THE ENERGY SITUATION IN BRAZIL: AN OVERVIEW

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Introduction

1. By far the largest and most populous country in Latin America, Brazil represents half the continent’s surface area, population and Gross Domestic Product (GDP). Brazil’s GDP ranks ninth in the world, just ahead of Russia. As such, Brazil also aspires to a leadership role on the international scene, and is one of the BRIC1 countries. Leader of the G20 group in the World Trade Organization (WTO), it plays an increasingly important role as an observer in OECD committees, representing the views of a large developing country in a consensual fashion. Brazil’s current peacekeeping role in Haiti demonstrates its greater international involvement in security issues, a crucial step for a country aspiring to a permanent seat on the U.N. Security Council.

2. Brazil presently is the 10th greatest energy consuming country accounting for about 2.1% of the world's annual total energy consumption and the fourth largest non-IEA energy consumer after China, India, and Russia (2003 data). Brazil's proven oil reserves are estimated (as of January 2006) at about 13 billion barrels, second greatest in South America (after Venezuela).

3. On the international energy scene, Brazil has achieved a visible presence thanks to its unique energy profile. Having achieved self-sufficiency in crude oil in 2006, it is also a hub for regional energy integration, especially for the development of the gas market; it stands as the world leader in ethanol use and production, and the predominant role of hydropower in electricity generation results in very low emissions from its power sector. These specific energy features underpin the country’s ambition to take on a more proactive role in regional organizations like the Latin American Energy Organization (OLADE) as vectors to disseminate Brazil’s biofuels experience to other Latin American countries. At the World Economic Forum in Sao Paulo on April 5-6 of this year, a plenary session concluded that “Brazil is a world reference for the development of the biofuels market because of its well-developed domestic ethanol fuel market and recent biodiesel initiatives”. From the same perspective, Brazil’s renewed eagerness to collaborate with international energy organizations such as the IEA can be viewed as an opportunity to project itself as a world champion in specific energy technologies, notably in ethanol production and bagasse cogeneration.

Overview of Brazil’s energy sector

4. In 2005, Brazil’s total primary energy supply amounted to 217.6 million tonnes of oil equivalent (Mtoe). The breakdown of primary energy supply is as follows: 38.4% from petroleum, 15% from hydroelectric sources, 13.7% from woodfuels, 13.1% from sugarcane by-products (bagasse), 9.1% from gas, 6.4% from coal, 2.9% from other renewable sources, and 1.4% from nuclear. Brazil is the largest producer of hydroelectricity in the world after Canada. In 2005, it generated 340 terawatt-hours (TWh), equivalent to 77.1% of total electricity generation2. The rest includes: imports (8.3%), gas-fired generation (4.1%), biomass (3.9%), oil derivatives (2.8%), nuclear (2.2%), and coal (1.6%).

Achieving net self sufficiency in oil

5. President Luis Ignacio Lula da Silva chose April 21st of this year, the anniversary day of Tiradentes, the country’s independence hero, to proclaim the country’s self sufficiency in oil. A near-doubling in Brazilian crude supply since the late-1990s has largely been achieved by

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1 Term used to refer to the combination of Brazil, Russia, India and China.
2 This number would reach 85.4% if the electricity co-generated with Paraguay in the Itaipu Power Station is counted. Half of it is for Brazil and a high percentage of Paraguay’s share is exported to Brazil).
the national oil company Petrobras, who invested in a $17 million advertisement campaign to celebrate reaching the self-sufficiency target set in 1953 when the company was created. According to Petrobras, the symbolic start of commercial operations at the 180,000 b/d P-50 platform at the Albacore Este field in the deepwater Campos Basin on April 21st will enable the company, which accounts for over 90% of Brazil’s oil output, to produce 1.9 Mb/d of crude oil this year. Crude supply will continue to grow in 2006 as five offshore developments in the Campos, Sergipe and Espirito Santo Basins are brought into production.

