

# Energy Briefing

Rory Johnston 1.416.862.3908  
[rory.johnston@scotiabank.com](mailto:rory.johnston@scotiabank.com)



**BRAZIL**

## Petroleum

- Brazil is one of the most promising sources of future petroleum supply, but regulatory, governance, and price hurdles will hamper near-term production growth.
- Petroleum demand growth will likely remain robust despite the country's economic contraction; this will continue to exacerbate the gap between demand and domestic refining capacity.

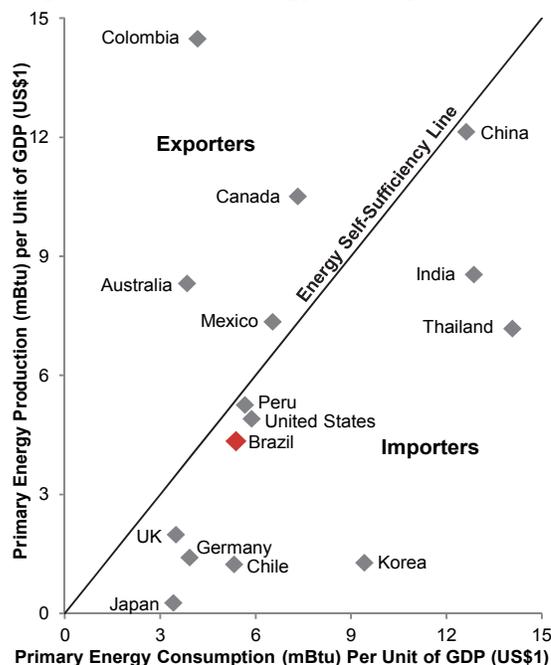
## Natural Gas

- Brazil's natural gas production outlook remains tied to oil given the importance of associated gas output. Similar regulatory, governance, and price hurdles will need to be overcome in order to realize any material supply growth.
- Demand has been driven largely by Brazil's ongoing drought and the resultant adverse impact on the country's dominant hydroelectric supplies; future demand will be negatively correlated with rainfall.

## Hydroelectricity

- The ongoing drought has pushed hydroelectric reservoirs to critically low levels, negatively impacting hydroelectric generation as operators attempt to maintain emergency supply.
- The shortfall of inexpensive hydroelectric supply has forced expensive thermal capacity into service, pushing wholesale electricity prices above retail rates.

**Figure 1: Brazilian Energy Intensity in Context**



Note: 2012 figures, the last year of reliable data availability.  
 Source: IMF, EIA, Scotiabank Economics.

**Figure 2: Key Energy Indicators**

|                                  | 2011  | 2012  | 2013  | 2014  |
|----------------------------------|-------|-------|-------|-------|
| <b>Crude Oil (kbpd)</b>          |       |       |       |       |
| Production                       | 2,105 | 2,068 | 2,024 | 2,254 |
| Refinery Input                   | 1,864 | 1,932 | 2,055 | 2,106 |
| Imports                          | 333   | 313   | 403   | 396   |
| Exports                          | 605   | 549   | 381   | 517   |
| <b>Petroleum Products (kbpd)</b> |       |       |       |       |
| Refinery Output                  | 1,921 | 2,023 | 2,135 | 2,179 |
| Demand                           | 2,107 | 2,235 | 2,366 | 2,492 |
| Diesel                           | 901   | 963   | 1,009 | 1,035 |
| Gasoline                         | 611   | 684   | 714   | 765   |
| Imports                          | 522   | 470   | 527   | 539   |
| Exports                          | 233   | 257   | 242   | 240   |
| <b>Natural Gas (bcm)</b>         |       |       |       |       |
| Domestic Supply                  | 12    | 14    | 16    | 18    |
| Demand                           | 22    | 27    | 33    | 36    |
| Imports                          | 10    | 13    | 17    | 19    |
| LNG                              | 1     | 3     | 5     | 7     |
| Pipeline                         | 10    | 10    | 12    | 12    |
| Exports                          | -     | -     | -     | -     |
| <b>Electricity (TWh)</b>         |       |       |       |       |
| Generation                       | 512   | 533   | 541   | 548   |
| Hydro (%)                        | 89    | 83    | 77    | 71    |
| Conventional Thermal (%)         | 8     | 13    | 20    | 24    |
| Nuclear (%)                      | 3     | 3     | 2     | 3     |
| Non-Hydro Renewables (%)         | 1     | 1     | 1     | 2     |

Source: ANP, MME, CCEE, Scotiabank Economics.

