



Developing competition while building up the infrastructure of the Brazilian gas industry

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ABSTRACT

For the last 20 years, countless countries have been carrying out structural reforms in the natural gas industry, trying to achieve efficiency and economic rationality with the introduction of competition. The objective of the paper is to present an approach to the development of competition and infrastructure of the Brazilian natural gas industry. This approach is based on a market projection to 2011, on the international experience and on the characteristics of the Brazilian market, infrastructure and regulatory framework. Possible impacts of the proposed measures are also provided. According to the market projection carried out in this paper, in 2011 there will be a possible surplus of natural gas in the country, which includes a dependence diminishing of the Bolivian gas supply. This gas surplus, allied to an upcoming Gas Law and the trade liberalization in the states of São Paulo and Rio de Janeiro, can stimulate the development of competition, if some changes that proposed in this paper are made in the current Gas Bills. The approach proposed herein seeks to stimulate non-discriminatory open access, focused on information transparency and tariff regulation to help the development of infrastructure and competition.

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1. Introduction

The natural gas industry has similarities with other network industries. For this reason, it requires large up-front investments due to the high marginal costs and high technical and financial risks involved. Hence, the monopoly structure can be considered adequate in the beginning of its development. With the depreciation of the investment, those risks and marginal costs tend to decrease, and in turn, investments return increase. The lack of price transparency of the natural gas commodity and transportation, coupled with profit increase, tend to provoke pressures from society for stricter regulation and/or introduction of competition (IEA, 1998).

In Brazil, the much-expected competition in the gas exploration and production activities has not been effectively developed yet. Enacted in 1997, one of the purposes of the Law No. 9.478 was to promote competition in the natural gas industry in Brazil. However, after 10 years of its enactment, small advance was made in this direction, with Petrobras and its subsidiaries dominating the natural gas exploration, production, transportation and storage activities in the country (Martins, 2006). The fact is that there are currently no safeguards to investors that the natural gas produced will be delivered up to the end user, whether due to the lack of regulation in the transportation activities or to the

impossibility of selling gas directly to the end user, but only to gas distributors.

Natural gas can be technically substituted for oil-derived energy sources, such as fuel oil. The difference is that in Brazil the natural gas tariff to the end user is regulated, while the prices of its substitutes are shaped according to the laws of supply and demand (which are normally and directly linked to crude oil prices). This detachment between the relative prices of the natural gas and its substitutes leads to artificial gas prices to the end user. It may result in pressures on gas demand—when its relative price is lower than other fuels—, or on gas surplus—when its relative price is higher. No matter how the natural gas price in Brazil is indexed to a fuel oil basket, to the dollar or to other price indexes, the problem is that regulation does not match with the market dynamics. The tariff readjustments in the Brazilian states are normally annual and the periodical tariff reviews usually occurs in every 4 or 5 years. Currently, there is an upward pressure on natural gas demand in Brazil due to its lower relative price compared with oil derivatives; crude oil prices have been rising faster than the natural gas for the last few years. As an example, Fig. 1 depicts the evolution of the accumulated price increase for the crude oil and the average tariff increase of natural gas for the leading gas distributor in Brazil (at current prices).¹ When natural gas prices were set by the regulatory commission in 1999 for the

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¹ Natural gas prices were obtained from the Sao Paulo State Regulatory Commission (ARSESP) at www.arsesp.sp.gov.br.

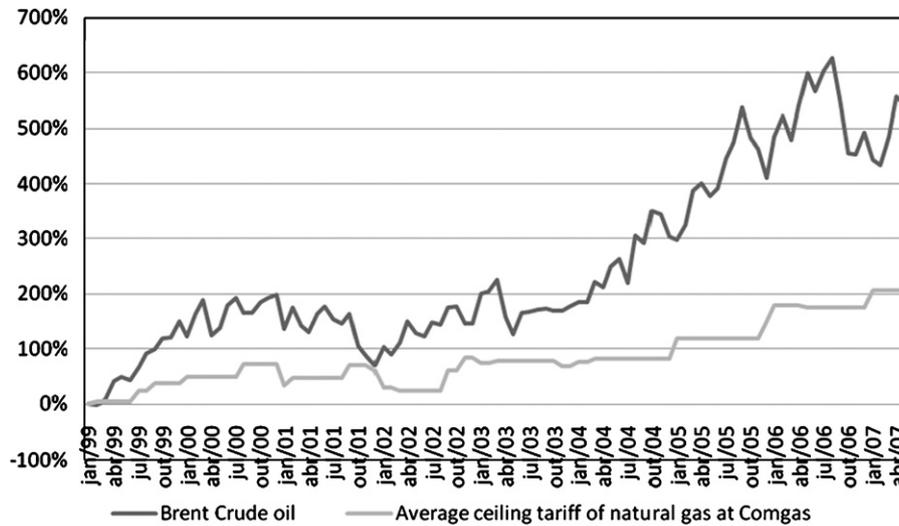


Fig. 1. Accumulated price increase from January 1999 to April 2007 for the Brent crude oil and the average natural gas tariff cap for Comgás (SP), at current values.

LDC's (which includes Comgas), it considered the netback price of fuel oil as a starting point. So, from this point, if natural gas prices increase less than those of crude oil, there will be more pressure on natural gas demand; if the price of fuel oil decreases, there will be a likely surplus.

The natural gas industry is relatively new in Brazil. It was restructured only at the end of the 1990s with the enactment of Law, 9.478/1997, which opened the oil industry's activities in Brazil to the private initiative and also created regulatory agencies at both state and federal levels. Before that, PETROBRAS legally held the monopoly on the activities of gas exploration, production, processing, storage and transportation. In addition, the activities of distribution and commercialization of natural gas were state monopolies. Currently, the natural gas industry in Brazil is organized as shown in Fig. 2. The National Oil & Gas Regulatory Agency (ANP) is responsible for the regulation, monitoring and supervision of the upstream activities of the natural gas industry. The state regulatory agencies are responsible for monitoring and supervising the downstream activities (distribution and trade to the end user). The states of Rio de Janeiro and São Paulo are responsible for approximately 60% of the total natural gas sold to end users in the country (35% in São Paulo and 25% in Rio de Janeiro) (Gasnet, 2007). São Paulo and Rio de Janeiro are also the only states whose infrastructure is more developed as well as the first states that foresee the trade liberalization to end users—São Paulo in 2011 and Rio de Janeiro in 2009.

From the MME—National Energy Balance (MME) (2007), the total natural gas consumption is the sum of the gas used for transformation and for final consumption. The natural gas for transformation is the sum of the natural gas used for generating electricity and for producing oil-derived fuels (refineries). The final consumption comprises its non-energy use (such as feedstock for the petrochemical industry), moreover as energy source (for the Energy, Residential, Commercial, Public, Agribusiness, Transport, and Industrial sectors and Non-Identified Consumption). Table 1 presents the Brazilian natural gas balance in 2006. The Brazil's proven natural gas reserves in 2006 totaled 347.9 billion cubic meters. The reserves-to-production ratio reached 19.6 years in 2006.²

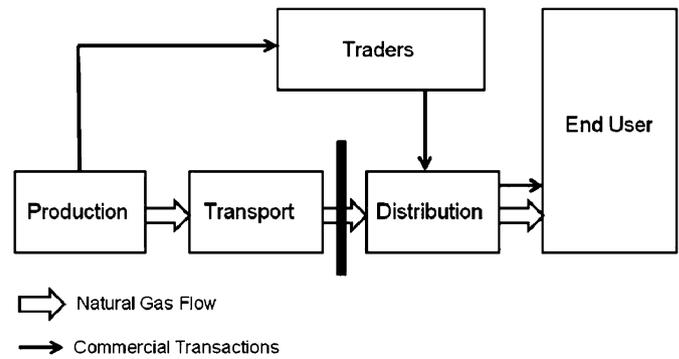


Fig. 2. Organization of the natural gas industry in Brazil.

Table 1
Natural gas supply and demand in Brazil in 2006

National production	17,706
Imports	9789
Adjustments and losses ^a	-5161
Total supply	22,334
Total consumption	22,334
Transformation	5957
Final consumption	16,377

Unit: Millions of cubic meters.

Source: Adapted from MME (2007).

^a Including non-exploited and re-injection.

The beginning of the development of natural gas supply was in the 1980s with the development of Campos bay fields to supply the Southwest region of Brazil. After the maturation of those gas fields, more gas was needed, initially to develop new electricity generation plants. The Bolivia–Brazil pipeline was built in this context, although most of the natural gas was used in industries (MME, 2007).

Today, the Brazilian natural gas supply is dependent on Bolivia since the end of the construction of the pipeline in 1999. Thirty million cubic meters are imported from this country since then. This was responsible for almost 50% of all natural gas consumption in 2006 in Brazil.

On May 6, 2005, the Hydrocarbons Law was approved by the Bolivian Congress. This law nationalized all hydrocarbons and

² In spite of being only a questionable indicator of resources, it allows evaluating some aspects of the offer on an instant manner.

Table 2
Natural supply forecast in Brazil

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Import										
Bolivian gas	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2
LNG	0.0	6.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Argentina	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
National										
Discovered	27.7	30.8	65.7	74.0	73.8	71.5	69.4	66.4	60.1	53.3
New discoveries	0.0	0.1	0.5	0.8	0.9	1.5	4.7	17.8	31.4	38.5
Total	62.9	72.1	121.4	130.0	129.9	128.2	129.3	139.4	146.7	147.0
Bolivian dependence (%)	51	45	27	25	25	25	25	23	22	22

Source: MME/EPE (2007).

natural resources, maintaining royalties at 18% and increasing taxes from 16% to 32%. The Hydrocarbons Law also gave the government control over the commercialization of the resources. The tension to renegotiate contacts with Petrobras and other oil companies was evident, so that foreign firms have practically stopped investing in the gas sector after this. Besides the political problems, in 2006, operational problems partially interrupted the supply of natural gas from Bolivia to Brazil, forcing the adoption of a contingency plan to ration natural gas during a few days. In September 2007, the spare natural gas-fired power plants had to start operating, resulting in a new gas rationing. This gas, which was firstly supposed to be reserved for thermal power plants, in fact was being sold by some distributors through firm contracts to end users. The lack of both demand flexibility mechanisms and natural gas availability by some distributors, moreover, the supply of natural gas at the limit were the major reasons for this rationing.

Petrobras initially cogitated to increase natural gas supply from Bolivia, but the crisis made the company to reevaluate this possibility. The oil and natural gas fields discovered in the last 5 years in Brazil led the company to direct all its effort to national production. Table 2 shows the result of a study carried out by the Research Planning Company of the Ministry of Mines and Energy. This table shows that the Brazilian dependence (measures by total supplied in percentage) on the Bolivian natural gas will decrease with time. Moreover, that national gas will play an important role in the near future.

For the last 20 years, countless countries have been carrying out structural reforms in the natural gas industry, seeking efficiency and economic rationality by introducing competition in some activities. The United States, Canada and the United Kingdom are a few successful examples of this strategy, which (if well conducted) tends to lower prices to the end user and propitiate improvements in the security of supply by creating new flexibility mechanisms capable to balance natural gas supply and demand (IEA, 2002; CGA, 2003).

According to IEA (1998), excess capacity and availability of natural gas are two essential conditions for effectively introducing competition. For this reason, before preparing an approach to promote competition and the development of the natural gas industry, this paper intends to carry out a projection of the Brazilian natural gas market for 2011. This year was chosen because it is when the trade liberalization of natural gas for large industries³ and gas-fired power plants will take place in the state of São Paulo, together with trade liberalization in Rio in 2009.

As previously mentioned, both states are responsible for 60% of the end-user sales in the country.

In this regard, this paper firstly intends, through simple logistic curves and based on the Petrobras's natural gas supply expansion plans in Brazil, to estimate the gas supply and demand for 2011. From its results, the paper proposes an approach to promote competition in the country's gas industry based on the international experience and on the domestic market characteristics, infrastructure and regulation. Lastly, the paper analyzes the possible impacts on prices and security of supply of the proposed model in Brazil. The main principles stated in this paper could be used in other countries whose natural gas industry is under development.

2. Methodology

The demand forecast is made by using the simple logistic curve model. Logistic curves are frequently used to estimate the penetration rate of a given technology, or the market penetration of a product or technology over the time. Logistic curves are normally used for supply projection, but in Brazil the development of natural gas industry is recent, with only 2 considerable gas supply fields developed until 2007. The first of these fields was developed in the beginning of 1980s at Campos Bay; this gas was rapidly consumed due to a constrained demand for this fuel in the Southwestern part of the country. After this, the Bolivian pipeline was finished in 1999, and again the pipeline capacity was fully used in approximately 6 years. These two gas fields development can be approached as logistic curves, one after another. Fig. 3 illustrates this statement. So, in the case of natural gas in Brazil, the characteristics of its market evolution fit into a logistic model, as the demand is strongly linked to supply. Hence, this is the model used for projecting the Brazilian gas demand for 2011, considering data since 1970. Only an optimistic scenario is adopted in order to find out if there will be a natural gas surplus in this year. Eq. (1) depicts the model being considered here

$$C(t) = \frac{K}{1 + \exp(-\alpha(t - \beta))} \quad (1)$$

where K is the carrying capacity, i.e., the limit where the growth of the system tends to stabilize. Parameter α determines the growth rate of the curve: the time that the curve takes to increase from 10% to 90% of the carrying capacity (K). Finally, β is the average growth rate: the time taken to reach 50% of K . It is important to stress that the basic logistic model is symmetrical around its mid-point β (Hosmer and Lemeshow, 2000).

For the supply projection, the authors used the study carried out by the Research Planning Company of the Ministry of Mines

³ Consumption above 500,000 m³/month, being that 1 m³ has 9400 kcal.

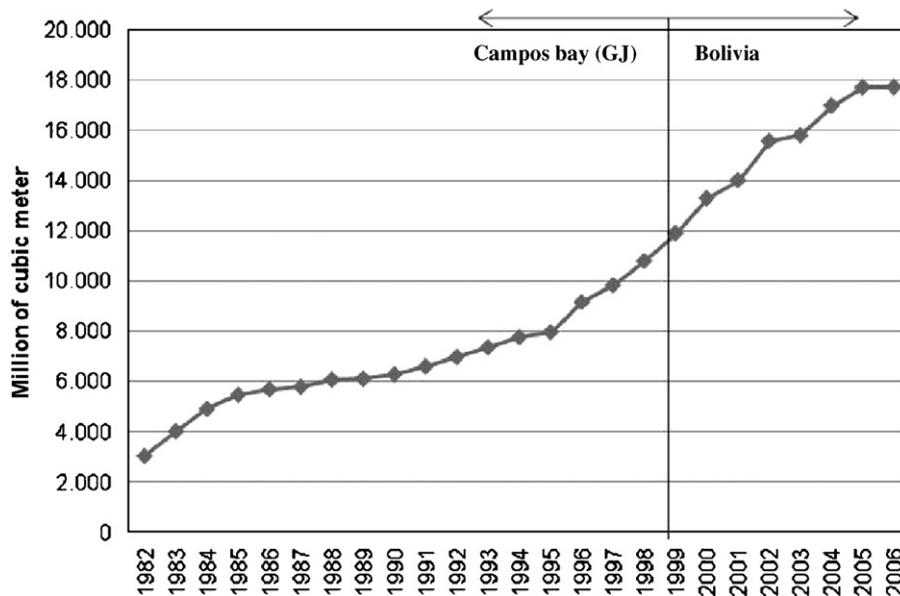


Fig. 3. Evolution of the total consumption of natural gas in Brazil between 1982 and 2006, in million cubic meters per day. * Indicates million cubic meters per day, excluding the gas consumption for electricity generation. Source: Adapted from MME—National Energy Balance (MME) (2007).

and Energy, which considers, among other factors, the Petrobras Strategic Plan 2007–2011.

For the promotion of competition and infrastructure development, this paper considered the international experience and the domestic market characteristics, existing infrastructure and regulation.

3. Projection of the natural gas market in Brazil for 2011

Before market projection of natural gas for 2011, it is important to explain the role of natural gas for electricity generation in Brazil. The Brazilian electricity matrix is hydro based. The supply structure in 2006 had hydro plants responsible for 74.1% of the total; thermoelectricity (mostly from fuel oil, coal and natural gas) was responsible for only 12.3%. Considering the electricity generation, natural gas plants were the responsible for 13TWh in 2006, corresponding to only 2.8% of the total of 460.5TWh produced. Natural gas, coal and fuel oil plants are run only to manage the interconnected national system. Those plants operate only in peak demand periods, in periods of low rain season or to allow the storage of water in the reservoirs (the interconnected system allows electricity exchange among different market regions in the country). The operation is coordinated by the Electricity National Operator System (Operador Nacional do Sistema Elétrico—ONS).

The natural gas supply scenario for 2011 considers the Energy Planning carried out by the Research Planning Company of the Ministry of Mines and Energy. For 2011, it is predicted that 32.2 mcm/day of natural gas comes from Bolivia, 20 mcm/day of LNG, and 74.7 mcm/day of national gas; this corresponds to 129.9 mcm/day for 2011. This plan shows the decrease of the Brazilian dependence over the Bolivian gas; moreover the LNG will also increase the security of supply, helping any supply constraint that may occur.

Besides the recent discoveries that Petrobrás has made in Santos and Espírito Santo Bays, which will be the responsible for most of the additional national gas supply until 2011, recent discoveries of oil and gas in the pre-salt layer have made the government re-think the awarding authorization process. The

reserves are still estimated, but all pre-salt area could reach from 70 to 300 billion barrels of oil equivalent, together with considerable quantity of natural gas. The government is studying two possibilities for the pre-salt management: the increasing of existing taxes and royalties, or the creation of a state-owned company that would manage these giant fields. The point is that Brazil has large natural gas reserves that will be soon produced in Santos and Espírito Santo Bays, and much more will be likely produced in the pre-salt area. It seems that the dependence over Bolivian (or imported) natural gas will not happen in the future. Also the two LNG facilities that will start operating in 2008 and 2009 will play an important role in supply flexibility and the supply in the near term, but do not seem to be a trend in the long term due to the existing and new gas reserves.

Another important issue to consider is the expansion plans of pipeline companies. According to ANP, the upstream pipelines (for high-pressure natural gas transportation) in Brazil have 6200 km of extension in the beginning of 2008. Transpetro (a Petrobras subsidiary company) is the largest transportation company in Brazil, with approximately 4000 km of natural gas pipelines in the country, transporting approximately 50 mcm/day. Practically all future transportation pipeline expansion in Brazil will be carried out by Transpetro in the next 10 years, which will allow all natural gas produced to be delivered to the distribution companies. According to Transpetro business plan, until 2011 the company will build approximately 1800 km of pipelines. The business plan will allow that Brazilian natural gas supply achieve 134 mcm/day in 2012, of which 114 mcm/day will be transported by Transpetro. Also the South-Southwestern and Northeastern part of the country will be inter-connected until 2011.

Considering now the demand scenario, it is important to estimate the value of K (upper limit) in the logistic curve equation. Some points are important:

1. The recent temporary shortage of natural gas has been slowing investments down in new expansions of distribution networks, which in turn slow the demand for gas down; this situation will last until the beginning of the expansions predicted in the Petrobras Strategic Plan 2007–2011;

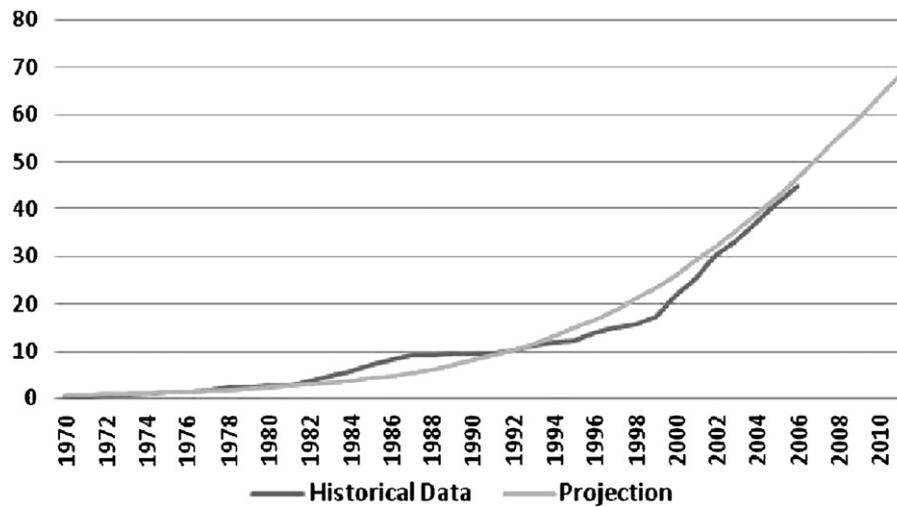


Fig. 4. Actual natural gas consumption and the logistic projection for 2011, in million cubic meters per day (total consumption excluding the predicted supply to gas-fired power plants).

- Since the data used in the model refer to the years up to 2006, the 2007 supply crises are not considered, which could distort the projection by using data under rationing.
- The recent crises in Bolivia, the supply operational problems and the availability of cleaner firewood-fired technologies in low-pressure boilers are forcing companies to revalue the risk of energy supply and to consider firewood as an alternative to natural gas.
- Petrobras recently increased natural gas prices from 25% to 30% to distributors. Even if this increase was justified (due to the high increase of the relative price of fuel oil and other products in relation to gas), it will avoid the gas demand growth even further.

The logistic projection herein presented does not take into account the amount of gas-fired power plants because the operation of these plants depends on countless factors that are not quantified in this paper. Since the proposal of this paper is to carry out an aggressive demand expansion scenario—to verify the possibility of a gas surplus in 2011—it is considered that the gas-fired power plants dispatch 100% of their electricity generation capacity in 2011 (48.4 mcm/day).

Based on the historical evolution and on the aforementioned factors, it is considered for an optimistic scenario $K = 129.4$ million m^3/day as its carrying capacity (the limit where the growth of the system tends to stabilize), since this will be the total availability of natural gas for the year 2011. Following the aggressive scenario assumption for the demand expansion, the projection model disregards even the 48.4 mcm/day intended to supply the thermal power plants.

Fig. 4 and Table 2 depict the results of this optimistic projection for the total natural gas consumption (excluding what is intended for the thermal power plants). Table 3 summarizes the scenario for 2011, considering that the electricity generated from all thermal power plants are dispatched and that the demand increase in other segments proceeds as shown in Fig. 4.

According to the proposed optimistic scenario, in 2011 there will be possibly a gas surplus of at least 13 mcm/day (the difference between 129.9 and 116.9). The surplus will probably be greater than it during most part of the year, since the thermal power plants in Brazil are used for balancing the hydrothermal electricity system, being barely used for base-load power generation.

Table 3

Natural gas supply in 2011 predicted by Petrobras and natural gas projected demand by the logistic model

	Demand		Supply 2011
	2006	2011 (projection)	
Electricity generation	11.39	48.4	–
Other consumption	44.87	68.5	–
Total	50.38	116.9	129.9

4. International experience

The natural gas industry worldwide has been going through fundamental changes as a result of structural reforms aimed to increase the economic efficiency by establishing competition in the supply of gas (IEA, 1998). The United States and the United Kingdom stand out in this process. The reform process in these two countries can subsidize Brazil in preparing a model that promotes competition and improves the security of supply.

4.1. Deregulation of the natural gas market in the United States

In the United States, the regulatory cornerstone for the deregulation of the natural gas sector was the “Order 636”, issued in 1992 by the Federal Energy and Regulatory Commission (FERC); this Order was known as the “restructuring rule”. It was elaborated to promote the most efficient use of the interstate natural gas transport system, fundamentally by changing the way in which the companies conduct their business. Prior orders encouraged pipeline companies to provide their services in a non-discriminatory basis, without favoring its own supply. Order 636 required that the interstate pipeline companies legally unbundled their sales from the transportation service. The purpose of the unbundling provision was to ensure that the gas of other suppliers could receive the same quality of transportation services previously enjoyed by a pipeline company’s own gas sales. This unbundling increased competition among gas sellers, diminishing the market power of pipeline companies. The Order also required that the pipeline companies had open access to the gas storage infrastructure, encouraged the development of market centers in the interconnections of the interstate pipeline system

(the so-called hubs⁴), in order to create conditions to develop the spot market.⁵ The release of the transport and storage capacity was established with the release of unwanted firm capacity, and also by allowing a replacement shipper to re-release capacity if permitted by the terms of the initial release. To help develop the hubs, FERC required gas transportation companies to publish daily bulletins so that shippers could have access to the information about the availability of service on their system. Order 636 also required that pipeline companies had to redesign their transportation tariff rates so that the majority of fixed costs would be recovered through the capacity reservation fee charged to firm customers; this reservation fee was charged on a monthly basis to reserve daily capacity, based on their peak period requirements. For the interruptible customers, obviously, the reservation fee was not charged. The variable costs were recovered through a usage fee applied on a volumetric basis to the gas actually transported. This new rate design aimed to help develop competition among gas suppliers, eliminating any price distortions inherent in the prior price setting, which allocated certain fixed costs to the gas commodity (usage) charge. Lastly, it was required that gas companies, which have unbundled their firm gas sales at the *city gates*⁶ to offer a new firm transportation service, called “no-notice” service. The “no-notice” service allowed the customers to receive more gas than the maximum contracted, reaching their peaks of demand without making prior nominations (FERC, 1992; Lee, 2004).

The restructuring of the natural gas industry in the United States was “market oriented”, mainly due to the so-called “gas bubble” in the 1980s, a period in which there was high spare capacity in the transportation system and gas surplus in the wells, but whose prices were regulated and the use of flexibility mechanisms was not allowed. Restructuring has brought tariff modicity and demand and supply flexibility mechanisms through optimizing the use of pipelines, the creation of hubs and spot market, and the development of a storage market.

4.2. Deregulation of the market of natural gas in the United Kingdom

In 1987, the *Gas Consumers Council* sent to the *Office of Fair Trading* (OFT) a denunciation that *British Gas Plc.* (BG), recently privatized by the British government, was conducting monopolistic practices against its non-captive consumers through lack of transparency in its tariffs, the refusal to provide uninterrupted supply to some consumers, the failure in providing information on the production costs and the exertion of its market power as the sole buyer of natural gas in Great Britain. Facing difficulties to politically sustain the thesis of the advantage of private monopoly over the state monopoly, the British government then created conditions, via BG regulation, to introduce competition in the open market, ruled by negotiated contracts between utilities and their consumers (DTI, 2005).

From 1988, the Monopoly and Mergers Commission (MMC) forced British Gas to embark on a gas release program, in which at

least 10% of the gas from new fields in UK should be sold to the open market (either sellers or end users). The program evolved on the early 1990s, forcing the annual release of a fixed volume of gas to other agents (DTI, 2005).

By means of the Gas Act of 1992, the regulatory agency released all customers which have an annual demand greater than 2500 therms (something around 6.7 million m³/year). In 1994, the accounting separation was required in the trading, transportation and distribution activities carried out by BG. The Gas Act of 1995 put into effect the legal separation of BG transportation and supply businesses into separate subsidiaries: the same legal entity could not hold a license for transportation as well as a trader or shipper at the same time. Later on there was the release of all the remaining customers (DTI, 2005).

Just like in the USA, the release of the natural gas market improved the economic efficiency in the gas industry, reducing the tariffs to the end users and improving security of supply through the implementation of gas demand and supply flexibility mechanisms. Even though the British model has been more coercive than the American, the result was achieved.

4.3. Current regulation of natural gas industry in Brazil

The landmark for the natural gas industry in Brazil was the enactment of *Law, 9.478/97*, known as the “Oil Act”.⁷ *Law, 9.478/97* ended the legal monopoly of PETROBRAS on the following activities:

- I. Oil and gas exploration and production;
- II. Refining of national or imported crude oil;
- III. Import and export of crude oil and natural gas;
- IV. Transportation of crude oil, its products and natural gas.

Its Article 5 describes that the above-mentioned economic activities (I–IV) are regulated and supervised at the national level and can be exercised, either through concession or authorization, by companies created under the Brazilian laws, with head office and administration in Brazil. The concession or authorization is awarded by the National Oil & Gas Regulatory Agency (ANP), the sector’s national regulatory agency, which was created by the same law with the objective of promoting regulation, contracting and supervision of the economic activities that comprise the industry of oil, natural gas and biofuels (*Law, 9.478/97*).

The distribution and trading activities of mains gas to end users are exclusively exploited by the states, either directly or under concession, in the terms of the Section 2, article 25 of the Federal Constitution. The states of São Paulo and Rio de Janeiro already foresee trade liberalization of natural gas in their concession contracts. It is expected to start in Rio de Janeiro and São Paulo, respectively, in 2009 and 2011 (for large industries and gas-fired power plants). However, in order to competition can actually take place in trading, some changes in the current regulation are needed. This paper seeks to propose a general approach whose principles could be possibly applied in other countries when the development stage of the gas industry will be more advanced.

5. An approach for the development of competition in the natural gas industry in Brazil

According to the DTI (2005) and IEA (1998), the main factors for developing competition are: mature markets, regulation of gas

⁴ Hubs are market centers which are normally located close to gas storage plants. The hubs provide the physical and administrative capacity services to the new transport companies, which were previously carried out by the transportation companies themselves. The two main services of the hubs are: (a) different possibilities of transport and interconnection between networks, and (b) physical balance of gas in the short term.

⁵ Energy Information Administration at the Department of Energy. http://www.eia.doe.gov/oil_gas/natural_gas/analysis_publications/ngmajorleg/ferc636.html. Accessed on 15 December 2007.

⁶ *City gate* is the physical location that interfaces the natural gas transmission network with the distribution network. In this place, the gas pressure is lowered and an odorant is added to allow the detection of gas leak downstream. At the city gate the custody of gas is changed from the federal to the state level.

⁷ Before *Law, 9.478/1997*, the legislation in force was Law no. 2004, of 1953, of the then-president Getúlio Vargas. This Law created the oil and gas company Petrobras and established the state monopoly over the activities of exploration, production, refining and transportation of oil and its products.

transport, distribution and storage activities, open access mechanisms and transparency of information. The suggestions, which are described in this section are based on these principles and seek to encourage the development of the natural gas industry in Brazil, avoiding coercive measures, which might scare investments away or harm the public or private assets already existent in the sector. The paper seeks solutions, which encourage the economic efficiency and demand and supply flexibility mechanisms.

The challenge of countries like Brazil, which are rapidly developing their natural gas industry is how to assure at the same time the development of infrastructure while developing competition. Directive 2003/55/EC of the European Parliament establishes common rules for the transmission, distribution, supply and storage of natural gas, seeking to achieve competition to improve economic efficiency. In countries where the natural gas infrastructure is still incipient, the obligation of open access may take more time depending on the analysis made; this shows that regions with different market and infrastructure should have different approaches for periods of exclusiveness.

5.1. Upstream

As described in the introduction, in the last 20 years, countless countries have been carrying out structural reforms in the natural gas industry, seeking efficiency and economic rationality by introducing competition in certain activities.

Law, 9.478/97 had the purpose of developing the natural gas industry in Brazil, promoting its competition. However, 10 years after its enactment, small advance was made in this direction, with Petrobras and its subsidiaries dominating the exploration, production, transportation and storage activities of natural gas in the country (Martins, 2006). The fact is that there are currently no safeguards to investors that the natural gas produced will be delivered up to the end user, whether due to the lack of regulation in the transport activities or to the impossibility of selling gas directly to the end user, but only to the gas distributors. Regarding the development of competition in the gas industry, there are currently two Gas Bills proposals going through the Chamber of Deputies and the Senate. The major points of the legislation in force, of those two Bills and the opinion of the authors of this paper are summarized in Table 4. The explanations of the authors' opinions are presented next.

Given that in Brazil the award for gas transport is by means of authorization, and that the adoption of this kind of award is not the determinant for the success of developing competition and the subsequent price reduction, there are no reasons to change it—countries such as the United States and the United Kingdom use the same type of award. The change in award of the current gas pipelines from authorization to concession would be an imposition, which drives it in the opposite direction of an incentive regulation. This change would injure the companies, which have already made investments, and also increase the regulatory risks (scaring new investors away or increasing the required investment rate of return). On the other hand, if the new gas pipelines had the concession award, without changing the existing gas pipelines, this would result in the adoption of a hybrid model, which is not desired because in different locations the gas molecules would be subject to different regulatory frameworks, which in the long term would become a torment in operational terms. Another point is that authorization awarding is more market driven than concession, which has a strong government influence. Authorization award leaves the investment risks to market. Because natural gas is an interchangeable fuel, its price depends on the price of its substitutes, which turns the market risky and not fully dependent natural gas price itself.

Table 4
Comparison of the legislation in force with the proposed bills pl 6.673/06, pl 334/07 and the opinions of the paper's authors

	Law, 9.478/97	Bill 6.673/06	Bill 334/07	Authors
Awarding authorization for gas transportation and storage activities	Authorization	Authorization or concession (defined by the Ministry of Mines and Energy—MME)	Concession	Authorization
Expansion planning	Company	Determinative (Ministry of Mines and Energy—MME)	Participative	Participative
Access and exclusiveness period	There is no exclusiveness period, and the third-party access is allowed, having to be negotiated among parties	10 years of exclusiveness, to release access to third parties later	None for new gas pipelines (auction of capacity). 8–15 years of exclusiveness	Case by case. Transparency of information and regulator as conflicts mediator
Tariffs	National and imported gas: tariffs negotiated among agents (since 31 December 2001)	Regulated tariffs	Regulated tariffs	Regulated tariffs
Cross-participations	Requires accounting separation of the production and transportation activities	Requires accounting separation of the production and transportation activities	The carrier, in addition to accounting separation, is limited to participate in gas production, storage and trading activities.	Requires accounting separation of production and transportation activities
National operator system	National Oil & Gas Regulatory Agency (ANP)	National Oil & Gas Regulatory Agency (ANP)	Creation of a National Gas Transport System Operator (ONGAS) subordinated to the National Operator of Electric System—ONS	Creation of an independent National Gas Transport System Operator (ONGAS)

The expansion planning should be participative. A company that wishes to build or expand gas pipelines should be encouraged to design the gas pipeline together with the government (intermediated by the Energy Research Company–EPE), state distributors, Universities, Research Centers, Traders and consumers (represented by associations).

Non-discriminatory open access is fundamental in the development of competition. Open access provides safeguards to producers that the gas being produced will be transported. In relation to the exclusiveness period, it should be studied on a case-by-case basis, considering an estimated time for the amortization of investments before opening access. This should be done by the federal regulator (ANP). Considering a fixed period to open access to all high-pressure pipelines, as discussed by the two bills, is complicated. For instance, one pipeline may serve a highly potential market with a huge constrained demand, which would have a quicker investment return; another might connect a mature or a low potential market, making the return more difficult. Investors may not decide to build pipelines like that because of such constraint, which could be solved if the exclusiveness period was defined case by case. However, the competition can be developed even before the end of the exclusive period, since it can be an advantage to a pipeline company to sell the transportation of natural gas to other interested agents in case there is spare capacity in the gas pipeline. There were advances in Brazil in relation to the open access. Resolution 27/2005 of the ANP, in its Article 7, states that all Available Transportation Capacity to contract Firm Transportation Service (STF) in Transportation Facilities will be auctioned and allocated according to the procedures of the Public Contest for Capacity Allocation.

Special attention should be paid to the transparency of information about the physical capacity of the gas pipeline and the natural gas transaction agreements. Like in other countries in which the competition was introduced, daily bulletins with information on gas availability and pipeline capacity should be published. Transparency avoids the occurrence of information asymmetry. In addition, standardization and harmonization of rules and procedures are important to the market works harmoniously.

Both Gas Bills currently passing through the Chamber of Deputies and the Senate propose that the tariffs for the gas pipelines must be regulated. According to Gordon et al. (2003) and IEA (2000), the transportation and distribution of natural gas have natural monopoly characteristics. For this reason, tariff regulation in these activities is important so that there is no abuse by dominant companies. In addition, the regulation must allow the entrepreneur to obtain a “fair” remuneration through a tariff cap (which may stimulate negotiations among parties).

In regard to cross-participations, the accounting separation of the production, transportation and trading activities provides information to the regulatory agencies on the discrimination and cross-subsidies, which must be avoided by means of effective monitoring and supervision.

The National Natural Gas System Operation should be an independent association, and not subordinated by the Electricity Operator (ONS). Both operators (natural gas and electricity) should work in coordination. If natural gas operator was subordinated to the electricity operator, natural gas would be prioritized for electricity generation, leaving other consumers (i.e., industries) insecure. The federal regulatory agency ANP should not be the responsible for the operation of natural gas; it has the role to only regulate and monitor the operation.

5.2. Downstream

The distribution and trading activities of gas to end-user consumers are exploited with exclusiveness by the states, directly or under concession, in the terms of Section 2 of Article 25 of the Federal Constitution. For this reason, there is no point to encourage competition in the upstream activities if the states do not allow the performance of direct sale to the consumer.

As described previously, the states of São Paulo and Rio de Janeiro are the first to establish an end to the trade monopoly to the end user. However, some measures should be adopted downstream so that trade liberalization in these states does not become only a regulatory milestone; it is also important that other states can adopt the same model when their markets are well established. The measures are similar to those in the upstream.

The distribution and trading activities of gas to end-user consumers are exploited with exclusiveness by the states. In both states of Rio de Janeiro and Sao Paulo, it was already predicted in the concession contracts signed with distribution companies that the exclusiveness of some end-user trading (large industries and electricity generation) would end in 2009 and 2011, respectively. This, together with the incoming Gas Law, could improve the economic efficiency through the development of competition. So the introduction of competition in the trade of natural gas and the non-discriminatory open access could be implemented in two coordinated blocks: one in the upstream, through an upcoming Gas Law (federal jurisdiction), and another in the downstream (state jurisdiction). The states of Sao Paulo and Rio de Janeiro are already studying how the distribution fee will be charged, among other operational issues, like the requirements for upcoming trading companies, contracts, information and exclusiveness period. Again, the approval of any State Law or Decree in Sao Paulo and Rio de Janeiro will not be needed at all because the concession contracts already predicted the open access for natural gas trading; everything will be done in the regulatory level.

6. Possible impacts on the Brazilian market

With the projection of the Brazilian natural gas market carried out in Section 3; the experience of countries such as the United States and the United Kingdom; and the specific characteristic of the Brazilian market and regulation, it was possible to draw a general approach that may increase the economic efficiency of the country's gas industry by means of a legal-regulatory framework, which provides the development of competition.

The likely surplus of natural gas in 2011 and the upstream and downstream approach proposed in this paper would create the necessary conditions for the development of competition in the Brazilian gas market. In the short term, it is expected that only the states of Rio de Janeiro (in 2009) and São Paulo (in 2011) will open their trading markets to some end-user segments. The other Brazilian states have signed concession contracts with their gas distributors that extend the exclusiveness period for distribution and trading for the totality of the concession period. Besides that, Petrobras has participation in almost all natural gas distribution companies in the others states; Petrobras does not have any participation in the distribution companies in the states of Sao Paulo and Rio de Janeiro.

Open access to the infrastructure leads to the creation of a new market for the natural gas (IEA, 2002). Competition in production would probably increase with the introduction of open access, regulated tariff and transparency of information. The producer would have certain that, existing available capacity in the pipeline, the natural gas produced would be delivered to the

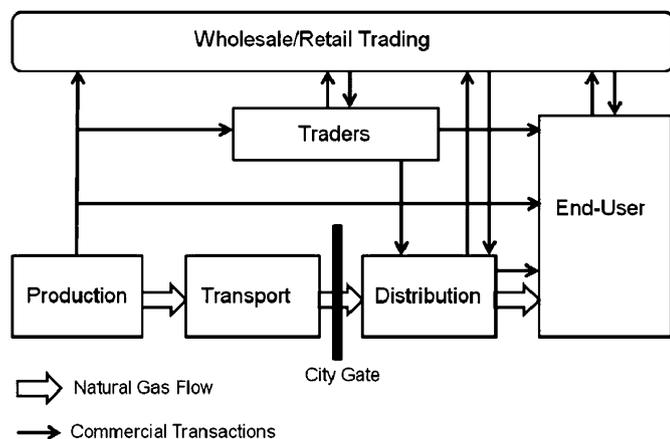


Fig. 5. Characteristics of the natural gas industry in Brazil with the introduction of the proposed approach.

end user. Even if there is no capacity available in the short term, the regulatory agency should have the power to request the gas pipeline expansion capacity, by means of a fair and adequate remuneration to the transport company. This is the procedure followed by the United Kingdom in case a producer wishes to be interconnected with the basic gas transportation network (that is full), when the Secretary of State holds the power to request that expansion.

With the adoption of the propositions made in this paper to the upstream and downstream activities, the characteristics of the natural gas market in Brazil would be as shown in Fig. 5. The natural gas producer could sell natural gas to distributors, end users, the wholesale market and traders.

With the increase of competition in the production, new trading agents would enter into the market, seeking to trade natural gas with distributors and end users. This would facilitate the creation of two new demand flexibility mechanisms, non-existent in typically monopolized markets,⁸ such as:

1. *Trading hubs:* Hubs are market centers that are normally located close to storage plants and large gas interconnections. The hubs provide physical and administrative services to the market. The two main services of hubs are: (a) providing different possibilities of transport and interconnection between networks; and (b) providing physical short-term gas balance. The trading hubs enable the creation of a spot market (IEA, 1998);
2. *Creation of a spot market:* The creation of a short-term market can help to optimize the spare capacity and gas; the spot market is essential to the creation of a natural gas wholesale

⁸ Some supply and demand flexibility mechanisms can be adopted in countries whose gas industry has monopoly or competition characteristics. In relation to the flexibility mechanisms for the natural gas supply, the following features highlight within this context: (1) Surplus of supply: a spare capacity of natural gas can help improve security of supply during periods of peak demand or operational problems. The most traditional option is to maintain a surplus of supply by using swing-type wells, which enter into operation in these occasions; (2) Liquefied natural gas (LNG) stations on stand-by; (3) Increase in pipeline pressure: increasing the pipeline pressure is an effective option in the hourly demand variations. In the United Kingdom, for instance, the increase of supply can reach 3% of the total demand by increasing pressure (IEA, 2002); (4) Storage of natural gas in aquifers, salt caves or depleted oil and gas wells: natural gas is stored to be used during periods of peak demand or operational problems. Regarding demand flexibility mechanisms, one of the most used refers to interruptible agreements with large industrial consumers or gas-fired power plants. These consumers have the ability of switching gas to other fuels in case the supply is interrupted.

and retail market, as well as the development of financial risk management (derivatives).

The adoption of traditional flexibility mechanisms and the introduction of these new mechanisms could have avoided the recent crisis in the supply of natural gas. With the introduction of competition, price becomes a new instrument to balance the gas supply and demand. Furthermore, in addition to the traditional mechanisms, new mechanisms would be created enabling that this gas could be traded, then increasing the system's economic efficiency by optimizing the use of the transportation capacity. In general, these mechanisms bring prices down to the end users (IEA, 1998, 2002; CGA, 2003). With competition, it is also possible to contract natural gas by short- (spot), mid- and long-term agreements (generally indexed to the spot market).

Another impact of the creation of the spot market and the trading hubs would be the creation of derivative mechanisms for energy, such as future markets of natural gas (IEA, 1998, 2000). Futures contracts and options usually arise in this environment for transferring price risks.

In the supply side, there is the possibility of creating a storage market, in which gas can be inserted or withdraw in storage facilities during periods of low and high gas demand, respectively, through capacity agreements. This also occurs in the United States and the United Kingdom.

7. Conclusions

The development of natural gas industry is recent in Brazil. The initial dependence on Bolivian natural gas will diminish in the next years due to the supply of Brazilian natural gas and LNG import. The prospect for oil and gas industry in Brazil are huge. The existing natural gas reserves to be delivered in the next 2–5 years, the development of the pre-salt area, and the dependence diminishing of the Bolivian gas shows this evidence.

Even though the natural gas industry in Brazil is relatively new, it already shows signs of maturity in large industrial markets, especially in the states of São Paulo and Rio de Janeiro. The trade liberalization in these states in 2011 and 2009, respectively, represents an opportunity for the development of competition in the country's gas industry.

The regulation in the states of Sao Paulo and Rio de Janeiro should work in parallel with federal law and regulation to build a developing environment for competition and to develop the infrastructure. The proposed Gas Bills are trying to create this condition, although some changes should be made, as proposed in this paper, to achieve better results.

The development of competition and infrastructure depends on a few factors, such as: (1) gas surplus and an effective regulation promoting non-discriminatory open access; (2) transparency of information; (3) regulation in the transportation, distribution and storage of gas. This paper predicted, based on the projection presented, that there will be a likely surplus of natural gas in Brazil in 2011; (4) period of exclusiveness of new gas pipelines should be on a case-by-case basis. In order for the natural gas to be traded at lower prices, this paper presented an approach aiming to promote the development of competition without using ruptures or coercive measures. As mentioned in this paper, the introduction of competition in the United States, Canada and the United Kingdom has promoted tariffs reduction to the end user by increasing the economic efficiency of the gas industry as a whole; it also improved the security of supply with the creation of new flexibility mechanisms.

The propositions in this paper have sustained some points included in one of the Gas Bills; moreover, it has made some

contributions that are not included in the two Gas Bills. The contributions include the period of exclusiveness of new high-pressure pipelines, which should be on a case-by-case basis, to attract investments in areas with low market potential (by increasing the exclusiveness period), and more efficient in high market potential areas (by decreasing the exclusiveness period). Another different proposition that differs from both Gas Bills is the creation of a National Natural Gas System Operation, which should be independent of the ONS.

The approach proposed in this paper sought to adapt the successful international experience with the reality of the Brazilian market and regulations. This approach, once adopted, would probably: (1) create a wholesale and retail natural gas market; (2) encourage the development of financial risk management tools (future contracts and options, for instance); (3) stimulate the shift from long- to short-term contracts in transportation and distribution activities; (4) create a spot and a future market; (5) stimulate medium and long-term contract indexation to natural gas prices at the spot and futures markets. These factors, as already mentioned, would lead to reduction of prices to the end user in Brazil, as well as increase the security of supply, with the creation of new flexibility mechanisms

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