International Regulatory Aspects on Underground Natural Gas Storage and the New Brazilian Natural Gas Act

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Abstract

This work aims to make a survey on the most important regulatory frameworks existing worldwide on Underground – or Geological – Natural Gas Storage and compare them to the regulation under development in Brazil regarding this subject. The nations considered – Canada, France, Germany, Italy, United States and Russia – as well as the Directives of the European Union, are those that have many sites in operation or great capacities of underground storage. First, for each country, it is identified the types of geological structures used as well as the national or regional purpose of the storage. Then, some technical studies in Brazil on the search of structures able to hold gas within are shown, as well as the objectives involved, like, for example sending gas for thermoelectrical generation. After that, the most common regulatory aspects identified in the nations considered, like, for example, the unbundling between the activities of transport and storage, the open or negotiated access to the facilities and the governmental authorities responsible for the permits, are compared to the existing Brazilian Petroleum Act, the Law number 9.478/97, and to the Natural Gas Act, the Law number 11.909/09, which is now the legal mark on natural gas in Brazil. A brief history of the recent changes on the Brazilian regulatory framework on oil and gas is also shown as well as other relevant aspects of the Gas Act, like the concession of gas pipelines and the legal requirements for the construction and operation of Liquefied Natural Gas – LNG facilities, for example. Regarding Underground Natural Gas Storage, it was possible to verify that there are some similarities and differences between the international framework analyzed and the new Brazilian Gas Act, like the access to the storage capacity and the establishment of Contracts of Concession for the exploration, development, construction and operation of geological storage facilities. Finally, among other observations, the work concludes that, as it happened to the oil industry in Brazil, whose production of oil and oil reserves have grown more than 100% and 78%, respectively, during the 10 years of the Petroleum Act, the establishment of specific rules for Natural Gas is a prime requirement for the development not only of Underground Natural Gas Storage businesses, but for the Brazilian natural gas sector as a whole.

1. Introduction

Existing in the world for almost a hundred years, underground – or geological – natural gas storage sites are developed to match the constant gas supply, that, in many cases, comes from long length pipelines, with demands that varies according to different factors, like the season of the year, weather and economic advantages that may be got when it is possible to control the volume of available gas (TEK, 1996). Underground Gas Storage (UGS) facilities can be used for:

(i) meeting uncommon demand peaks and exceeding gas production;
(ii) storing gas during the summer to be delivered during the winter, especially in countries located in temperate zones;
(iii) assuring gas supply during operational, economical or political problems that may interrupt the pipeline’s gas flow (emergency situations).

Those objectives may vary from one country to another, according to its climate, gas productions, reserves and national consumption profiles. In addition to these traditional usages, storage is also being used to meet services created by both the unbundling of storage and by the new market conditions of some nations, like, for example:

(i) ensure liquidity at market centers to help contain price volatility and maintain orderly gas markets;
(ii) make money keeping the gas stored during periods of low prices and sell it during periods of higher values;
(iii) meet the regulatory obligation to ensure supply reliability at the lowest cost to the ratepayer by maintaining specific levels of storage inventory (EIA, 1995; FERC, 2004).

The nations where the use of underground natural gas storage is more developed are those that were pioneers of the employment of the technique or whose natural gas industry is already at a high level of maturity. In those countries, regulation is generally well established for the siting, construction and operation of UGS facilities as well as for commercial storage activities. Among them, are the United States of America (USA), Canada, Russia, Germany, France and Italy.

Brazil still does not have sites of geological storage that would be part of Brazilian infrastructure for the transport of natural gas. It is probable that the objectives of the development of this specific industry will be the assurance of gas supply during emergencies and the matching of gas production and consumption for thermo-electrical generation.