6. The national oil and gas company, Petrobras, the largest company in Brazil in terms of profits and revenues, and the 14th largest international oil company, has won international recognition as an expert in deepwater offshore drilling technology. Even though the federal government controls only 32.5% of the total equity, it has retained 55.7% of the voting shares of the company. Therefore, Petrobras is not state owned but state controlled. The government ended Petrobras’ monopoly in 1997 creating the ANP to take on the role of regulator of the oil and gas sector. Petrobras still dominates the hydrocarbons value chain, but the 1997 Oil Law opens each stage of the chain to other private sector companies. The percentage of Petrobras participation in national oil and gas production will rise in the short term but will lose its preponderance in the future, as private oil companies make new discoveries and start producing. To date, the only commercial field not controlled by Petrobras is operated by Shell. Chevron is scheduled to start their first project in the coming year. Petrobras is also developing an international strategy to diversify its portfolio. In 2004, it started buying shares in exploration concessions in Angola, Equatorial Guinea, Nigeria, and Libya; established an ethanol import subsidiary in Japan and has made a number of discoveries in the Gulf of Mexico where it started deepwater natural gas production.

7. According to Petrobras CEO Jose Sergio Gabrielli, self-sufficiency will help to protect Brazil from international energy crises and contribute to managing excessive volatility in the world commodity market. However, although it will produce the same volume of oil as it consumes, Brazil will still depend on light oil imports because the country’s refining profile is unable to process all of the domestically produced heavy oil. Therefore, reaching the milestone of net self-sufficiency in crude oil will push the government to redefine its policies for the oil sector going forward in order to stretch self-sufficiency as long as possible by attracting investment in E&P and by developing a strategy for expanding refining capacity.

8. Until 1995, Petrobras enjoyed a monopoly regime and had exclusive rights to explore and produce oil and gas. That year, the Ninth Amendment to the Brazilian Constitution was issued, allowing other companies to perform E&P activities. In 1997, the Oil Law was published, (creating the National Council for Energy Policy (CNPE), the National Petroleum Agency (ANP) and the Concession Model), establishing the legal and regulatory framework for the oil industry in Brazil. Since then, over fifty companies including Petrobras have acquired rights to explore and produce oil and gas in Brazil. In 2002, with the free import and export of crude and by-products, Brazil completed a new step towards a fully-opened market.

9. For Brazil, the first key to extending self-sufficiency is to ensure high investment in exploration, as today Brazil is producing the oil that was discovered in the 1980s and 1990s. Petrobras expects domestic production to continue growing at an average 6% per year until 2010, with planned investments in E&P of $28 billion until 2010, while other international companies are expected to invest an additional $7.4 billion. The national regulator for oil and gas, ANP, which began auctioning exploration blocks in 1999, held its seventh bidding round for oil concessions in October 2005. This can be considered the most successful bidding round so far, with a high level of participation (44 companies qualified). Among the winners were 11 companies new to the Brazilian market, which testifies to an attractive business
environment reflective of the country’s political maturity and economic stability, together with the relative stability of E&P rules since the market opening in 1999. The agency also stimulated domestic companies’ participation in the E&P bidding, looking to build a sustainable local oil and gas sector. There are still vast areas unexplored, which carry high potential for new discoveries. So far, less than 7% of all the gas and oil prone areas have been bid for concession. The main focus of the oil and gas companies is the offshore basins of Espírito Santo, Campos and Santos, where large discoveries have already been made. Some important companies like Shell, Chevron, Devon, and Petrobras, are developing recent discoveries in these areas.

10. Up to now, Brazil is still a net importer of both crude and oil products. In 2005, net imports fell to $3.60 billion from $4.75 billion in 2004. In addition, natural gas imports amounted to $785 million in 2005. This is because most of the 2mbpd refining capacity of Petrobras’ refineries cannot use heavy crude as raw material. Petrobras plans to invest $8 billion through 2010 to expand and modernize its refining park and to add value to its products. 40% of this investment will aim to improve the quality of diesel and gasoline, 25% to improve conversion, and the rest for extension and maintenance of the installations. Petrobras’ petrochemicals group Ultra and national development bank BNDES plan to develop a heavy crude refinery and petrochemicals complex in Rio de Janeiro state, a project that will add value to locally produced crude. Petrobras also recently bought a refinery plant in Pasadena, Texas. The company follows closely the set schedule for reducing sulphur specifications city by city in Brazil. Therefore, Petrobras is implementing an explicit strategy aiming to add value to locally produced oil products.

