With the 17th World Petroleum Congress being held in Brazil in September 2002 the JCPT is pleased to include two articles on the Brazilian industry and economy with particular emphasis on its energy sector and rapidly growing oil and gas industry. In the first article, Annette Hester captures the current political and economic flavour of Brazil. In the second, Dr. Abbas Naini provides background information and reviews the development of each sector of the energy industry.

Ms. Dimitra Katsuris serves as co-ordinating editor for the presentations. She has assisted the Canadian Association of the WPC since 1997 and especially with the development of the Global Business Opportunities Centre at the 16th WPC held in Calgary in June 2000. Currently, she is assisting with the development of the Canadian booth program and other business development initiatives at the 17th WPC. Ms. Katsuris is an independent consultant with 20 years of oil industry experience, currently specializing in international project development and trade. She graduated from the University of Calgary with a B.Sc. in geomatic engineering and is a member of APPEGA.

Brazil—The Land of New Beginnings

Ms. Annette Hester was born and educated in Rio de Janeiro. Since coming to Canada 20 years ago, she has obtained a master’s degree in economics from the University of Calgary and established her own consulting firm. Her occupation—and her passion—is building connections in the Americas. Her primary activities have included developing market strategies and acting as a liaison between leading oil, gas, and energy companies in Canada, North America, and Latin America. She has also provided consulting services to governmental agencies in several countries of the Americas, especially Brazil and Canada. Annette writes comment pieces for several newspapers including regular contributions to the Globe and Mail. Recently, she was appointed director (interim) of the new Latin American Research Centre of the University of Calgary.

With her unique expertise, Annette has frequently been an invited participant in round table discussions on hemispheric inte-
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September in Brazil! It is spring there, and the days are just perfect, warm but not too hot. Spring is a time of new beginnings, too. It's a perfect time to visit Rio de Janeiro, especially in 2002.

As delegates start arriving in Rio to take part in the World Petroleum Congress 2002 (WPC), the one thing that is likely not to go unnoticed—aside from the signature landmarks of the Sugar Loaf, Christ the Redeemer, and the beautiful beaches—is the overwhelming abundance of electoral posters and electoral propaganda of all kinds, including people in the streets dressed with shirts coloured to identify their candidates blowing horns and handing out material.

It is, after all, a time of new beginnings: only one month before the elections that will decide Brazil's next president. It is unknown at this point how many individuals will be competing for Fernando Henrique Cardoso's job of eight years but, by then, they will be fighting hand-to-hand combat for the position. I am certain they will manage to find an occasion to visit the WPC, to show the electorate they can rise to the occasion and hobnob with the world's oil and gas leaders.

So far, according to opinion polls, the leading candidate is the Partido Trabalhista's (Worker's Party) Luiz Inácio Lula da Silva, or as he is known to Brazilians, Lula. This is Lula's fourth attempt to become Brazil's president and not the first time he has led the opinion polls early in the campaign. Up to now, Brazilians have been reluctant to elect someone who sees Venezuela's Chavez and Cuba's Fidel Castro as role models. The second placed contender is Roseana Sarney, the photogenic governor of the State of Maranhão, daughter of senator and former president José Sarney, and sister of the current environment minister José Sarney Filho. As you can imagine, she is not a lightweight when it comes to policy in Brazil. For now, the remaining candidates remain bunched together at quite a distance. But that is only because José Serra, the individual who will probably represent the governing party, the PSDB, has yet to officially throw his hat in the ring and start campaigning in earnest.

It is still early in the race, and it is not clear whether Cardoso's low approval ratings of late will turn out to be a liability for anyone who is perceived as being part of the old regime. According to a survey conducted by the polling organization Datafoha in the last weeks of June 2001, the low ratings were a result of the voters' perceptions of problems with unemployment, hunger, health, violence, energy crisis, and corruption—in that order. So far, the low ratings have persisted and were confirmed by two other polls (conducted by pollsters Ibope and Sensus) taken in early December. However, elections are not until October and lots can change between now and then.