Up to this year, there was no regulation on Underground Natural Gas storage in Brazil. However, on March, the 4th, a new Act, the Law n° 11.909/09, also known as “Gas Law” or “Gas Act”, came to determine rules to the Brazilian Gas Industry and included, among other businesses, the geological storage. Before that, in terms of Law, the Gas Industry was only regulated by the “Petroleum Law” or “Petroleum Act” or Law n° 9.478/97, issued on 1997, August, the 6th, who doesn’t establish different rules for petroleum, derivatives, natural gas and Biofuels. In other words, the specific characteristics of the Natural Gas industry, especially those related to transportation and storage wasn’t taken into consideration by the “Petroleum Act”. The discussion of the New Gas Act took about 5 years in the Brazilian National Congress, being approved by the House of Representatives in 2007 and by the Senate in 2008. After receiving some amendments, the Natural Gas Act Proposal went back to the House of the Representatives to approve them and, by the end of 2008, the text totally passed the two houses of Brazilian Congress. The Proposal finally became a Law after being approved and signed by the President of Brazil on March, 2009.

This article, therefore, aims to make a comparison between this New Natural Gas Act and the existing regulatory aspects worldwide, in order to identify, among the international experience, those characteristics that are similar and those that are different to the new rules established in Brazil for the UGS sector. To do so, first this work presents an international panorama of the underground natural gas industry and its regulations in the countries where this technology is intensely in use for decades or where there are huge volumes of gas kept underground. After that, some studies and considerations are shown to clarify what would be the purpose of developing underground storage sites in Brazil and the regulatory aspects introduced by the Natural Gas Act. Finally, this work is finished with some relevant conclusions on Brazilian geological storage regulation.

2. Underground – or Geological – Natural Gas Storage

As mentioned before, geological or underground natural gas storage can be defined as a tool to match production or supply and consumption by the use of natural geological structures. So, according to that definition, the use of underground tanks to storage gas (or maybe, light petroleum products) is not considered by this work and, as explained further, storage in tanks is treated by a different way by the Brazilian Natural Gas Act. Underground storage is also defined as the volume of gas transferred from the reservoir where it was found to another, closer to the markets (Energy Information Administration – EIA, 1995).

The three most important types of underground storage used nowadays are: (i) depleted or exhausted oil or gas fields, (ii) aquifers and (iii) salt domes or caves. Each one of those types has its own physical (porosity, permeability, retention capability) and economic characteristics (site preparation and maintenance costs, deliverability rates, and cycling capability) which govern its suitability to particular applications. There are also other less used types of storage, like the storage of gas in abandoned mines and in lined-rock-caves (EIA, 1995, 2004).

One of the most important characteristics of a storage site is its volume of natural gas available for delivery, that is, its working gas capacity (top gas or working gas). Underground storages also have cushion gas, whose main function is keeping suitable pressure for efficient withdrawn. In case of depleted reservoirs, the cushion gas may be the part of the native natural gas which still remains within the field after the end of commercial production. During the development of an underground natural gas site, additional gas is usually injected and combined with the existing volume of gas in order to keep the suitable pressures for required withdrawn rates.
Figure 1 shows the most important cases of underground storage existing in the world. It is possible, by this drawn, to have an idea on the dimensions of geological structures compared to surface facilities. Porous structures, mentioned by Figure 1, include depleted reservoirs as well as aquifers.

![Figure 1 – Different kinds of Underground Natural Gas Storage. Source: CONFORT, 2006, adapted from SLB, 2002.](image)

### Depleted or Exhausted Oil and Gas Fields

It is the simplest way of storing natural gas underground, usually employed when there is no more oil or gas that can be commercially produced by the field. It is usually employed at the end of the commercial production period of the field. The gas is kept within porous and permeable rock structures that, in the past, stored and produced hydrocarbons, confined underground by rock seals of low permeability and/or water. This kind of underground storage is the easiest to be developed, for there is an important amount of geological data obtained during the seismic investigations carried on during the exploration and production of the field (Tiratsoo, 1972; EIA, 1995). Depleted reservoir sites are usually projected for one injection and one withdrawn per year (one cycle). On the other hand, these structures, which usually have great retention capabilities, can store huge volumes, delivering gas during 50 to 100 days, at maximum withdrawal rates. They are used, in many cases, to deal with different rates of consumption reported during different seasons, in regions and countries where gas is typically withdrawn in the winter and injected during the summer. This type of storage facility, therefore, can be used for seasonal system supply, for peak-day demands or even to assure gas supply during periods of emergency (Federal Energy Regulatory Commission – FERC, 2004).

