Brazil has experienced rapidly expanding oil, natural gas, and electricity consumption in recent years. Brazil is the ninth largest energy consumer in the world and the third largest in the Western Hemisphere, behind the United States and Canada. Total primary energy consumption in Brazil has increased by close to a third in the last decade, due to sustained economic growth. In addition, Brazil has made great strides in increasing its total energy production, particularly oil and ethanol. Increasing domestic oil production has been a long-term goal of the Brazilian government, and recent discoveries of large offshore, pre-salt oil deposits could transform Brazil into one of the largest oil producers in the world.

Total Brazilian energy consumption grew to 13.6 quadrillion British thermal units (BTU) in 2010. The largest share of Brazil’s total energy consumption comes from oil and other liquids (39 percent, including ethanol), followed by hydroelectricity (29 percent) and other renewables (21 percent). The other renewables category consists mostly of biomass, which is used intensively in both the residential and industrial sectors in Brazil.
Brazil was the largest producer of liquid fuels in South America in 2011.

Oil and Other Liquids

Overview

According to the Oil and Gas Journal (OGJ), Brazil has 14.0 billion barrels of proven oil reserves in 2012, the second-largest in South America after Venezuela. The offshore Campos and Santos Basins, located off the country’s southeast coast, hold the vast majority of Brazil’s proven reserves. In 2010, Brazil produced 2.7 million barrels per day (bbl/d) of liquids, of which 75 percent was crude oil. Average liquids production in Brazil contracted slightly in 2011, with modest gains in crude oil production offset by a decrease in ethanol production stemming from a poor sugar cane harvest.

Based on its January 2012 Short-Term Energy Outlook, EIA forecasts Brazilian oil production to reach 2.8 million bbl/d in 2012 and 3.0 million bbl/d in 2013. Brazil’s liquids consumption averaged
2.6 million bbl/d in 2010.

**Exploration and Production**

Most Brazilian oil is currently produced in the southeastern region of the country in Rio de Janeiro and Espírito Santo states. More than 90 percent of Brazil’s oil production is offshore in very deep water and consists of mostly heavy grades. Six fields in the Campos Basin (Marlim, Marlim Sul, Marlim Leste, Roncador, Jubarte, and Barracuda) account for more than half of Brazil’s crude oil production. These Petrobras-operated fields each produce between 100,000 and 350,000 bbl/d.

International oil companies also play a role in Brazilian production. The Shell-operated Parque de Conchas project and the Chevron-operated Frade projects produce 75,000 and 85,000 bbl/d, respectively. In November 2011, Chevron reported an oil spill of about 2,400 barrels at the Frade facility. Chevron took full responsibility for the accident and has paid more than $27 million in fines. The spill has caused numerous Brazilian legislators to question Chevron’s presence in their country.

Recent offshore exploration efforts in Brazil have yielded massive discoveries of pre-salt oil fields.

**Exports and Imports**

In 2009, Brazil’s liquids production surpassed its liquids consumption. Brazil continued to be a net liquids exporter in 2010 and preliminary EIA estimates show that the country remained a net exporter in 2011. Brazil’s economy grew rapidly in 2011, driving up fuel demand. At the same time, reduced ethanol production and rising ethanol prices caused Brazil to import refined products from the United States.

![Brazil's Liquid Fuels Production and Consumption (2003-2013)](image)

EIA projects that Brazilian liquids consumption will roughly equal Brazilian production in 2012 and that the country will return to being a net liquids exporter in 2013, largely driven by expanded crude oil production.

**Sector Organization**

State-controlled Petrobras is the dominant participant in Brazil’s oil sector, holding important positions in up-, mid-, and downstream activities. The company held a monopoly on oil-related activities in the country until 1997, when the government opened the sector to competition. Royal Dutch Shell was the first foreign crude oil producer in the country, and it is now joined by Chevron, Repsol, BP, Anadarko, El Paso, Galp Energia, Repsol, Statoil, BG Group, Sinopec, ONGC, and TNK-BO. Competition in the sector is not just from foreign companies: Brazilian oil company OGX, which is staffed largely with former Petrobras employees, started to produce oil in the Campos Basin in 2011.
The principal government agency charged with monitoring the oil sector is the National Petroleum Agency (ANP), which is responsible for issuing exploration and production licenses and ensuring compliance with relevant regulations. Recent legislation concerning pre-salt exploration and production has changed the operating environment somewhat. A full discussion of this can be found in the pre-salt section.

**Downstream**

According to OGJ, Brazil has 1.9 million bbl/d of crude oil refining capacity spread amongst 13 refineries. Petrobras operates 11 facilities, the largest being the 360,000-bbl/d Paulinia refinery in Sao Paulo. The refining capacity in Brazil is relatively simple, meaning that the country must export some of its heavy crude oil production and import light crude oil. With domestic demand growing, Brazil’s refineries are currently operating at full capacity.

Petrobras plans to increase its Brazilian refining capacity to more than 3.1 million bbl/d by 2020 to meet burgeoning domestic demand. Under the company’s 2011-2015 business plan, Petrobras will build five additional refineries to meet this goal. Notable among these facilities is the Abreu e Lima refinery, a 230,000-bbl/d joint-venture with Petroleos de Venezuela (PdVSA) due to come online in 2013 pending PdVSA’s ability to meet their component of the financing arrangement. The facility will be designed to process heavy Venezuelan and Brazilian crude oil.

Fuel prices are regulated in Brazil. Despite rising world oil prices, Petrobras left retail gasoline prices unchanged for most of the 2008-2010 period. This stressed the company’s finances in 2011, with rising refined product imports and ethanol prices. To offset Petrobras’ losses without raising consumer prices, the Brazilian government lowered their tax on gasoline and allowed the company to increase their wholesale price.

**Ethanol**

Brazil is the second largest producer of ethanol in the world after the United States. In 2010, Brazil produced 486,000 bbl/d of ethanol, up from 450,000 bbl/d in 2009. A combination of high world sugar prices, a poor sugar cane harvest, and underinvestment caused a precipitous decline in ethanol production in 2011. While official numbers for the year have not been released, estimates place 2011 production around 390,000 bbl/d – close to a 20 percent drop year on year. This shortage forced Brazil to import corn ethanol from the United States.

The Brazilian government has taken measures to prevent future ethanol supply shortages and increase public involvement in the sector. The government lowered the blend requirement in gasoline from 25 percent to 20 percent. Additionally, it brought regulation of the ethanol sector under the jurisdiction of the ANP and announced plans to expand Petrobras’ presence in the ethanol market. In the medium term, Brazil aspires to export ethanol to the United States, which...
recently removed tariffs on Brazilian sugar cane ethanol.

Pre-Salt Oil

A consortium of Petrobras, BG Group, and Petrogal discovered the Tupi field in 2007, which contains substantial reserves in a pre-salt zone 18,000 feet below the ocean surface under a thick layer of salt. Following Tupi, numerous additional pre-salt finds were announced in the Santos Basin, such as Iracema, Carioca, lara, Libra, Franco and Guara. Additional pre-salt discoveries were also announced in the Campos and Espirito Santo Basins. Estimates for the total pre-salt resources vary. Some analysts place total extent of pre-salt recoverable oil and natural gas reserves at more than 50 billion barrels of oil equivalent (boe).

In December, 2010 Petrobras submitted a declaration of commerciality to the ANP for the Tupi and Iracema fields, which renamed the fields Lula and Cernambi, respectively. The total recoverable reserve estimate for these fields is 8.3 billion boe (6.5 billion boe for Tupi and 1.8 billion for Iracema). In January, 2011 Petrobras declared the Guara field to be commercial, with a reserve estimate of 1.1 billion boe.

Petrobras plans to develop its major pre-salt assets in three discrete phases: extended well tests,
pilot projects, then large-scale production through multiple, duplicate floating production, storage, and offloading (FPSO) facilities. Pilot production projects in the Lula and Guara fields began production in 2010 and 2011, respectively. According to Petrobras, Brazil currently produces more than 100,000 bbl/d of oil from its pre-salt fields.

In its 2011-2015 business plan, Petrobras laid out plans to invest $224.7 billion, $53 billion of which will be in pre-salt exploration and production activities. This constitutes a major increase from the $33 billion targeted at pre-salt activities in the previous year’s plan. The company is shifting its focus away from downstream and international expansion to focus on the domestic upstream sector. Although Petrobras will finance most of this work through operating cash flow, the company’s 2010 initial public offering ($67 billion) and 2011 and 2012 corporate debt offerings ($6 billion and $7 billion, respectively) all set records.

Brazil’s pre-salt announcements immediately transformed the nature and focus of Brazil’s oil sector, and the potential impact of the discoveries upon world oil markets is vast. However, considerable challenges must still be overcome in order to bring these reserves to fruition. The difficulty of accessing reserves, considering both the large depths and pressures involved with pre-salt oil production, represent technical hurdles that must be overcome. Further, the scale of the proposed expansion in production will also stretch Petrobras’ exploration and production resources and Brazil’s infrastructure, as will strict local content regulations.

Regulatory Reforms
The Brazilian government passed legislation instituting a new regulatory framework for the pre-salt reserves in 2010 that includes four notable attributes. First, the legislation creates a new agency, Petrosal, to administer new pre-salt production. The second component allowed the government to capitalize Petrobras by granting the company 5 billion bbl of unlicensed pre-salt oil reserves in exchange for larger ownership share. The other two components establish a new development fund to manage government revenues from pre-salt oil and lay out a new production sharing agreement (PSA) system for pre-salt reserves. In contrast to the earlier concession-based framework, Petrobras will be the sole operator of each PSA and will hold a minimum 30 percent stake in all pre-salt projects.

For these reforms to be implemented, Brazilian legislators must first agree on a system for distributing royalties from the pre-salt oil. Currently, most oil production revenue accrues to the state and municipal governments of oil-producing states Rio de Janeiro, Sao Paulo, and Espirito Santo. Other Brazilian states are fighting for a greater share of the royalties from the pre-salt oil. Until this happens, Brazil’s eleventh licensing round (which will predate the next pre-salt auction and only feature non-pre-salt blocks) will not be able to move forward. Brazilian officials aspire to hold the eleventh bid round sometime in 2012.

Natural Gas
OGJ reported that Brazil had 14.7 trillion cubic feet (Tcf) of proven natural gas reserves in 2012. The Campos, Espírito Santo, and Santos Basins hold the majority of reserves, but sizable reserves also exist in the interior of the country. Despite Brazil’s substantial natural gas reserves, natural gas production has grown slowly in recent years, mainly due to a lack of domestic transportation capacity and low domestic prices. In 2010, Brazil produced 445 billion cubic feet (Bcf) of natural gas – the majority of this production was associated with oil. Natural gas consumption is a small part of the country’s overall energy mix, constituting only 7 percent of total energy consumption in 2010.
Sector Organization
Petrobras plays a dominant role in Brazil’s entire natural gas supply chain. In addition to controlling the vast majority of the country’s natural gas reserves, the company is responsible for most domestic Brazilian gas production and for gas imports from Bolivia (see below). Further, Petrobras controls the national transmission network and it holds a stake in 18 of Brazil’s 27 state-owned natural gas distribution companies. However, Brazil passed a new Natural Gas Law in 2009 that created a separate regulatory framework for natural gas. This law is expected to facilitate private investment in the sector.

Exploration and Production
The largest share of Brazil’s natural gas production occurs in offshore fields in the Campos Basin in Rio de Janeiro state. Most onshore production occurs in Amazonas and Bahia states and is mostly for local consumption due to the lack of transportation infrastructure.

In order to meet rising demand and decrease reliance on imports, Petrobras plans to bring several new natural gas projects online over the coming years. The largest is the Mexilhão project, which contains estimated total reserves of 8 Tcf. Production began in March 2011 at 154 Bcf per year, eventually rising to 193 Bcf per year in 2012.

As discussed in the oil section of this report, recent announcements about discoveries in Brazil’s offshore pre-salt have generated excitement about new gas production. Along with the potential to significantly increase oil production in the country, the pre-salt areas are estimated to contain sizable natural gas reserves as well. According to Petrobras, Tupi alone could contain 5-7 Tcf of recoverable natural gas, which if proven, could increase Brazil’s total natural gas reserves by 50 percent.

Pipelines
Petrobras operates Brazil’s domestic natural gas transport system. The network has over 4,000 miles of natural gas pipelines, mostly in the southeast and northeast parts of the country. For years these systems were not interconnected, which has hindered the development of domestic production and consumption. However, in March 2010 the Southeast Northeast Interconnection Gas Pipeline (GASENE) linked these two markets for the first time. This 870-mile pipeline, which runs from Rio de Janeiro to Bahia, is the longest ever built in Brazil. GASENE is intended to offset supply shortfalls in the northeast caused by declining local production with southeastern offshore supply.
The other major natural gas market in Brazil is the Amazon region. In 2009, Petrobras completed construction of the Urucu pipeline linking Urucu to Manaus, the capital of Amazonas state. This project is expected to facilitate development of the Amazon’s considerable natural gas reserves.

**Imports**
Brazil imported 445 Bcf of natural gas in 2010, a 50 percent increase from 2009, stemming from a large rebound in gas demand. The country currently receives imports by pipeline from Bolivia and liquefied natural gas (LNG) imports primarily from Trinidad and Tobago, Qatar, and Nigeria. Import growth in the future is expected to be met more with LNG than with pipeline imports.

**Imports from Bolivia**
Bolivia accounts for 78 percent of Brazilian gas imports. Brazil imports natural gas from Bolivia via the Gasbol pipeline, which links Santa Cruz, Bolivia to Porto Alegre, Brazil, via Sao Paulo. The 2,000-mile Gasbol has a maximum capacity of 1.1 Bcf per day (Bcf/d). Despite efforts to reduce dependence, Brazilian imports of Bolivian gas increased by 21 percent in 2010 according to the ANP.

**Liquefied Natural Gas**
Brazil has two liquefied natural gas (LNG) regasification terminals, both installed in the last two years: the Pecem terminal in the northeast, and the Guanabara Bay terminal in the southeast. Both facilities are floating regasification and storage units (FRSU), with a combined sendout capacity of 740 million cubic feet per day (MMcf/d). The Pecem received its first LNG cargo from Trinidad and Tobago in July 2008, while the Guanabara Bay terminal came online in May 2009. Petrobras plans to bring a third terminal online in Bahia state in 2013, which will have a capacity of 495 MMcf/d.

**Electricity**
Brazil had 106 gigawatts of installed generating capacity in 2009, with the single largest share being hydroelectric capacity. In 2010, the country generated 470 billion kilowatthours (Bkwh) of electric power. Hydropower accounted for 85 percent of this generation, with smaller amounts coming from conventional thermal, nuclear, and other renewable sources.

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*Brazil has the third-largest electricity sector in the Western Hemisphere, behind the United States and Canada.*

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**Sector Organization**
The government plays a substantial role in the Brazilian electricity sector. Until the 1990s, the state controlled the electricity sector almost completely. Brazil initiated an electricity sector privatization process in 1996. However, when drier-than-average weather led to severe energy
In 2004, the Brazilian government implemented a new Power Sector Model. This hybrid approach to state involvement splits the sector into regulated and unregulated markets for different producers and consumers. This allows for both public and private investment in new generation and distribution projects. Under the plan, however, Electrobras was formally excluded from privatization efforts.

**Hydroelectricity**

Brazil generated 401 Bkwh of hydroelectric power in 2010. Many of Brazil's hydropower generating facilities are located far away from the main demand centers, resulting in high transmission and distribution losses. Brazil's largest hydroelectric generation asset is the Itaipu facility on the Parana River, which Brazil maintains with Paraguay. According to Itaipu Binacional, the facility generated 92.2 Bkwh of electricity in 2011. Although Brazilian planners aspire to diversify away from hydropower to mitigate supply shortage risks brought about by dry weather, new hydro projects continue to move forward. Most notable among these projects is the Belo Monte plant in the Amazon basin which, upon completion, will be the third largest hydroelectric plant in the world behind China's Three Gorges Dam and Itaipu.

**Thermal Generation**

Thermal generating sources provided only a small part of Brazil's electricity supply, contributing about 12 percent in 2009. The largest sources of thermal generation in Brazil are natural gas and biomass. Natural-gas-fired power generation more than doubled in 2010 and now accounts for a third of total generation, according to Brazil's Ministry of Energy and Mines. EIA projects that natural gas use in the electricity sector will increase as Brazil expands and diversifies its natural gas supplies.

The other major contributor to Brazil's thermal power generation in 2010 was biomass (32 percent). This figure includes “autoproducer” electricity, which is generated at ethanol plants by burning sugar cane byproducts. This source could increase in significance if transmission and distribution hurdles are overcome.

**Nuclear Power**

Brazil has two nuclear power plants, the 630-megawatt (MW) Angra-1 and the 1,350-MW Angra-2. State-owned Eletronuclear, a subsidiary of Eletrobras, operates both plants. Construction of a third plant, the 1,350-MW Angra-3, started in 1986, but was never finished. In 2008, construction began again, with completion slated for 2015. According to industry sources, Eletronuclear plans to build at least four new nuclear power plants (in addition to Angra-3) by 2030, in order to meet expected growth in Brazilian electricity demand.
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