For one, the energy crisis—a California-style electricity debate—is easing thanks to a successful rationing program, a slowdown in the economy, and a lot of help from São Pedro, the saint responsible for rain. The crisis was a result of overuse of reservoirs and lack of rain, causing extremely low water levels (hydroelectric power accounts for over 90% of the country's electricity production). To make matters worse, lack of transmission lines meant that even though some regions did have higher reservoir levels, electricity couldn't be delivered where it was needed.

The situation became so drastic that in the middle of May the government announced a mandatory rationing program for everyone. Residential, commercial, and industrial users were required to decrease their electricity consumption by a whopping 20%.

The crisis happened in spite of the fact that experts had warned the government since at least 1996 that investment in that sector was insufficient. New hydroelectric projects were not approved, investment in transmission lines did not take place, and the gas transport, pricing, and electrical pricing regulations were so flawed that investment in alternative sources was not forthcoming.

While the worst seems to be over, the reasons for this reversal of fortunes seems more circumstantial than planned. The December newsletter from Brazil's Central Bank suggests that the stringent cutbacks will be relaxed after February, bringing permitted power usage back to approximately 95% of 2000 rates. Critics are quick to point out that the changes needed in the regulatory environment to create stability and lower risk factors have not been forthcoming, rendering the predicted reduction in rationing merely an election campaign tool.

However, although Cardoso was warned and failed to act in order to avoid the electricity rationing, other leaders in more developed countries with a great deal more experience in regulatory matters suffered the same fate. That speaks to a problem that faces all countries, developed or not: getting the regulatory regime right.

In this area, especially taking into consideration the far-reaching changes introduced by Cardoso in Brazil's oil and gas environment during his eight-year tenure, perhaps history will judge him with a lot more candour than his countrymen.

After all, he presided over the 1995 constitutional change that loosened up regulations in the sector to allow foreign investments in the exploration and production of oil and gas in the country. In 1997, he enacted legislation that created a regulatory agency—the Agência Nacional do Petróleo (ANP)—charged with regulating all activities related to oil and gas, from exploration to the gaso-line pump. He kept his 1996 promise of not privatizing Petrobras—the Brazilian energy company controlled by the government—and still managed to replace and change the legal composition of the Board of Directors to allow the company to function as a competitive major while keeping its control in government's hands. These are considerable accomplishments.

The transformation of the hydrocarbon sector in Brazil offers a great study on the challenges a government faces when trying to find the right formula to go from a monopoly system to an open,

As expected, Serra announced his candidacy on January 17, 2002.

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free competition, economic model.

For instance, the ANP managed to effectively negotiate Petrobras' retention of a number of areas and then had the company compete as an equal player with all other domestic and international corporations in three successful exploration and production licensing rounds (by the time the WPC 2002 takes place, a fourth round will have been completed). If the success of the opening is measured by the number of companies who bid, won, and formed partnerships in these rounds, no one would argue it was a complete success. Today, 29 international companies and nine domestic companies are active participants in the exploration and production of oil and gas in Brazil.

However, all is not well in the land. Delays in issuing environmental licenses have increased the costs of upstream activity in the country to the point that several companies have opted to either abandon specific projects or just leave the country altogether. The gist of the problem is that although all oil and gas activity is regulated by the ANP, other governmental agencies, both federal and state, have jurisdiction over environmental areas. These agencies were not designed nor equipped to handle the increase in the volume of applications for licenses. It is not difficult to understand the crunch caused by a shortage of technically trained people to staff a number of agencies all experiencing high demand at the same time.

The other issue is a lack of maturity of the political system regarding the interaction of government agencies in cases where there is overlapping jurisdiction. It takes time to achieve the political compromise needed to establish a leading agency. Time, however, is in short supply when companies have a limited period in which to fulfill their concession contract obligations. Perhaps, as some leading figures in the sector have suggested, it would be better to offer exploration rights only in areas that have pre-approved environmental licenses.

Although these might be costly lessons for Brazil, they should nevertheless be accepted as normal growing pains for the kind of transformation we are seeing in the country.