The development, operation and maintenance of underground natural gas storage in depleted fields are more economic, if compared to aquifers, salt caves, abandoned mines and line-rock-caves. The costs of cushion gas, on the other hand, are high due to the need of fill from 50 to 60 % of the reservoir volume with this gas to achieve required pressures (EIA, 1995 e Appi, 2005). The total capacity of storage of those structures (cushion gas plus working gas) varies from 100 and 7,000 millions of m³.

### Aquifers

In cases where hydrocarbons depleted fields are not available, any geological strata saturated with water may keep natural gas stored within if the water bearing the sedimentary rock formation is overlaid with an impermeable cap rock. Aquifers are, therefore, usually, an interesting option when located close to gas markets. Generally, it is more expensive to develop, operate and maintain gas storage in aquifers than in depleted oil or gas reservoirs (Tiratsoo, 1972 & EIA, 1995). Instead of what happens to exhausted fields, aquifers’ geology is often unknown when a storage project is carried on and is, therefore, necessary to determine whether the structure will be able to keep gas within. In other words, sismic investigations must be
More than 20 sites; 
10 to 20 sites; 
Up to 10 sites; 
No sites, but researches.

Salt Caves

Some storage facilities use caverns that are leached or mined out of underground salt deposits (salt domes or salt formations). Salt cavern capacity typically is 20 percent to 30 percent cushion gas and the remaining capacity is working gas. Working gas can generally be recycled 10-12 times a year in this type of storage facility. These facilities are characterized by high deliverability and injection capabilities and are mainly used for short peak-day deliverability purposes. This kind of storage is more interesting for financial purposes. Besides, salt has several properties that make it ideal for gas storage: for example, its porosity and permeability to liquids and gaseous hydrocarbons are close to zero, avoiding leakages (EIA, 1995 & FERC, 2004). The total capacity of salt caves or domes storages varies between 30 and 150 millions of m³.

Other Structures

There are gas storages that are developed in structures that can be considered interesting alternatives, when no suitable geological formations are available, like abandoned mines and lined rock caves. However, these storage sites are rare and, in many cases, still experimental.

3. International Technical Aspects of Underground Natural Gas Storage

North America and Europe are the continents where underground gas storage activity began and had the most advanced development. So it is not a surprise that those regions are the home of almost all of the existing sites in the world. Figure 2, based on data from 2004 to 2006, shows the geographic distribution of geological storage in the world. The nations in green (Argentina, Brazil and Mexico) didn’t have any commercial operating sites by the end of 2006, but they have some published studies and researches on this theme. Nations in grey were not part of the research.

The United States have more underground natural gas storage sites than any other country in the world. In 2004, there were 393 sites, 320 of those developed in depleted oil and gas fields, 43 in aquifers and 30 in salt caves/domes. By the end of 2004, the USA kept about 107.6 billions of m³ of natural gas underground, approximately one third of the total volume stored in the world. Russia has the world’s second largest volume of gas stored, with 62 billions of m³ within its geological structures. Russia is notable for the operation and maintenance of great storage sites, for that huge volume is stored within only 24 facilities – a small number,
if compared to the USA, 17 of that total are storage sites developed in exhausted oil and gas fields and the other 7 are sites developed in aquifers. Huge sites are also operated in Ukraine, where the world’s third largest volume of gas is stored: 31.88 billions of gas kept underground in 17 depleted reservoirs and 7 aquifers. Germany occupies the third place in the number of operating sites: 43 – 15 of them in depleted fields, 8 in aquifers and 20 in salt caves/domes – storing 20.20 billions of m$^3$ of gas. Canada has the fourth largest volume of gas stored – 14.82 m$^3$ – and it is the second one in terms of number of sites: total of 49 sites, 41 of them in depleted fields and the others in salt caves. France and Italy have also got importance in the world of underground storage, keeping underground, respectively, 11.64 and 12.70 billions of m$^3$ of gas. In France, gas is kept within 12 aquifers and 3 salt caves, while, in Italy, all of the 10 existing storage sites were developed in exhausted fields. These data are shown at the Table 1 below.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of storage sites</th>
<th>Working Gas (billions of m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depleted Fields</td>
<td>Aquifers</td>
</tr>
<tr>
<td>USA</td>
<td>320</td>
<td>43</td>
</tr>
<tr>
<td>Russia</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Ukraine</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Germany</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Canada</td>
<td>41</td>
<td>-</td>
</tr>
<tr>
<td>Italy</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>France</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>Others</td>
<td>54</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>468</td>
<td>79</td>
</tr>
</tbody>
</table>