## PETROLEUM

### Demand | Thirst for Diesel & Gasoline Outstrips Refining Capacity

Brazil consumed 2.5 million barrels of petroleum products per day (bpd) in 2014 (up 5.3% y/y), with transportation (gasoline and diesel) fuels contributing the lion's share of the growth. Fuel oil consumption rose by roughly 21 thousand bpd (up 24% y/y) as drought-induced hydroelectric weakness necessitated increased thermal generation (see hydroelectric analysis on page 4). Brazil's robust petroleum demand gains are unlikely to slow materially despite the country's ongoing economic downturn; petroleum demand grew by an average annual rate of 5.8% from 2012 to 2014 while the country's real GDP growth only averaged 1.6% annually over the same period.

Brazilians consume roughly one million bpd more today than they did a decade ago, putting increased strain on the country's aging refineries and forcing Petrobras (Brazil's state-owned oil company) to import fuels from abroad. The government controls the wholesale price of gasoline and diesel as a means of managing inflation, which puts Petrobras in a situation where it has to purchase these products at global prices and then sell them domestically at a loss (Figure 1). Government price-setting in the gasoline and diesel markets amounted to direct import losses of roughly US\$1.4 billion and US\$5.7 billion between 2011 and 2014, respectively; if all domestically sold transportation fuels are considered, total foregone sales revenue exceeds US\$40 billion over the same period.

### Supply | Plenty of Potential Runs Headlong Into Red Tape

Brazilian crude oil production stood at 2.25 million bpd in 2014 (up 11.3% y/y), reversing two consecutive years of production declines (Figure 2). Over 90% of Brazil's oil production is derived from offshore fields, the majority of which are categorized as deepwater (500-1,500m) and many of the highest potential fields considered "ultra-deepwater" (1,500m+), lying up to 300 km off the coast.

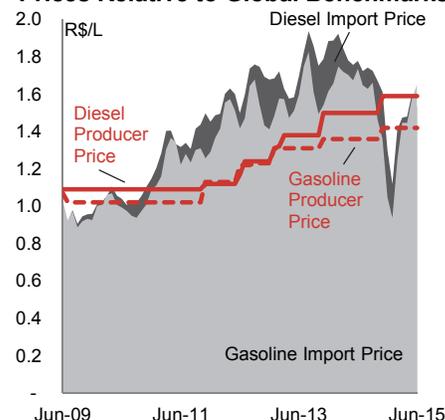
Production growth has been far slower than originally envisioned when the prolific "pre-salt" basins (so named because the oil is trapped beneath a thick layer of salt on the ocean floor) were discovered in 2007. The pre-salt area holds at least 50 billion barrels of oil, but production has been hampered by 2010 legislation which mandates that Petrobras serve as the sole operator of all "strategic areas" (which includes pre-salt) and hold at least a 30% stake. These requirements placed too much of the operational and financial burdens on Petrobras, which is already spread too thin. Amid the ongoing crude oil price collapse, heavily-indebted Petrobras cut its five-year investment plan by 37% in an attempt to de-lever the company and simultaneously reduced its 2020 production forecast by 1.4 mbpd to 2.8 mbpd. New legislation is currently working its way through the Brazilian congress that would remove Petrobras' sole operator and minimum stake requirements, but would likely maintain a "right of first refusal" for Petrobras. High local content laws require upward of 85% of the equipment and services brought to bear in the pre-salt basins to be sourced from Brazilian firms, putting significant upward pressure on operational costs; however, the recent depreciation of the Brazilian real has likely lessened the burden of these local content requirements.

Brazil's pre-salt oil is estimated to be of good quality — averaging 28-31 API gravity (medium-light) — and requires roughly US\$45 per barrel to produce profitably. The IEA forecasts that Brazil will be the largest marginal source of non-OPEC oil production to 2020 after the US, but these high expectations are tempered by onerous regulation, low oil prices, and most recently the Petrobras scandal, which has strained long-standing relationships between industry and the government.