The ANP is also facing some daunting tasks in other areas. How do you develop and apply a competitive regulatory model when you have a "de facto" monopolist in the market. "With difficulty" must be the answer. Take for instance, the refining sector where in law anyone with money to spare can build and operate a refinery but Petrobras controls over 98% of the total capacity. Another challenge is that of access to terminals, pipelines, and infrastructure. It is easier to approve legislation giving free access to all agents than to implement it and monitor it. How do you judge excess capacity when the entire infrastructure is in the hands of . . . Petrobras through one of its subsidiaries. Remarkably on the newly approved opening of the products' market for imports, a Dutch trading company executive comments in Brazil's leading energy publication, Brasil Energia, "The new investors are going to encounter a giant in production, industrialization and distribution (in the oil and gas sector) that, depending on its price structure, will be able to make imports of any product unprofitable." He adds that the rules of the game must be firm and transparent if the perpetuation of the monopolist system is to be avoided.

Setting the rules and finding the delicate balance between maintaining the strength of Petrobras—a reason for much national pride—and stimulating fair competition requires skilled leadership and a lot of political wallop. That seemed to be the case with the team Cardoso had in place in early 1999. Rodolpho Tourinho, Minister of Mines and Energy, made a series of controversial decisions from the moment he accepted his position in January 1999. Although some will argue that much of the electricity debacle was exacerbated by his dealings with the electric sector regulatory agency (ANEEL), it is widely accepted that the choice of economist and financier Henri Philippe Reichstul as the new president for Petrobras certainly paid off in unexpected ways.

When his name was first announced, the market reception was less than warm. After all, what do you make of a president of one of the largest oil companies in the world who has never seen a rig in his life? Reichstul proved to be a fast learner. Undaunted by anyone's perception, he went about asking as many questions as possible and applying his vast experience in the financial markets to move the company into a new era. Without a doubt, the Petrobras of today is a completely different company than the one Reichstul took over. It is an integrated energy company with a clear strategic vision and accountable to shareholders. There were also some very low points: the sinking of P36 and the oil leak in Guanabara Bay. Nonetheless, under Reichstul's leadership, the government was not able to use the company for every political whim as it had in the past, in spite of its majority shareholder position.

Sparring with Reichstul was an equal heavyweight at the ANP. David Zylbersztajn, the director general of the agency, was clearly qualified for the job. An engineer by training with a Ph.D. in ener-
Brazil's Economy and Energy Industry

Abbas Naini holds a Ph.D. in econometrics and industrial organizations from Dalhousie University. Over the past 23 years, he has focused on applied statistics, simulation, forecasting, and modelling. His research interests include analysis of economics, energy, and environmental issues. Dr. Naini has authored and co-authored numerous economic, energy, and environmental articles published in North American and European journals. He is an adjunct professor at the University of Calgary, and serves on the Board of Directors of the Canadian Association for Business Economics. He was president and chairman of the Economics Society of Canada. He was the recipient of the Society’s Leadership Award in 1994 and television station Shaw Community 10’s Outstanding Achievement Award in 1995.

The Federated Republic of Brazil with 8,511,965 km² is the largest country in South America and the world’s fifth largest, after Russia, Canada, China, and the USA. Brazil borders every country in South America except Chile and Ecuador.

In the 1980s (after 20 years of military rule) the country slowly returned to democracy and in 1988 enacted a new constitution, which allows the president who is also commander-in-chief of the armed forces to choose ministers of State, initiate legislation, and maintain foreign relations. Brazil is administratively divided into 26 states and one Federal District.

The presidential powers are balanced by a bicameral legislature, which consists of a 72-seat senate and a 487-seat chamber of deputies. Presidential, state, and congressional elections are held every four years.

Brazil, with a population around 170 million, is the world’s sixth most populous country. However, it is one of the least densely populated in the world, averaging only 20 people/km².

The capital of the country is Brasilia and the most populous city is Sao Paulo, with more than 10 million inhabitants, followed by Rio de Janeiro with almost 6 million. The Brazilian population’s annual growth has dropped from 2.4% in the 1970s to almost 1% in the year 2000.
TABLE 1: Comparison of Canadian and Brazilian major economic data – 2000.