Notes: Data from 2005 to Italy and from 2004 for the other countries. Storages in rock caves and in abandoned mines were not considered.
Source: Adapted from EIA, 2004; GDF, 2004; IGU, 2006; NLFB, 2005.

The reasons that led those countries to develop geological storage are different, according to the maturity and competitiveness of the gas sector, the availability of suitable structures and its gas dependence on other nations, that may classified them as importers or producers/exporters.

Storage in the USA, for example, has objectives that can be considered “traditional” and “non-traditional”, as shown as following:

(i) Traditional objectives: meeting of production and demand, which can be seven times higher in the winter; storing to improve industry efficiency as a whole; supplying uncommon peaks; storage for periods of emergency;

(ii) Non-traditional objectives: ensure liquidity at market centers to help contain price volatility and maintain orderly gas markets; meet the regulatory obligation to ensure supply reliability at the lowest cost to the ratepayer by maintaining specific levels of storage inventory (FERC, 2004).

The high level of maturity and competitiveness of the American gas sector, as well as the fact that the USA is one of the pioneers of the use of this technology, justify the variety of different objectives for the use of geological structures for storage.

Canada, as the United States, is also a great producer and consumer of natural gas. However, the North-American country is also an important exporter and, just like the USA, has probably taken into consideration the optimization of gas facilities to develop underground storage sites, as well as the seasonal balance between production & demand and the assurance of gas supply during technical failures in the transportation and distribution systems.

Germany has used underground storage due to two main purposes: large volumes for seasonal balance generally controlled by national companies, and storage to short peak-day deliverability purposes generally operated by local companies that also use them to make profits during periods of high prices of natural gas. Like in the US and in Canada, German storages are also maintained by several operators.

In France and Italy, sites were stimulated by seasonal demands and by the need of keeping strategic volumes of storages, due to the high dependence of these countries on foreign gas. Differently from the US, Canada and Germany, storage sites are operated by few players: In France, storage sites are under the
responsibility of Gaz de France (GDF) and Total Infrastructures Gaz France (TIGF); in Italy, storage sites are in charge of Stoccaggio Gas Italia SpA (STOGIT) and Edison SpA.

Underground storage sites in Russia are projected to smooth seasonal gas demand variations and, in some provinces, are the only gas sources during the winter. The presence of the company Gazprom is strong in that sector, as well as in the gas industry as a whole. It is important to point that gas is responsible for almost 55% of the Russian energy matrix.

4. International Regulatory Aspects on Underground Natural Gas Storage

This section presents the main rules for underground natural gas storage or even for the gas sector in nations that are notable for maintaining several storage sites or huge volumes of gas kept underground, covering aspects related to the construction and operation of storage facilities. The nations considered in the present section are the USA, Canada, France, Germany, Russia, Italy and also the Directives of the European Union (EU).

Regulation of Underground Natural Gas Storage in the USA

North-American geological storage sites are under the jurisdiction of the federal regulatory body, the Federal Energy Regulatory Commission – FERC, when operated by inter-state companies or when they offer inter-state commercial services. Local or State underground storage sites are, by the other hand, regulated by State Agencies or Commissions. The FERC is also responsible for inter-state gas pipelines, as well as local authorities or commissions are responsible for intrastate pipelines.

