gas price determined by supply and demand fundamentals.
- *Linkage of power and gas prices.* The development of Brazil's gas industry is predicated on the development of gas-fired power generation. However, the development of this industry is hampered by the "delinkage" of power from gas prices. Under a rational pricing mechanism, power prices are determined by the marginal power producer, most often natural gas-fired and margins are guaranteed through power purchase agreements that explicitly link power to gas prices. Presently, power is sold at a regulated rate in *reais*. Gas, however is sold at a fixed rate in U.S. dollars to new power plants. All other consumers pay a price linked to international oil prices. This not only exposes the power

producer/gas consumer to commodity price risk, but also to risk from currency fluctuations. This problem has been exacerbated by higher oil prices, which are completely unrelated to the Brazilian gas market. Again, the creation of a competitive gas market in the Southern Cone would solve many of the problems of tying commodity prices to arbitrary indices.

## **Regulation**

- *Strong regulatory agencies and policy coordination across countries.* On paper, Brazil has organized its gas pipeline industry as an open access system. However, Petrobras can flout its dominant position in the industry and effectively shut out potential competitors. Most foreign energy companies consider it challenging to enter the Brazilian energy market without the involvement of Petrobras. The ANP requires more "teeth" to be able to enforce existing third-party access rules. The effectiveness of the ANP is currently limited by the market and political power of Petrobras.
- *Collection and dissemination of information.* Currently, Petrobras holds a monopoly on information on Brazil's production and transmission system. The ANP requires federal budgetary support to create and maintain information systems that can be disseminated electronically to all potential market participants. This will create a level playing field capacity and transparency for all participants.
- *Removal of Power Price Caps.* Development of the Brazilian gas sector is driven almost exclusively by power generation, but price caps on generation impede private investment. The power regulator's (ANEEL) price caps on power have created disincentives to investments by domestic and international thermal IPPs. This is a major contributor to underdevelopment in Brazil's thermal power generation sector and has precipitated the current power crisis. Generators must be permitted to pass on gas costs to consumers through power price increases. Failure to change this regulatory obstacle will prolong and exacerbate the current crisis and will impede Brazil's economic development.

## **Industry Restructuring**

- *Failure to privatize large generating companies.* The Brazilian government must demonstrate the political will to offer up the largest generating companies for private bid. Failure to do this expeditiously will send signal to the international investment community that the government is protecting its most valuable assets and is not serious about establishing a truly competitive power generation sector.
- *Private investment in upstream gas assets.* Producer concentration in the upstream sector results in monopoly prices at worst and price regulation at best. In either case, the market functions less efficiently leading to under-investment in production. Brazil can avoid this outcome by aggressively offering attractive gas acreage up for competitive bidding.
- *Resource ownership versus production sharing.* The Brazilian government continues to retain rights over hydrocarbons. Although it is the norm for most countries to attract foreign capital by offering production-sharing agreements and other incentives, ultimately private ownership of resources results in their most efficient use and is usually a precursor to the development of a functioning commodity market.
- *Improved third party access to transmission.* Third-party producers and marketers that are not vertically integrated with pipeline and gathering system are discriminated against by Petrobras, which controls domestic and major transnational pipeline routes. Petrobras' control of the Bolivia to Brazil pipeline is already resulting in preferential treatment to its Bolivian producing subsidiary, effectively locking other Bolivian producers out of the Brazilian market. Access to pipeline systems must be made available on a nondiscriminatory basis.
- *Creation of market mechanisms to attract participants.* Creation of a secondary market in pipeline capacity, with active participation of producers, marketers, and consumers would create some price transparency. Petrobras' significant ownership shares in gas fields in Bolivia, the BTB pipeline, state distribution companies, and significant stakes in numerous thermal power projects, is shutting out competition. Petrobras should be forced to adhere to ANP regulatory policy on third-party access to non-affiliated marketers and shippers.

## **Conclusions**

This paper shows that Brazil has most of the elements in place to develop a vibrant natural gas industry. It has access to domestic and international supply basins, multiple cross-border pipeline routes, and is expected to see a return to a healthy growth in gas demand. Brazil has also initiated necessary market reforms that, if aggressively implemented, will lead to an efficient and competitive gas market.

Major obstacles to the gas industry's development are not the physical limitations of natural gas resources and transportation to demand centers. Rather, it is the threat that reform and deregulation will be circumvented by state-run giant Petrobras, as it seeks to further consolidate its already dominant position in the market.

Brazil has already demonstrated a reformist zeal to privatize, liberalize and develop other sectors of the economy that allows them to compete in a global market. These measures have resulted in greater private investment and encouraged much needed competition. It must show similar commitment to the entire energy sector in general, and the gas industry, in particular.

Prudent regulation and the continuation and extension of market driven reforms to the natural gas industry will facilitate private investment and generate rapid growth over the next five to ten years.