<table>
<thead>
<tr>
<th>Economic and Demographic</th>
<th>Canada</th>
<th>Brazil</th>
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<tbody>
<tr>
<td>Area – Square Kilometres</td>
<td>9,918,000</td>
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<tr>
<td>Population – millions</td>
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<td>170</td>
</tr>
<tr>
<td>GNP – Billions CDN$</td>
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<td>$923</td>
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**GDP Components, %GDP**

- Consumer Expenditures: 55.3   62.5
- Government Expenditures: 18.2  18.2
- Business Investment: 20.5     20.5
- Exports: 45.4                 10.9
- Imports: 40.3                 12.1

**Other Data**

- Per capita GNP – CDN$: $33,670  $5,429
- Inflation rate: 2.7  4.7
- Unemployment rate: 6.8  7.1
- Currency: Canadian (CDN) $, Real (BRL)

BRL 1=US$ 2.58, US$ 1=CDN$ 1.59 (6 Nov, 2001)


**Economic Overview**

Brazil's economy has consistently been among the 10 biggest in the world, and the largest economy in South America. Brazil and China are the only developing countries among the top 10 in the world.

During 1968 to 1980, the Brazilian economy expanded rapidly and the gross national product (GNP) enjoyed an average annual growth rate of 7%. In the 1980s Brazil's economic performance became unstable as the GNP growth rate varied from -4.2% to 6.9%. The instability of economic performance and high inflation continued to the early 1990s. By 2000 the economy saw a slow recovery, with the strongest growth rate in five years of 4.5%. The poorer performance of the economy was related to internal factors such as significant rigidities in budgeting and public expenditures, and external events such as the second oil price shock, increases in international real interest rates, the Latin American external debt crisis, and cutoff of foreign credit and direct investment. The above pressures led to a steady rise in inflation as the monthly inflation rates reached 50% by the middle of 1994.

On July 1, 1994, the Brazilian government introduced an "economic stabilization" program, known as the "Real Plan" (The Real is the unit of Brazil's new currency which was introduced in 1994). The objective of the plan was to reduce inflation and inflationary expectations in Brazil through interest rate setting, and a managed exchange rate. In other words, monetary policy was clearly structured to controlling inflation through variable interest rates.

Under the "Real Plan" in the mid-1990s Brazil pegged its currency to the US dollar and successfully reduced the inflation rate to single digits. Inflation that had reached an annual level of nearly 5000% at the end of 1993 has since dropped to its lowest level in over 40 years at less than 5% in 2000.

However, this policy created a substantial exchange rate appreciation making Brazilian goods more expensive relative to goods from other countries, resulting in a large current account deficit.

In 1998, Brazil received US$41.5 billion from the International Monetary Fund (IMF) and in early 1999, the Brazilian Central Bank announced that the exchange rate would no longer be pegged to the US dollar forcing a 40% devaluation. The devaluation helped moderate the downturn in economic growth in 1999, as Brazil's debt to GDP ratio reached 48%.

Another objective of the Brazilian government is privatization, which began in 1990 under the National Privatization Program (Programa Nacional de Desestatizacao-PND). The main objective of the program is to privatize state-owned companies, and allow private operation of public services such as energy, telecommunications, transportation, and sanitation. Brazil has implemented the world's largest privatization of public services and has successfully privatized 65 state agencies, and 56 public services by early 2000.

In 2000, Brazil with total exports of US$55.0 billion and imports of US$55.7 billion had a trade deficit of US$7 billion. In the same year, Canadian exports to Brazil were CDN$1.07 billion and Canadian imports from Brazil were CDN$1.50 billion. Brazil's major exports are manufactured products, coffee, footwear, and iron ore. Major imports include raw materials, capital goods, oil, electricity, and consumer goods.

Overall, market liberalization and economic stabilization have significantly enhanced economic activities. In 2000, Brazil's GNP reached US$595.5 billion and its unemployment rate 7.1%.