In the USA, when a natural gas company decides to construct and operate gas pipelines or storage facilities, it is necessary to obtain a certificate of public convenience and necessity, issued by the FERC, before engaging in the project. In determining whether to issue a certificate, the FERC will balance the public benefits of the project against the project’s potential adverse consequences to the community. The natural gas company must also demonstrate that the pipeline will comply with applicable environmental laws. The FERC may authorise temporary certificates of public convenience and necessity in the event of an emergency. Additional federal, state and local authorisations may be required as well, depending on the location of the pipeline. Additionally, companies that engage in interstate pipeline or storage facility operations must file a tariff with the FERC that describes the conditions, rates and terms of service. The rates and terms must be reasonable and non-discriminatory (Global, 2006).

It is important to mention that with the passage of the Energy Policy Act of 2005 (EPAct 2005), Congress amended the Natural Gas Act to require the Federal Energy Regulatory Commission (FERC) to coordinate the environmental review and the processing of all federal authorizations relating to proposals for natural gas infrastructure under the FERC’s jurisdiction (pipelines, storage fields, compressor stations, liquefied natural gas facilities, etc.) and to maintain a consolidated record for any subsequent appeal or judicial review (FERC, 2009).

After the issuing of FERC Order 636, a significant change occurred for the transportation and storage gas sector. This new rule established the unbundling of sales and transportation (storage) services, in other to improve competitiveness for the gas industry by separating the property of the gas from the delivering activity (Global, 2006 & FERC, 2004).

The FERC regulations mandate that access to interstate natural gas transportation and storage services shall be provided to customers on a non-discriminatory basis (non-restrictive and fair taxes and conditions for all players), with the aim of creating an efficient response to market demand for such services. This is the “open access” concept, existing in the USA, whose one’s of the most important targets is to improve competitiveness of the gas markets. When the capacity of interstate transportation and storage is limited, additional capacity is offered through a bidding process. Finally, it is important to point that the information on those services must be provided quickly and easily accessible by all.

Regulation of Underground Natural Gas Storage in Canada

In Canada, just like in the USA, there is a federal regulator and provincial public bodies. The National Energy Board – NEB is responsible for the regulation of interprovincial and international pipeline transport, but, differently from FERC, storage sites are not under the jurisdiction of NEB. Intraprovincial transportation is regulated by provincial agencies and storage services are generally unregulated if not integrated to the distribution system of gas. In that case, they are under the jurisdiction of the provincial regulatory body.
The National Energy Board Act provides that all pipelines are common carriers and pipeline owners have an obligation to receive, transport and deliver all gas offered for transmission through the pipeline. The Act also prohibits unjust discrimination in tolls, service or facilities against any person or locality. Where excess capacity exists along a pipeline, it is allocated through a queuing system or ‘open season’ procedure. Since storage facilities are largely unregulated, access is currently determined by the policies of the companies owning the facilities (Global, 2006).

Regulation of Underground Natural Gas Storage in the European Union (EU)

Gas regulatory framework in countries like France, Germany and Italy, important nations for the geological gas storage market, was conceived according to principles discussed at and issued by the European Union (EU), an economic and political partnership between 27 European countries. So, it is important to analyze the regulatory aspects of the EU as a whole before studying the characteristics of some of its members.

One of the most important rules related to natural gas in the EU is the Directive 2003/55/CE (also called the Acceleration Directive) of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in natural gas and repealing Directive 98/30/EC. The Acceleration Directive builds on this framework by introducing, among other matters, a mandatory system of regulated third-party access to gas infrastructure, greater separation of companies’ gas production and supply activities from their infrastructure-based activities, and the establishment of a common minimum set of responsibilities for national regulatory authorities. This directive also includes underground natural gas storage.

In particular, the Directive 2003/55/CE provides (Global, 2006 & EU, 2003):

(i) for the right for all gas customers to choose freely their supplier by 1 July 2007 (Article 23);
(ii) for third-party access to gas transmission and distribution networks on the basis of published and regulated tariffs (Article 18);
(iii) access to gas storage facilities on either a negotiated or regulated basis (Article 19);
(iv) for legal unbundling of gas transmission and large and medium-sized distribution companies (Articles 9 and 13).

The organization and the property of the natural gas transportation and storage structures are partially regulated by the EU. Since July, 2004, vertically integrated companies had to separate transmission and production activities, due to the new principle of unbundling, introduced by the Directive of 2003. Some Member States have created totally separated companies for network operation, while others have created legal entities within vertically integrated companies. The unbundling rules of the Directive 2003/55/CE, according to the Directive itself, shall not prevent the operation of a combined transmission, LNG, storage and distribution system operator, which is independent in terms of its legal form, organization and decision making from other activities not relating to transmission LNG, storage and distribution system operations.

For the countries of the EU that grant authorization (as a unilateral administrative act of a government authority) for the construction and operation of gas pipelines and storage facilities, the denying or the issuing of authorizations shall be done according to objective, transparent and not-discriminatory criteria. If the granting of an authorization is denied, the applying company as well as de European Commission shall be informed on the reasons of the refusal.

According to the Directive, the third-party access to storage facilities can be regulated or negotiated, and it is up to Member States the choice between these two options. Regulated third-party access means that eligible customers can require access to the relevant facilities on the basis of published tariffs, or through a non-discriminatory and transparent auction procedure. In a system of negotiated third-party access, the access conditions are negotiated freely between the eligible customer or supplier requesting access and the storage system operator. The storage system operator must, however, publish its main commercial conditions for use of the system. In addition, the Commission and the European Regulators Group for Electricity and Gas (ERGEG) have jointly formulated the Guidelines for Good Third-Party Access Practice for Storage System Operators, which entered into force on 1 April 2005 (the Guidelines). The Guidelines, which are non-binding, intend to provide a minimum set of rules required for the organization of the market for storage capacity, which was excluded from the scope of the Regulation (Global, 2006).

Access to a downstream transportation or storage facility can be refused in four circumstances:

(i) Lack of capacity: A refusal based on lack of capacity must be duly reasoned. Vertically integrated companies are not permitted to discriminate between users, particularly in favor of related undertakings, when granting capacity.
(ii) Public service obligations: A company may refuse access where allowing access would prevent it from carrying out its public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies, and environmental protection, including energy efficiency and climate protection (EU, 2003);

(iii) Take-or-pay contracts: A company may refuse access on the basis of serious economic and financial difficulties with take-or-pay contracts. Where access is refused on this basis, the company must apply to the relevant national authority for a temporary exemption from the third-party access obligation, which will be considered on the basis of various strict criteria.

(iv) Major new infrastructure: The Acceleration Directive has introduced the possibility of obtaining an exemption from the obligation to provide TPA to major new infrastructure (which is defined as comprising LNG and storage facilities and interconnectors between member states only) and infrastructure, which has been subject to significant modifications or increases in capacity (Global, 2006).

Finally, it is important to mention that there is a Proposal (COM(2007)529) for a New Directive of the European Parliament and of the Council that amends and revises the Directive 2003/55/EC. According to the Explanatory Memorandum of the Proposal, there will be some changes, if the text passes, like:

(i) Total separation from transportation/distribution and production/supply activities. In other words, ownership unbundling. However, where the transmission system belongs to a vertically integrated undertaking, an independent system operator shall be designated by the Member State;

(ii) Making the principles in the Guidelines for Good Third Party Access Practice for Storage System Operators' (GGPSSO) legally binding;

(iii) Establishing legal and functional unbundling of storage system operators who are part of supply undertakings;

(iv) Enhancing the powers of national regulatory authorities to oversee access to storage;

(v) Requiring clarity on the regulatory regime that is applied to storage facilities.

The Directives and Regulations will be published in the Official Journal of the EU in August 2009 and enter into force on the twentieth day following that of their publication. The Electricity and Gas Directives have to be transposed into national law 18 months after entry into force with the exception of the rules on unbundling of transmission, which are to be transposed after 30 months (EU, 2009).

**Regulation of Underground Natural Gas Storage in Germany**

Administrative competence in respect of the natural gas sector rests predominantly with the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (Bundesnetzagentur – FNA) at federal level and the regulatory authorities of the 16 federal states, which are monitoring the requirements with regard to unbundling, network connection and network access (production and storage/transportation infrastructure. In addition, the Federal Cartel Office (Bundeskartellamt – FCO) – as the federal competition authority – and the competition agencies of the federal states remain key players in liberalizing the gas sector by applying their ex-post powers of control under competition law (Global, 2006).

In accordance with the EU Directive 2003/55/EC, the Energy Industry Act (Energiewirtschaftsgesetz) requires legal, functional and accounting unbundling of network and storage activities from other activities of a vertically integrated utility and comprises rules ensuring the preservation of sensitive commercial information. According to the Energy Industry Act, the construction, operation or modification of gas transportation pipelines with a diameter of more than 300mm requires permission on the basis of an environmental impact assessment or an obligatory planning procedure. The permission includes, in general, also other environmental and construction issues. In addition, depending on the project, other administrative law requirements such as regional planning procedures may have to be observed. Under the amended Energy Industry Act, the commencement of network operations is subject to regulatory approval of the energy agency of the respective federal state. The approval can only be refused if the applicant does not provide for sufficient staff or the technical and economic capability and reliability to operate the network in accordance with the regulatory requirements.
In July 2005, the legislator established a regulated network access regime. Operators of gas networks have to grant access on a non-discriminatory, objective and transparent basis. In addition, the Energy Industry Act forces grid operators to open their network for third party access at terms that are not less favorable than the conditions for services within their own company, or to affiliated or associated companies in comparable cases. Access may only be refused if it would be technically or economically unreasonable or impossible. Any refusal of network access has to be justified in writing and notified to the responsible regulatory authority. Upon request of a gas utility it is for the regulator to decide whether the transportation network operator can invoke unreasonableness of network access as a consequence of take-or-pay obligations.

In contrast to the access to transportation services, access to upstream pipeline networks and storage facilities shall continue to be organized on the basis of negotiated third-party access. In essence, negotiated third-party access to upstream pipeline networks and storage facilities has to be granted if the access is technically or economically necessary towards obtaining efficient network access (Global, 2006).

**Regulation of Underground Natural Gas Storage in France**


The French market is regulated by the Energy Regulation Commission (Commission de Régulation de l’Energie – CRE). The CRE is an independent administrative authority in charge of ensuring that producers and eligible consumers can access the public grid under fair and non-discriminatory conditions. The CRE also elaborates the accounting principles relating to the unbundling of generation, transmission and distribution activities and monitors their implementation to avoid any discrimination, cross-subsidization or any other restriction of competition. The policy for natural gas is set by the minister for energy. In general, the policy focuses on three main objectives: ensuring security and continuity of supply; allowing energy utilities to obtain energy at the lowest price in order to remain competitive on foreign markets and to offer favorable conditions to their customers; and ensuring the compatibility of the energy policy with environmental constraints (Global, 2006).

The construction and operation of a storage site are subject to an authorization delivered by the French minister for energy. A company, having received the authorization from the minister for energy as regards the construction of transportation pipeline or a storage facility, does not need to obtain the rights to construct on the land concerned. The grant of this right is contained in the authorization itself. The above-mentioned 9 August 2004 Act has introduced a principle of access to the storage facilities. Access may be refused for technical motives or lack of capacity; the possibility to refuse access is also given in cases where it can be demonstrated that the access to storage is not technically or economically necessary to allow an efficient supply of customers.

In order to guarantee transparent and non-discriminatory access to transport and storage gas facilities, grid managers have worked out standard-term contracts made available on their websites. The CRE may take part in the drafting of these contracts, but cannot make a decision on their content. The regulator must, however, make sure that standards clauses are not potentially discriminatory. Moreover, contracts must be sent to the CRE to check that they comply with standard-term contracts.

Storage contracts state general terms and conditions such as prices, quantities, duration and force majeure. They also include daily minimum and maximal stock, injection and withdrawal daily capacities (Global, 2006).

It is important to mention that natural gas production is very limited in France: the needs are mostly met by resorting to imports.

**Regulation of Underground Natural Gas Storage in Italy**

Since 1 January 2002, transport activities have been subject to mandatory legal separation from all other gas industry activities, except for storage activities that must in any case be separate in terms of accounting and management from transport activities. Hence storage activities are subject to mandatory company separation from all other gas industry activities except transport. Distribution activities are subject to legal separation from all other gas industry activities (Autorità per l’Energia Elettrica e il Gas – AEEG, 2008).
The directives of the UE, as in France and Germany, are already implemented in Italy by laws and administrative measures. The Directive 98/30/CE was implemented by Law Decree nº 164/2000, also known as Decreto Letta, of may/23rd/2000, whose main objective was the reduction of natural gas prices and the competitiveness improvement (AEEG, 2005). The liberalization, that is, the opening of the gas sector to private investors, took place at all steps of the natural gas chain. The Decreto Letta, issued before the Directive 2003/55/CE, anticipated some regulatory themes like the unbundling of monopolistic activities from those that can be considered competitive, the access to infrastructure, including underground gas storage sites (Stogit, 2009 and AEEG, 2005).

The liberalization process has continued after the issuing of the Law nº 239/2004, from august, 2004. The main objective of that Act was make clearer the relationship between the Italian regulatory authorities and the operator of the sector, in order to simplify the authorization processes, in accordance with the principles of competitiveness promotion and public safety. This Law Also introduced some exceptions for third-party access to infrastructure, in case of new gas pipelines (AEEG, 2005 and Global, 2006).

The Italian body responsible for the regulation of the natural gas sector is the Autorità per l’Energia Elettrica e il Gas – AEEG, that, with the Ministry of Economic Development (Ministero dello Sviluppo Economico, who was the Ministry of Productive Activities, or Ministero delle Attività Produttive, up to 2006), the Italian Competition Authority (Autorità Garante della Concorrenza e del Mercato – AGCM) have different competences in the gas industry. In general, all of these bodies’ policies are aimed at ensuring the swift completion of the liberalization process, promoting competition and assuring gas supply (Global, 2006).

In order to construct natural gas transportation pipelines, an authorization of the Ministry of Economic Development and a positive environmental impact assessment are necessary (the latter only if the pipeline is longer than 40 kilometers and has a diameter exceeding 800 millimeters). Natural gas storage, on the other hand, is operated under a concession regime. These concessions are issued by the Ministry of Economic Development with a 20-year term, and require a positive environmental impact assessment. Under Law No. 239/2004, storage concessions can be renewed only twice for 10 years per renewal. The Ministry of Economic Development has recently issued rules for the transfer of exploitation concessions or existing storage concessions to new storage concessionaires, but, as far as this job could research, none of them are already operational (Global, 2006 and AEEG, 2008).

Natural gas transport and mining, strategic and modulation storage are activities of public interest and the respective services are to be provided on a non-discriminatory basis to any requesting entities. Interconnection and provision of storage services are mandatory only if technically and economically feasible. In the event of an unjustified refusal of interconnection or provision of storage services, the AEEG – having heard the transportation company – can order that the requested interconnection or storage service is made or provided. The powers of the AEEG do not preclude the competence of the Competition Authority in this field (ie, regarding the possible abuse of a dominant position). Access to the national gas system must be granted for any quantity of natural gas, unless there is no available capacity. Access can be denied if the grant would prevent transport companies from fulfilling their public service duties, or if the said transport capacity is necessary to transport natural gas purchased under take-or-pay agreements entered into before the implementation of the EU Gas Directive. Access and storage can never be denied to domestically produced natural gas. