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# The energy revolution in the USA and the pre-salt reserves in Brazil: Risks and opportunities for the Brazilian petrochemical industry



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## ABSTRACT

The petrochemical industry is known for its interrelations with the oil industry. In recent years the world has witnessed the rapid growth of the Chinese economy and an associated surge in demand for petroleum and oil products, alongside the emergence of alternative sources of oil and natural gas to those produced by OPEC (Organization of Petroleum Exporting Countries) and Russia, such as Brazil's pre-salt reserves and shale gas in the United States. The US is undergoing a veritable energy revolution with its use of unconventional oil and natural gas production techniques in low-permeability reservoirs, chiefly shale gas. Brazil's prospects as an international player are on the rise thanks to the exploration of oil and natural gas from its pre-salt reserves, which could lead to exports of petroleum of over 2 million barrels/day. All these movements have a direct influence on the petrochemical industry. This article aims to foster discussions about the risks and opportunities facing the Brazilian petrochemical industry with the exploration of oil and natural gas in Brazil and unconventional sources in the United States. Systemic thinking and scenario-based planning were used as the basis for the analysis.

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## 1. Introduction

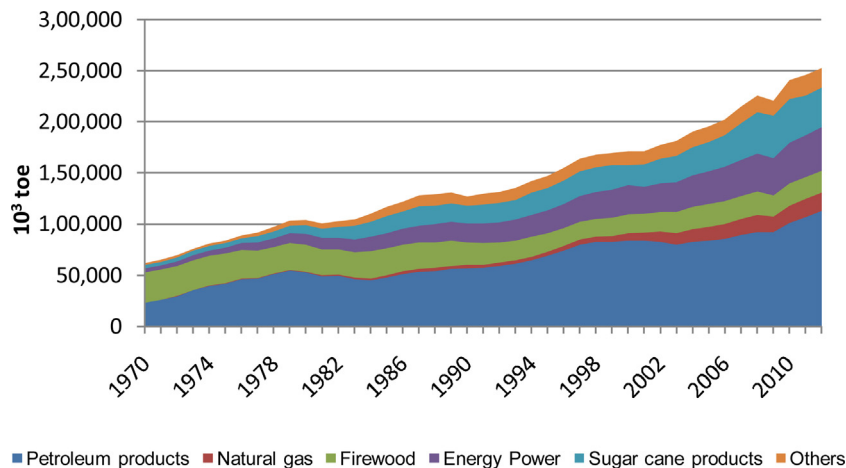
The Brazilian petrochemical industry burgeoned in the second half of the twentieth century with the incipient production of ethanol and ammonia at the Presidente Bernardes Refinery in Cubatão (Perrone, 2010), São Paulo state.

However, it was only in the 1960s that the industry really took off, with a project to build three petrochemical industrial complexes in Mauá (São Paulo), Camaçari (Bahia) and Triunfo (Rio Grande do Sul). These came into operation in 1972, 1978 and 1982, respectively, and processed naphtha for the priority production of ethylene.

In the 1990s, Brazil's installed ethylene production capacity rose to around three million tons a year, and Brazil started to make its mark on the global petrochemical industry, accounting for approximately 3% of world ethylene production (Wongtschowski, 2002). In 1999, Brazil's petrochemical industry composed five naphtha cracking units, each with a production capacity of between 500 and 700 kta ethylene at the three main industrial complexes.

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**Fig. 1.** Brazilian energy consumption, according to the national energy balance sheet produced by Empresa de Pesquisa Energética (EPE, 2012).

One interesting feature of the growth of this industry in Brazil is that it took place at a time when natural gas was in short supply in the Brazilian energy mix, as can be seen from the energy consumption data in Fig. 1, expressed in tons of oil equivalent (toe). The industry therefore developed a strong dependency on the refining industry, and by 2000 was absorbing 11.1% of the total output of oil products in the form of petrochemical naphtha, a proportion that dropped to 4.3% in 2013, resulting in increased naphtha imports, according to data from Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP, 2014).

In view of this limitation, Brazil's petrochemical industry developed at its three industrial complexes through the processing of naphtha, which was initially acquired from domestic refineries, but was supplemented by imports as of 1990 (Brasil, 2013). New feedstocks, including ethane and liquefied petroleum gases (LPG)<sup>1</sup>, were introduced in 2005 when a cracker entered service in Rio de Janeiro state, where most of the country's oil and gas has been produced since the late 1970s (ANP, 2013).

While relying on naphtha imports and suffering from a shortage of natural gas, Brazil's petrochemical industry also had to cope with its dependency on foreign technology and the distance of its two biggest industrial complexes (Camaçari and Triunfo) from the areas where most petrochemical products were consumed, namely Rio de Janeiro and São Paulo. In response, the government introduced tax subsidies and raised customs duties on imported petrochemicals in order to boost the international competitive capacity of the Brazilian petrochemical industry (Moreira et al., 2011). Even in 2014 the industry counts on a relative high degree of protection, with 20% and 14% tariffs being charged on imports of polyethylenes and polypropylene, respectively (Brasil, 2014).

In the 1990s, companies in the Brazilian petrochemical industry started to be the target of mergers and acquisitions in a bid to achieve greater market consolidation and improved international competitiveness (Azevedo & Rocha, 2005). This resulted in the emergence of Braskem as the only Brazilian company to operate in the manufacture of basic petrochemical products. Its main shareholders are Petrobras, its primary supplier of feedstock, and the Odebrecht Group, specialized in engineering and civil construction with extensive international experience (Braskem, 2010).

In 2012, the petrochemical industry's combined installed capacity for the production of ethylene and propylene, the main building blocks for resin synthesis based on polyolefins, was around 6.3 million tons in four states (São Paulo, Bahia, Rio Grande do Sul and Rio de Janeiro), consuming an estimated 9.7 million tons of naphtha, 0.4 million tons of propane, 0.4 million tons of ethane, 0.3 million tons of refinery gases, and 0.1 million tons of ethanol. Even so, Brazil has become less competitive in recent years, as can be seen by the rising volumes of imports of polymer resins shown in Fig. 2.

In recent years, the United States has witnessed a veritable energy revolution, sustained by the emergence of hydraulic fracturing (fracking) and horizontal drilling techniques, which have enabled the unconventional production of natural gas, mainly shale gas, from low-permeability reservoirs (Asche, Oglend, & Osmundsen, 2006). This has had an impact on global markets, especially the US petrochemical market, which has taken advantage of the supply of ethane to improve its competitiveness and margins (PricewaterhouseCoopers, 2013).

Parallel to this, Brazil has plans to double its oil and gas production thanks to its pre-salt reserves, bringing its oil production from 2.2 million barrels/day in 2012 to 5.4 million barrels/day in 2021 (EPE, 2013). The prospects for increased oil

<sup>1</sup> Liquefied petroleum gases (LPG) is a product that is compound mainly by propane and butane.

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