The "Plano Real" and "privatization" programs have raised the income of poor Brazilians, but Brazil continues to have one of the world's most inequitable distributions of income as the 10% of richest Brazilians control 54% of the nation's wealth. Table 1 shows a comparison of Canadian and Brazilian major economic and demographic variables.

**Crude Oil and Refining Industry**

Crude oil was first discovered and produced in Brazil in 1939. Prior to that, the Brazilian crude oil supply was totally imported, by 1959 the demand was 6,041 m³ per day. After the 1959 discovery, The National Oil Council (CNP) (est. 1938) declared that all oil deposits and the refining capacity were the property of the state.

In 1953, Petroleo Brasileiro (Petrobras) was founded and began its activities with a production capacity of 429 m³ per day inherited from the CNP.

Petrobras was founded exclusively with Brazilian capital and initially has enjoyed a monopoly in the exploration, drilling, production, importation, and refining of petroleum products.

The most important crude oil producing area is the Campos Basin, in the Rio de Janerio areas. It includes giant fields of Alba-cor, Barracuda, Marlin, Roncador, and Guarupua in deep water. Oil was first discovered in this Basin in 1974 and by 1981 supplied more than 50% of the country’s total offshore production of crude oil. Petrobras has achieved success in world records in deep-water exploration reaching 1,850 metres in the Campos Basin.

In 1997 the Brazil energy market was opened to both domestic and foreign competitors to ensure energy demands of Brazil's fast growing economy were met with the introduction of the new petroleum law (Amendment No. 9 of 11/1996).

The first partnership agreements between Petrobras and the private sector were signed in 1998 for onshore and offshore exploration. Since the agreement Petrobras has sold some of its refineries, offshore platforms, ships, and pipelines. The state company also has reduced its investment portfolio, relying more on its partners for financial resources. It plans to sell hundreds of marginal fields (mainly onshore) which require revitalization. Also in 1998, price control was removed and oil prices fixed by Petrobras became linked to world oil prices.

Following enactment of the petroleum law, the National Oil Agency (ANP) was created for the purpose of regulating and supervising the activities in the oil industry. In the same year, the National Council for Energy Policy was formed for formulating the public energy policy.

Exploration and production rights are granted by the ANP through public bidding rounds. The first ANP bidding round occurred in June 1999, with foreign companies allowed to compete against Petrobras. Thirty-eight companies qualified and competed for 27 exploration and production concessions (23 offshore and four onshore). Lack of definition of the regulations and taxes until a few days before the auction impeded full participation and complete success of the event. As a result, only 12 blocks received offers.
The June 7, 2000, second ANP bidding round, was more successful due to the high price of crude oil and a clearer definition of the regulations. Forty-four companies including three Canadian companies, PanCanadian, Canadian Hunter, and Crestar Energy, qualified to participate in the auction of 23 blocks (13 offshore and 10 onshore).

In August 2000, the government sold a 28.5% stake in Petrobras (over half the shares were sold to foreign investors), but Petrobras remained the majority shareholder.

Brazil has more than 4,000,000 km² of onshore and more than 1,000,000 km² of offshore sedimentary areas, comprising around 29 basins. Approximately 77% of Brazil's oil and NGL production is offshore, and the remaining 33% onshore. The Campos Basin off Rio de Janeiro accounts for 93% of Brazil's offshore oil and NGL production. After Venezuela, Brazil contains the second largest oil reserves in South America at 1.3 billion m³. In 2000, Brazil produced approximately 200,000 m³ per day of crude oil (85%) and natural gas liquids (15%). In 2000, consumption of crude oil reached approximately 290,000 m³ per day. Brazil's oil imports come mostly from Venezuela and Argentina. Brazil has 14 refineries with a distillation capacity of approximately 286,000 m³ per day. Major refineries and their capacities (cubic metres per day) are: Paulinia in Sao Paulo (55,994), Mataripe in Bahia (48,649), Duque de Caxias in Rio de Janeiro (35,930), Sao Jose dos Campos in Sao Paulo (34,023), Canoas in Rio Grande do Sul (30,048), Araucaria in Parana (30,930), Cubatao in Sao Paulo (27,027), and Betim in Minas Gerais (24,007).