11. In order to further facilitate investment in E&O, there are several areas where the government could improve the business environment: by outlining long-term exploration goals; by unveiling details of future licensing rounds; by financing further research and mapping of the country’s sedimentary basins; by accelerating environmental licensing procedures; and by strengthening the ANP, which has been underfunded for years. High local content percentages imposed by the government also remain a controversial point. Although these requirements are unquestionably important for the development of the local industry, there are still some doubts in the market regarding the real capacity of local companies to deliver the high local content proposed, especially as the market becomes increasingly tight.

12. Controlling demand is also critical to extending Brazil’s self-sufficiency, since according to the most optimistic projections new finds would only increase proven reserves to a ceiling of 30 billion barrels of oil equivalent of recoverable reserves. The supply and demand margin is still narrow, and the prospects for future production and especially increasing reserves remain uncertain. On the demand side the current self-sufficiency situation benefited from the recent recession, as the country has yet to face a period of strong demand growth. Currently, oil consumption is estimated at 1.8 mb/d and is expected to grow at 2-2.6% per year. As Brazil continues to develop its industrial sector, oil consumption will likely increase dramatically, potentially reaching consumption levels comparable to those in Europe. This ongoing pressure from the demand side will make it difficult for Brazil to maintain its self-sufficiency past 2012-14 unless major new discoveries are made soon. Brazil’s current oil consumption per capita is 4 barrels per year, whereas in Spain, this value is 12 barrels and in the United States, 25 barrels.

Gas: Upheaval in Bolivia, short-term challenges and long-term responses

demand continued to grow rapidly, and was set to reach 100Mm3/d in 2010, growing at an average annual demand of 14%. To face this rapidly growing demand, Brazil was hoping to double the capacity of the Gasbol pipeline from the current 30Mm3/d, and at a minimum was planning to expand the capacity of the pipeline by 15 Mm3/day over the next 4 years. In the past two years, natural gas prices in Brazil did not follow the escalation of international oil prices, increasing the competitiveness of natural gas vis-à-vis its energy substitutes. This was the result of an explicit government policy aiming to diversify energy sources in all sectors, including for thermal generation. Government energy planning relied on gas fired generation as an alternative to stabilize seasonal changes in power supply due to rainfall variations and manage prudently the level of reservoirs. As a result, combined demand from the industrial, power generation, and automotive sectors grew by 12% between 2004 and 2005.

14. The current total gas supply (excluding Petrobras’ own consumption and losses) amounts to 56.2 Mm3/d. Bolivian imports currently account for 42% of total gas supply in Brazil. If we exclude Petrobras’ consumption for its refineries (11.7 Mm3/d), Bolivia represents 58% of commercial gas supply in Brazil. The main end-user of gas is the industrial sector, which consumes 60% of commercial supply, and in particular the chemical and petrochemical sector, the iron and steel sector, the cement sector, as well as other energy-intensive industries such as glass, ceramics, food, paper and pulp. Thermal generation is the second largest consumer with 22.5% and the transport sector, where the use of Vehicular Natural Gas dramatically increased in the last few years, consumes about 14% of commercial gas.

15. Bolivia’s reserves of natural gas are the largest in South America after Venezuela’s. Large deposits were discovered in the 1990s after the oil industry was re-privatised. Foreign companies, including Petrobras, Total, BP, BG and Repsol invested an estimated $4 billion to develop those reserves.

16. The first pipeline to connect Brazil to foreign natural gas sources was the Bolivia-Brazil gas pipeline (Gasbol), tapping Bolivia's Rio Grande sources. This 3,150 Km long pipeline came on-stream in June 1999, with service to São Paulo and a terminus in Porto Alegre. It is the single largest private-sector investment in South America with a total cost of $2.1 billion. The pipeline has a maximum 29.7 Mm3/day capacity. In the first few years of the Gas Supply Agreement between Brazil and Bolivia, Brazil only took a fraction of the natural gas to which it had agreed. Government delegations from Bolivia and Brazil met repeatedly in 2003 to renegotiate the terms of the contract. Brazil wanted to import less and pay less for the natural gas from Bolivia, suggesting a more flexible agreement, but Bolivia indicated after a meeting held in May 2003 that it would not change the contract unless Brazil would guarantee that exports would increase in the future. In response, the Brazilian government launched in June 2003 its new Natural Gas Expansion Project. The objective of the plan was to expand the country's natural gas pipeline network, bringing natural gas to industrial and thermal power plants, particularly in the southeastern and northeastern regions of the country where no pipelines existed. Brazil was highly successful at developing its domestic demand in the following years.

17. On May 1 2006, Bolivian troops seized gas fields and installations after the Bolivian Government promulgated the so called “hydrocarbon nationalization” under Supreme Decree No. 28,701. This Decree establishes the following:

- Transfer of ownership and possession of 100% of oil and gas production in Bolivia to Yacimientos Petrolíferos Fiscales de Bolivia (YPFB), the state oil company.
YPFB takes full control over the value chain of the oil and gas business in Bolivia: volumes, prices and condition of sales of natural gas, crude and condensates in both the domestic and external markets.

Oil companies will have a 180-day transition term to subscribe the new agreements which will be individually authorized and approved by the Bolivian Legislative Power. The Ministry of Hydrocarbons and Mines will determine, on a case by case basis, the interest corresponding to oil companies by means of investment audits, operation costs and profitability indicators.

Fields that produce more than 100 million cubic feet a day will pay 82% of the value of production in taxes and royalties. Only two fields are affected: San Alberto and San Antonio both operated by Petrobras. The 82-18 split in intended to be a mirror image of the tax regime established by the original privatization contracts.

Expropriation and transfer to YPFB, without compensation to the current holders, of the 48-49% stakes in Andina, Chaco and Transredes (operated by Shell and Prisma Energy) held today in trust by private pension fund managers for all Bolivians 21 years or older by December, 1995.

Nationalization of controlling stakes in Andina, Chaco, Transredes, the two refineries and the product transport and storage company.

During the transition period, for fields with a 2005 daily average certified production of natural gas lower than 100 million cubic feet, the current distribution of the hydrocarbon production value will be maintained. The Government’s take will be negotiated field by field, no lower than 50%

Ongoing talks revolve around about the price of gas imports, which Bolivia wants to increase by 2$ per million British Thermal Units (Mbtu) from $3.60 currently. For every $1 dollar rise, this would increase Bolivia’s income by an estimated $300 million, which is considerable in relation to Bolivia’s nominal GDP of $9,650 million. At stake also is the price YPFB will offer for gas produced at Petrobras production fields still under Petrobras control. However, the essence of the debate will be over compensation for Petrobras investments in Bolivia, as well as the reimbursement to be offered by YPFB for taking over a 50% plus one share control of Petrobras two refineries and their associated downstream operations. Petrobras Bolivian subsidiary Petrobras Bolivia has a book value of $1.3 billion but the net worth of assets is estimated to be far less. The difference is made up of liabilities and debts, including to banks, suppliers, the International Finance Corporation and taxes. The company’s gas reserves in Bolivia account for approximately 2.7% of its total reserves.

There is a striking contrast between Bolivian and Petrobras share in each other’s activities. Petrobras’ activities in Bolivia contribute 18% of the country's GDP. Petrobras owns 95% of the refining capacity in Bolivia; 57% of the country’s natural gas daily production, 40% of oil and condensate production; 25% of all fuel retail outlets and 100% of jet fuel supply to the country. Whereas Bolivia owns 3.7% of Petrobras proven oil and gas reserves, and 2.4% of total oil and gas production by Petrobras. In the short run, however, Bolivia and Brazil are inexorably interdependent. On the one hand, Brazil is Bolivia’s best customer and imports about 72% of Bolivia’s total gas production. On the other hand, Brazil imports 42% of its total gas consumption from Bolivia. Furthermore, in the short term Bolivia has few other options because of the long standing border dispute with Chile leaves it with no access to the Pacific Ocean. Brazil will also need some time to implement alternative sources of supply such as LNG and to develop its domestic production of natural gas.

Therefore, the challenge in the short run is for Petrobras to supply at a reasonable price sufficient quantities to ensure continuous economic growth, especially given the industrial sector’s heavy reliance on gas. According to the Gas Supply Agreement, prices are set in US
dollars and indexed to a basket of international fuel oil prices, but cannot be renegotiated until 2009. As a result of a sharp increase in international oil prices the price of Bolivian gas in reais had steadily risen since 1999\(^3\). Petrobras will insist on not paying higher prices for gas since mirror agreements with gas distribution companies in Brazil do not allow the company to pass on the increase to distribution companies. But eventually the price of natural gas in Brazil will go up (it was maintained artificially low for political reasons from 2002 until the end of 2004). Then in turn Petrobras may be able to sell its own domestic production for more and offset higher prices of Bolivian gas.

21. In the short run, gas imports from Bolivia will not increase since all investment plans for further expansion have been cancelled by Petrobras. Those end-users that can use one of two fuels, will “switch back” to either fuel oil or diesel. It can be expected that the environmental agencies, under the threat of a potential energy supply disruption would show a certain degree of flexibility and allow some industries to switch to a dirtier fuel. In this category, Petrobras’ refineries, which consume 7 Mm3/d, could switch to fuel oil in a few months, the supply of which is abundant. Some thermal generation plants could do the same, as well as some industries. The transport sector could also be encouraged to switch to other fuels. Most taxis in large cities in Brazil would be negatively affected, but one could imagine a subsidy to compensate them for switching to ethanol. Some industries could also be negatively affected through the price increase of energy. For example, in the glass and ceramics industry, energy costs already represent between 12% and 15% of the total costs.

22. In the longer run, Brazil will have more options to diversify its gas supply, either from domestic sources or through liquefied natural gas (LNG) imports. Although not included in its 2006-2010 business plan published last year, Petrobras just announced the rapid development of its natural gas import program through LNG re-gasification ships that will be anchored in strategic ports. The company plans to anchor one of the re-gasification ships off Rio de Janeiro city with capacity to produce 14 Mm3/d of natural gas and a second unit would be located off the coast of the northeastern state of Ceará, where there is large demand from thermal plants, with capacity to produce 6 Mm3/d. Gas could be imported from Algeria, Angola, Trinidad and Tobago, Qatar or Nigeria.

23. Petrobras also announced it will invest $16 billion through 2010 to accelerate the development of Brazil’s domestic natural gas resources, especially from the Santos Basin, crucially positioned to supply the large and rapidly growing market of the Southeast. In this perspective, the seventh licensing round achieved one of ANP’s key declared objectives as about 90% of the natural gas-oriented blocks in new onshore exploratory areas were awarded. As part of a series of measures to make Brazil self-sufficient in natural gas in the coming years to reduce the country’s dependence on imported Bolivian gas, the government recently requested that ANP increase by 30% the number of gas-prone exploration blocks to be offered at the next bidding round. The government also determined that the eighth round be brought forward to the end of August 2006 from November 27-29 when it was previously scheduled. The eighth round will include known onshore regions in the Espírito Santo, Santos and Campos basins as well as other well-explored basins and will also include the unexplored offshore basins of Curumuxatiba and Pernambuco-Paraiba in the country's northeastern region.

24. Petrobras also recently announced an “Anticipated Production Plan” aiming to increase natural gas production by 24.2 Mm3/d by 2009, which is equivalent to the current level of gas imports from Bolivia. The objective is to increase production at the Espírito Santo basin more

\(^3\) OECD/IEA (2003) *South American Gas: Daring to Tap the Bounty*
than tenfold by 2009 to 16.7Mm³/d from the current 1.4Mm³/d as well as from the Campos basin, where Petrobras will increase production by 6Mm³/d from the current 22.8Mm³/d and by 1.5Mm³/d from productive fields in the Santos basin. Current production in the Santos basin is around 1Mm³/d. The new gas reserves in the Santos basin, mainly the 419 Bm³ Mexilhão giant field, are currently under development but cannot be included in the Anticipated Production Plan because of lack of equipment on the international oil market. The production of non-associated gas at Mexilhão field is only expected to start in 2009.

25. Upon seizing the oil fields on May 1, Morales claimed that the mines, forest resources and land were next on his agenda. The danger of resource nationalism lies in the fact that by making outsiders warier about investing in those countries it raises the cost of capital not just for the oil industry but for the country as a whole. Resource nationalism also opens the door to inefficiencies as national oil companies tend to become huge bureaucracies, they also risk becoming politicized and are less subject to the principles of economic and technical efficiency. This is the third time that Bolivia has nationalised its oil industry. In many cases state-run oil companies are prone to suffer from underinvestment as national governments tend to extract as much revenue as possible to implement their social programs.

**Power Generation: The Narrowing Margin between Power Supply and Demand**

26. Hydropower, accounts for nearly 80% of generation capacity in Brazil. The country enjoys the largest capacity for water storage in the world, and one of largest transmission networks, given the vast geographical area to cover and the resulting long distances between power stations and consumers and the need for back-up circuits to ensure alternative supply routes and optimal regional balance in supply. Both private and government-owned companies operate in generation, transmission, and distribution. Eletrobrás, which is controlled by the federal government, and three other state-owned companies account for one-half of generation capacity, while more than two-thirds of the distributors are privately owned. The transmission grid is run by a group of producers, transmission and distribution companies, and the government through the Ministry of Mines and Energy.

27. In recent years, there has been insufficient investment in the electricity sector and the role of gas-fired powering the aftermath of the Bolivian gas crisis is uncertain for the time being. Electricity demand is expected to grow at the brisk pace of 5% per year until 2012, despite the reductions following the rationing programme implemented in response to the power crisis in 2001. Accordingly, Brazil’s power margin between capacity and average demand began to decline in 2004, and the trend is expected to accelerate in the coming years. The country’s power margin fell from estimated 12% in 2005 to 6% in 2006. Using the government’s assumed 4.8% power demand growth rate, this drop would be even more dramatic, reaching 2% by 2007. Brazil is suffering from a lack of investment in infrastructure as a result of recent regulatory changes and inadequate price signals.

28. A new model for the electricity sector was approved by Congress in March 2004, which creates a “Pool”. This Pool aims to match electricity demand and supply capacity through long-term contracts, which will replace on a competitive basis the “initial contracts” inherited from the 1990s before privatization of the distribution segment took place. Under the new Brazilian power model, demand is estimated by the distribution companies, which have to contract 100% of their projected electricity demand over the following 3 to 5 years⁴. These projections are submitted to the Energy Planning Agency (EPE), who estimates the required

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expansion in supply capacity to be sold to the distribution companies through the Pool. The price at which electricity will be traded through the Pool is an average of all long-term contracted prices and will be the same for all distribution companies. The price ceiling for new hydro projects in the first power auction based on the new model, which took place on December 16, 2005 – almost two years after the new model was approved by Congress – was set at R$116 per megawatt-hour (MWh)-US$50.4 per MWh at the then exchange rate. New hydro generation plants were awarded contracts with an average price varying from US$46.3 per MWh to US$49.9 per MWh depending on the year, while thermal generation was granted average prices about 15% higher.

29. Set to be the first real test of the new Brazilian power model, the new power auction will have limited impact on the declining trend of the margin between power supply and demand. Limited by delays in environmental licensing of hydroelectric power projects, the Brazilian government was able to present only one new hydro generation project for a total of 805 MW. This represents 1% of the current installed capacity in the National Integrated System and will not be able to shift the energy balance levels by more than 1%. With no significant increase in gas supply in the short term, only gas-fired thermal generation plants with gas supply contracts were awarded long-term contracts. The auction therefore focused on awarding long-term contracts to preexisting installed capacity, strengthening the existing generation players but doing little to address a looming shortage by the end of the decade. Under the Proinfa program, designed to stimulate generation from alternative energy sources, a total of 3,300 MW was contracted but in mid-2005, there were indications (e.g. equipment orders) that only 80% of the projects had actually started, which will incur further delays in new capacity. The next auction in 2006 will allow contracts starting in 2009 and 2011.

30. Brazil will need an estimated $6 billion/year in investment to deliver the projected annual load growth of 5%, equivalent to 3,200 MW/year. Therefore, improving Brazil’s power supply reliability over the next four years now must rely on non-hydroelectric initiatives and emergency measures. New power auctions in 2006 should offer new hydro generation concessions, but those plants are not likely to be online before 2010. The two giant hydroelectric projects of Belomonte and Rio Madeira are progressing very slowly because of their considerable environmental and social impacts. The Environmental Agency is understaffed and risk averse regarding these projects. The first of three environmental licenses (preliminary, installation, and operation) is known to be the most difficult to obtain as it triggers economic and financial feasibilities studies. An increase in thermal generation using natural gas will now depend on supply growth from either the Santos Basin or LNG and would require contracting no later than early 2007. This will pose quite a challenge, leaving Brazil with few options other than to use diesel-fired emergency plants and to switch from natural gas to diesel in the industrial and power sectors wherever possible. In the short term, in light of the Bolivia gas crisis, and with reservoirs 87% full, there may be the temptation to delay some decisions until the next administration comes into office in January 2007. The risk of a drought itself is highly unpredictable, and in a worse case scenario of enduring underinvestment could potentially provoke another dreaded power supply crisis.

31. Small gains of incremental capacity could be obtained through energy efficiency standards and policies, as well as through bagasse cogeneration (estimated potential between 4,000 and 6000 MW) as ethanol production expands. This will require a favourable business environment and appropriate financial instruments to finance the purchase of high pressure boilers from the owners of new mills.

The recent success of ethanol
32. Brazil is the world’s second largest producer - and the most efficient - of fuel ethanol from sugarcane. Between 1975 and 2004, the ethanol program substituted about 230 billion liters of gasoline. Brazil’s national ethanol programme (ProAlcool) began in response to the oil crisis of the 1970s. By the mid-1980s more than three quarters of the 800,000 cars could run on ethanol thanks to a combination of high subsidies and policy decisions. However, when sugar prices rose sharply in 1989, sugarcane growers diverted crops to the export market, and a severe shortage of ethanol occurred in the second quarter of 1989. This shortage resulted in a loss of consumer confidence in the security of ethanol supply and discredited ProAlcool. In response, the government authorized ethanol imports, and Brazil became the world’s largest importer of ethanol. Brazilian drivers as well as Brazilian car makers were left in disarray for lack of fuel. By the end of the 1990s, the sales of ethanol-fueled cars amounted to less than 1% of total annual auto sales because fuel manufacturers could not assure hydrous-ethanol consumers security of supply.

33. The turning point took place in 2003 when car manufacturers, beginning with Volkswagen introduced the “flex fuel” car, which gave consumers the choice and resilience to buy any combination of the cheapest fuel while protecting them from any fuel shortages. Today ethanol accounts for 40% of Brazil’s driving fuel, and 70% of the cars sold in Brazil (an estimated 1.1 million in 2006) have flex fuel engines, and cost no more than conventional cars. The country’s ‘flex fuel’ car fleet is the only one in the world that can use 100% of either ethanol or gasoline. Brazil’s ethanol production was 15.9 billion liters in 2005, more than a third of the global production, of which 2.6 billion litres were exported. Brazil has a 50% market share of global ethanol exports. India is Brazil’s biggest ethanol export customer, just ahead of the U.S. More recently, Brazil has authorized that biodiesel be added to diesel fuel as part of the Brazilian strategy for the Green Fuel Matrix Program. The biodiesel program is set to guarantee a 2% obligatory mixture starting in 2008, which will rise to 5% in 2013.

34. In Brazil, ethanol is used in two forms. In “anhydrous ethanol”, water has been almost totally removed to a level that makes it suitable for blending with gasoline. On the other hand, “hydrous ethanol” is about 95% pure, the balance being water. Hydrous ethanol is not suitable for blending with gasoline and is used directly as a fuel. Flex-fuel vehicles, widely marketed in Brazil beginning in 2003, are capable of running on any combination of hydrous ethanol and a gasoline-anhydrous ethanol blend. Pure gasoline is no longer sold in Brazil, and until April 2006 the gasoline-anhydrous ethanol blend contained 25 percent anhydrous ethanol. In other countries, a blend of gasoline and 5 to 10% ethanol is most common. Before the introduction of flex-fuel cars, ethanol vehicles could only use hydrous ethanol, that is, without addition of gasoline. Nowadays, flex-fuel vehicles in Brazil can run on any mixture of a gasoline-ethanol blend and hydrous ethanol.

35. Although Brazil's biofuel policy was not initially created to reduce climate change, the World Resources Institute estimates that the country not only saved US$100 billion on its oil imports, but also reduced its carbon dioxide emissions by about 574 million tonnes since 1975 - equivalent to ten per cent of the country's emissions during that period.

36. Brazil is currently exporting ethanol to the US, India, Venezuela, Nigeria, China, South Korea and Europe. It is negotiating with Japan to export ethanol to it after Japan authorized the substitution of up to 3% of gasoline with ethanol to help meet its Kyoto Treaty commitments. Japan is a very attractive export market for Brazilian ethanol as it must import all of its consumption, while US ethanol producers are in a better position to increase their production thanks to subsidies and import tariffs. A MOU with Mitsui to carry out feasibility studies for the joint production and export of ethanol complements MOU for transport logistics. South

5 ESMAP/The World Bank (October 2005) The Potential for biofuels in developing countries
Africa and Brazil are in the process of signing a memorandum of understanding where Brazil will provide technical assistance for an ethanol programme.

37. Several Central American Caribbean countries benefit from special duty free access to the US market. By encouraging ethanol production and refining through joint programs with these countries (such as the one linking Coimex and Petrojam in Jamaica) Brazilian sugar producers can in fact export to the US, while positively contributing to these economies through transfer of technology and know-how that yield efficiency gains. However, it is still uncertain whether the US will lift ethanol import tariffs, in which case those countries might lose their relative competitiveness.

38. In the last few months, the price of ethanol has increased to levels where it was becoming uncompetitive with the price of gasoline. Because of ethanol’s lower fuel economy, the price of hydrous ethanol cannot exceed 70% of the price of gasoline, at which point it becomes less attractive. Furthermore, the export sugar market has a strong impact on ethanol supply and can lead to ethanol shortages in times of high world sugar prices. As a result, the price of ethanol has little to do with the cost of production and is in fact the opportunity cost of producing ethanol versus sugar; it is also linked to the price of gasoline. To avoid shortages, the government ordered that the level of ethanol in petrol be cut to 20% from 25%, which immediately relieved the supply constraint. Another aspect to bear in mind is the seasonality of ethanol production, which further compounds the price effect.

39. Furthermore, in trying to meet its announced goal of increasing production by 40% by 2010, the logistics of distribution, rather than productive capacity, could limit the expansion of Brazil’s ethanol exports. The country needs to build ports with storage tanks and loading facilities, and to improve railway and pipeline links between the ports and sugar-producing regions. A new ethanol port in Santos is scheduled to increase Brazil’s export capacity to 5.6 billion litres by the end of 2007.

40. Going forward, given the multiplicity of actors involved (Ministry of Agriculture, Environment, Energy, ANP for taxation issues, private companies, BNDES, etc.) Brazil would greatly benefit from a clear regulatory framework in order to increase production while mitigating the potential environmental and social impacts of expanding ethanol production and to introduce a sound pricing mechanism. A crucial question to explore is how replicable Brazil’s experience is in other countries, both in terms of sugarcane production costs and the other attributes that make Brazil an efficient producer of both sugar and ethanol.