### Trade | Brazil Looks Abroad For Lighter Crudes & High-Value Refined Products

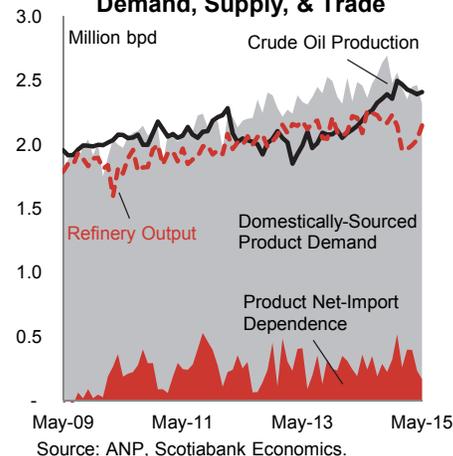
Brazil was a net exporter of 121 kbpd of crude oil in 2014, mostly destined for the US, China, India, and Chile. However, as the bulk of Brazil's crude production is considered "heavy" or "intermediate", it also imports lighter crudes (primarily from Nigeria) in order to balance its refinery slate. As discussed above, Brazil's domestic demand for refined products has outstripped its refining capacity and pushed the country to import a record 299 kbpd in refined products — primarily gasoline, diesel, and naphtha — in 2014.

**Figure 3: Brazilian Government-Set Prices Relative to Global Benchmarks**



Note: Import Price = US Gulf Coast Spot + MME Estimated Import Cost (R\$0.053/L).  
Source: MME, Bloomberg, Scotiabank Economics.

**Figure 4: Brazilian Petroleum Demand, Supply, & Trade**



Source: ANP, Scotiabank Economics.

## NATURAL GAS

### Demand | Weather More Than Economic Fundamentals

Natural gas consumption grew by 11.5% y/y to 36 billion cubic meters per annum (Bcma) in 2014 on the back of continued growth in power sector demand. Industrial demand — historically accounting for 55-65% of total draw — has experienced muted expansion while demand from natural gas power plants has exploded, increasing by over 350% since 2011 (Figure 5). However, these power plants have not responded to a surge in total electricity demand — which has only risen in line with GDP — but, rather, the negative impact of Brazil’s ongoing drought on the country’s traditionally dominant hydroelectric system, which has seen generation contract in each of the last 3 years (see hydroelectric analysis on page 4). Non-industrial natural gas demand has roughly tracked non-hydroelectric electricity generation (Figure 6), which foretells that marginal domestic demand for natural gas will be primarily driven by environmental factors and be negatively correlated with precipitation. This relationship makes anticipating natural gas demand difficult: forecasting future weather patterns is far more challenging than economic fundamentals.

Outside the industrial and power sectors, Brazil’s domestic natural gas market remains underdeveloped. Only 2.7 million households (roughly 4%) and 31 thousand commercial units (0.6%) have access to piped natural gas, accounting for less than 2% of total natural gas demand compared to 35% in the US.

### Supply | Natural Gas Prospects Likely to Mirror That Of Oil

Brazilian natural gas production rose by 13.2% y/y to 32 bcma in 2014 but marketed natural gas — gas that actually made it into the system — only rose by 7% to 20 bcma. Of the 32 bcma of gas produced in 2014, 6 bcma was reinjected into Brazilian hydrocarbon wells, 4 bcma was consumed by the Brazilian exploration & production sector, and 2 bcma was flared on site.

Associated gas accounted for two-thirds of Brazilian natural gas production in 2014 (Figure 7), indicating that the likely driver of future domestic gas production will be the domestic oil industry, which continues to suffer from a combination of low prices, excessive regulation, and investor wariness stemming from ongoing political scandals. While natural gas production has benefited from rising crude oil output, the natural gas intensity of oil activity has also increased; the volume of natural gas yielded from one barrel of Brazilian oil has increased 30% since 2007 to 28 cubic meters of gas per barrel in the first quarter of 2015.

### Trade | One Big Pipeline & Ever-More LNG

Brazil has traditionally relied on Bolivia for most of its natural gas imports since the completion of an 11 Bcma pipeline in 2000. However, as Brazilian demand ballooned on the back of increased thermal electricity generation, Bolivian supplies could not keep pace with demand, pushing Brazil onto the LNG market.

Brazil imported more than 7 Bcma of liquefied natural gas (LNG) in 2014 (roughly 40% of total imports) and the country’s three LNG import terminals (Pecém, Guanabara, and Bahia) have a combined capacity of roughly 15 bcma, with all three terminals owned and operated by Petrobras. LNG import volumes will likely increase in 2016 on the back of the Summer Olympic Games hosted in Rio de Janeiro; the games will put upward pressure on electricity demand and heighten government sensitivity related to “keeping the lights on”. However, a material shift in environmental factors could put tremendous downward pressure on imports given that the recent boom in LNG imports would have been almost entirely unnecessary absent recent drought conditions and rising non-hydroelectric generation requirements.

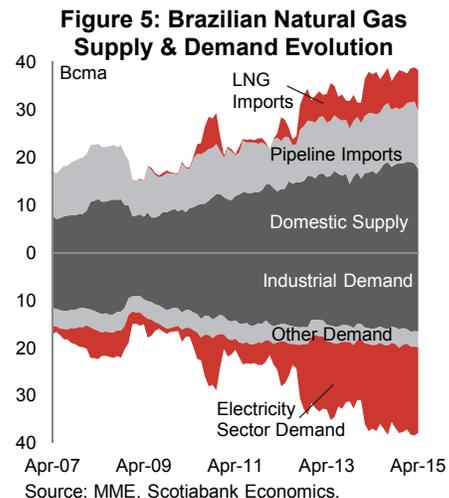


Figure 6: Drought Increased Need For Non-Hydro Electricity Generation, Driving Natural Gas Demand Growth

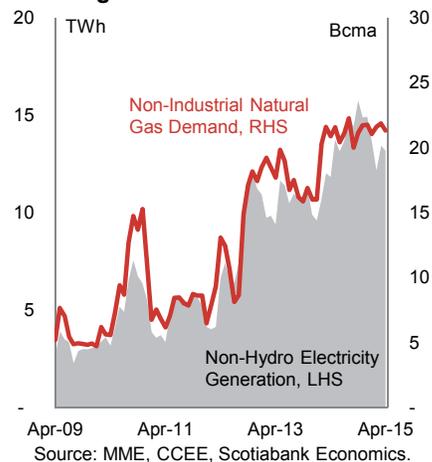
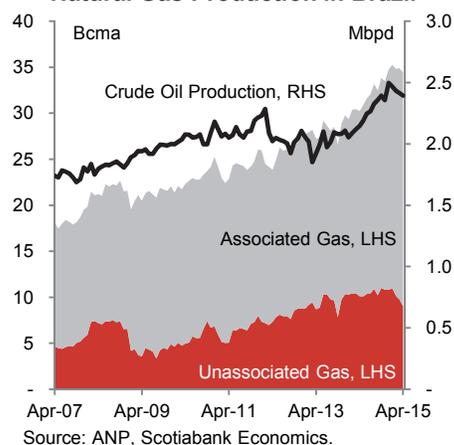


Figure 7: Associated & Unassociated Natural Gas Production in Brazil



## HYDROELECTRICITY

### Demand | Steady Growth In Line With Economic Fundamentals

The nature of hydroelectric resources makes it difficult to discuss demand in the same way as oil or natural gas. An economy demands electricity and in Brazil hydroelectricity is the cornerstone of the grid, providing low-cost baseload generation. The total volume of electricity generated in Brazil has grown more-or-less in line with the country's real GDP (Figure 8), but hydroelectric energy's share of what arrives at the homes and businesses of Brazilian consumers has been falling. High temperatures and drought have put upward pressure on aggregate electricity demand to power luxuries like air conditioning while at the same time depleting the water resources that underpin the majority of the grid. Electrobras, Brazil's state-owned electricity utility, reported a US\$390 million second-quarter loss due to increased purchases of alternative thermal feedstock to make up for lackluster hydroelectric supply. Wholesale electricity rates have spiked as demand has exceeded low-cost hydroelectric supply, while retail electricity rates have only gradually adjusted to newer production costs (Figure 9).

### Supply | Hydroelectric Contribution Impacted By Drought

Hydroelectric resources account for roughly two-thirds of Brazil's installed generation capacity, but traditionally make up a far larger share of actual generation due to high capacity utilization rates compared to other feedstocks. Brazil generated 548 TWh of electricity in 2014, with hydroelectric generation accounting for 71% of the total, down from a 89% share in 2011. Hydroelectric generation fell by 6% y/y in 2014 following a 7% contraction in 2013 on the back of ongoing droughts that have materially impacted reservoir levels (Figure 10).

Only one-third of Brazil's potential hydroelectric capacity (estimated at 245 GW) has been tapped, with roughly 89 GW installed at the end of 2014. However, 90 GW of the country's hydroelectric potential is located in the Amazon River basin where expansion is limited by the region's distance from major electricity demand centres as well as concerns regarding environmental sustainability and the displacement of indigenous populations. The latter concerns have shifted the likely character of future hydroelectric projects to run-of-the-river plants with little or no reservoirs, compared to the traditional large reservoir formats. Without sizable reservoirs, new hydroelectric capacity will lack the storage and flexibility that have made past capacity so valuable to the grid and is thus bearish for future proportional contributions to the aggregate supply. Easily dispatched backup generation (e.g. natural gas) will likely be needed to supplement the far more variable run-of-the-river hydroelectric supply.

The current hydroelectric supply crisis can be contrasted with a similar drought experienced in the summer of 2001, which also depleted reservoirs to critically low levels. However, in 2001 Brazil did not have the thermal backup capacity it enjoys today, so the mismatch between supply and demand fell on consumers: the Brazilian government implemented a rationing system that shaved domestic electricity consumption by 20%. While Brazil's current drought is putting tremendous strain on the system, the mismatch is being primarily met on the supply side through the enlistment of expensive thermal generation capacity.

### Trade | Joint Brazil-Paraguay Dam Primary External Source

Hydroelectric resources also make up the majority of the electricity that Brazil imports (roughly 5% of demand), which come primarily from the Paraguayan portion of the joint Brazil-Paraguay Itaipu Binational dam. Itaipu is the second-largest hydroelectric facility in the world, with annual generation near that of China's Three Gorges Dam, and is located on the border between Brazil and Paraguay. Brazilian electricity exports are negligible.

Figure 8: Electricity Generation Tracks GDP; Hydro's Contribution Falls

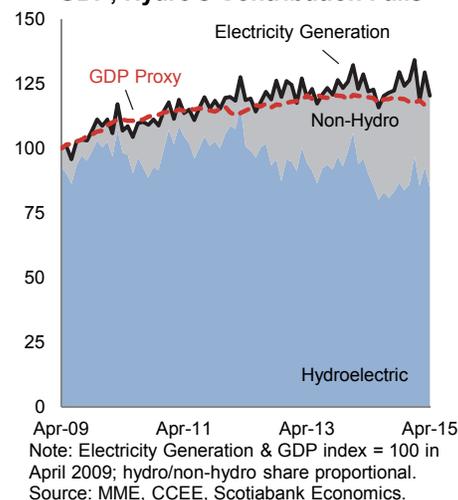


Figure 9: Hydro Weakness Pushes Wholesale Prices Above Retail Rates

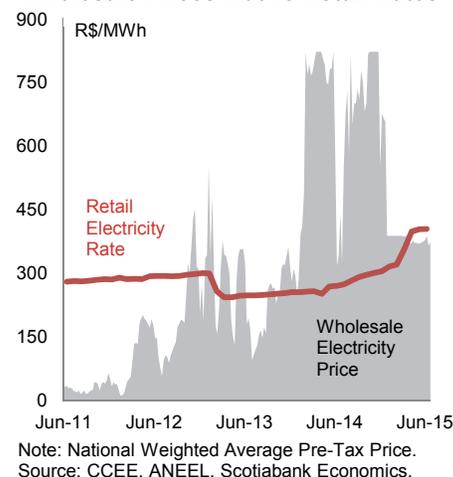
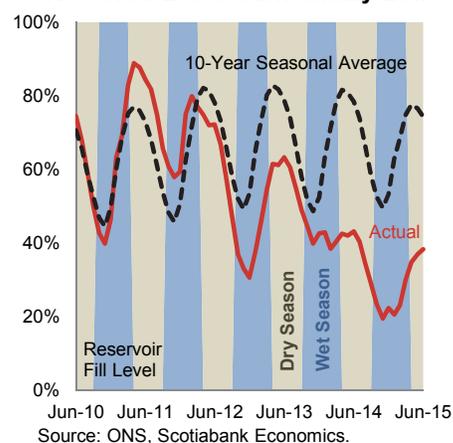


Figure 10: Brazilian Hydroelectric Reservoir Levels Abnormally Low



**INTERNATIONAL ECONOMICS GROUP****Pablo F.G. Bréard, Head**

1.416.862.3876

[pablo.breard@scotiabank.com](mailto:pablo.breard@scotiabank.com)**Erika Cain**

1.416.866.4205

[erika.cain@scotiabank.com](mailto:erika.cain@scotiabank.com)**Rory Johnston**

1.416.862.3908

[rory.johnston@scotiabank.com](mailto:rory.johnston@scotiabank.com)**Tuuli McCully**

1.416.863.2859

[tuuli.mccully@scotiabank.com](mailto:tuuli.mccully@scotiabank.com)**Estela Molina**

1.416.862.3199

[estela.molina@scotiabank.com](mailto:estela.molina@scotiabank.com)**Scotiabank Economics**

Scotia Plaza 40 King Street West, 63rd Floor

Toronto, Ontario Canada M5H 1H1

Tel: 416.866.6253 Fax: 416.866.2829

Email: [scotia.economics@scotiabank.com](mailto:scotia.economics@scotiabank.com)

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