The Mining and Energy Ministry estimated that oil consumption in Brazil will grow 4 to 5% per year and in 2005 demand for crude oil will reach 366,000 m³ per day, surpassing the country's refining capacity. Petrobras and private companies were encouraged to further research for substitutes for refined petroleum products (RPP) to reduce demand and dependency on imported crude oil. One example is the National Alcohol Program and the incentive to use ethanol (derived from sugarcane) as automotive fuel. The production of ethanol has reached approximately 16 billion litres annually.

**Natural Gas and Gas Pipelines**

Natural gas was used modestly in Brazil beginning around 1938, when oil and gas were discovered in Bahia and gas used as fuel in the industrial plants of the Recôncavo region. Some years later, almost all production from the Recôncavo, Sergipe and Alagoas basins were used as fuel and feedstock for the Landulfo Alves refinery and Camaçari petrochemical plants. Brazil has the fourth-largest gas reserves in South America, after Venezuela, Argentina, and Peru. At the end of 2000, natural gas reserves were estimated at 0.23 trillion m³. Over 80% of the natural gas is associated with oil deposits with the Campos and Santos basins holding the largest Brazilian gas fields.

Brazil's natural gas production and consumption rose steadily throughout the 1990s, with imports beginning in 1999. Natural gas production in 2000 was 7.7 billion m³. Offshore gas accounted for 65% of the total production.

The Brazilian government has plans to increase its 2.7% share of natural gas consumption by importing natural gas and encouraging its use in the industrial and commercial sectors. The Ministry of Mines and Energy, to reduce electricity shortages, plans to create 56 thermoelectric plants by 2003, with a capacity of 20,000 megawatts (MW). The fuel requirements of the plants will also increase the demand for natural gas.

The upward trend in Brazilian natural gas demand, and encouraging new international partnerships, particularly with South American countries, will stimulate development of the future natural gas supply. Currently, gas imports from Bolivia and Argentina help meet Brazil's gas needs.

The construction of pipelines for importing gas to Brazil's fast-growing economic sectors is an important achievement. Brazil has two existing international pipeline connections, with several more under construction. The first pipeline connected Brazil to gas sources in Bolivia. Partners in the Brazilian sector of the pipeline include Petrobras, Enron, Shell, and BBPP. Construction began in 1996 at an estimated cost of US$2.1 billion and added a capacity of 30 million m³ per day.

The Bolivia-Brazil Gas Pipeline was completed in March 2000, and serves 29 Brazilian cities along its 3500-km route from the Santa Cruz region of Bolivia to Sao Paulo and on to Porto Alegre in southern Brazil.

The second operational pipeline links Paraná (Argentina) to Uruguaiana in Brazil. Partners are Petrobras (Brazil), Transcend (Canada), YPF and TGN (Argentina), and Total (France). The Argentina-Brazil gas pipeline with daily capacity of 2.5 million m³ was completed in July 2000 and serves the 600 MW Brazilian thermoelectric plant (joint venture with Argentina) in Uruguayan. An extension of the pipeline, which will connect Uruguaiana to Porto Alegre, is currently under construction.

Petrobras also is planning two projects in northwestern and southeastern Brazil for which it is actively seeking partners.

It is anticipated that natural gas from the Campos and Amazon basins, and imports from Argentina and even Peru will increase gas delivery to Brazil to more than 50 million cubic metres daily by 2005. Figure 4 shows Brazil's main gas pipeline network.

The transportation and distribution of natural gas within individual states (a state government responsibility), also has been opened to the private sector. Privatization of many state distribution companies, such as CEG (Rio de Janeiro) and COMGAS (Sao Paulo) is already completed. Most gas distributors are curr...

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<th>Fossil Fuels</th>
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</tr>
<tr>
<td>Natural Gas - billion cubic metres</td>
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<tr>
<td>Coal - billion tonnes</td>
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<tr>
<td>Annual Production</td>
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<tr>
<td>Conventional Oil - thousand cubic metres daily</td>
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<tr>
<td>Natural Gas - billion cubic metres</td>
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<td>Annual Consumption</td>
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<td>Conventional Oil - thousand cubic metres daily</td>
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<tr>
<td>Coal - million tonnes oil equivalent</td>
<td>29.3</td>
<td>12.2</td>
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Source: BP Amoco statistical review of world energy 2000

rently expanding and improving gas distribution to industrial and residential sectors. In addition, since April 1999, all domestic or foreign companies can apply for a license to import gas and/or construct pipelines.

Coal

Brazil has the largest coal reserves in Latin America, estimated at approximately 12 billion tonnes of lignite and sub-bituminous coal. However, it imports a significant amount of coal due to the high ash and sulfur content and low caloric value of its domestic coal. In 2000, domestic production was 3.2 million tonnes oil equivalent while consumption was 12.2 million tonnes oil equivalent.

Coal is used predominantly for the domestic steel industry, with a small portion burned to generate electricity. The country’s steel industry is expected to remain the largest domestic coal consumer for the foreseeable future. Brazil plans to increase its use of steam coal (both domestic and imported) for electric power generation. In brief, Table 2, shows Brazil’s fossil fuels reserves, production and consumption compared to Canada.

Electricity

In 1999, Brazil used 354 billion KWh of electricity where 338 billion KWh was produced domestically and 40 billion KWh was imported from Paraguay. In the same year hydroelectric power provided approximately 91% of electricity generation. Brazil’s Itaipu hydroelectric power project is the largest in the world.

Brazil’s power generation capacity is 72,200 MW and it is one of the world’s leading producers of hydroelectric power, with capacity of 58,000 MW. The dominance of hydroelectric power is mainly due to enormous hydroelectric resources, and the poor quality of domestic coal reserves.

However, the dominance of hydropower has left the country’s electric power supply vulnerable to drought and water shortages. In the summer of 2001, after several years of below-average rainfall and 70% of the reservoirs depleted, Brazil implemented an electricity-rationing plan. Under the “Emergency Plan” all industrial and residential customers were forced to reduce their consumption by 20% from 1 June to 1 December of 2001.

Another primary cause of the electricity shortage is the lack of investment in new power plants due to fixed electricity prices to industrial and residential customers. In Brazil, the charges of utility companies to consumers were held below the rates of inflation. This policy of anti-inflation forced some utility companies into bankruptcy. In addition, most state-owned utility companies have accumulated significant debts and investors are reluctant to lend them more money.

At present, Brazil’s electrical power generation is in the process of changing and the IMF, which has loaned Brazil billions of US dollars, has insisted that the Brazilian state utility companies be privatized.

The Ministry of Mines and Energy due to electricity shortages, has created the Priority Program for thermoelectricity plants (Decree no. 3.371). The program is intended to create 56 thermoelectricity plants by 2003, with a capacity of 20,000 MW. Each plant will be owned by a consortium of investors from different countries. The thermoelectricity plants use natural gas for power generation. Privatization of the Brazilian power sector, the development of gas turbine technology, and import of natural gas from Bolivia and Argentina, have attracted the interest of a number of institutions for investment.

The new plants, which will be located close to the consumer markets and transmission grids, offer two major advantages in relation to the hydroelectricity plants. They achieve a return on investment in a shorter period, and generate both electricity and

FIGURE 4: Brazilian main gas pipelines.

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FIGURE 5: Electricity generation by resource type.
steam (cogeneration), which meet the needs of several industries at the same time.

Brazil has two operational nuclear plants, Angra-1 and Angra-2. The operation of the first plant commenced in 1969, and the second plant in 2000. The nuclear plants operate under the Ministry of Defense rather than the Ministry of Mines and Energy. Recently, a government company, Electronuclear, was created to assume responsibility for the plants.

Figure 5, shows a comparison of resources used in Canada and Brazil for electricity generation in 2000.

Acknowledgment

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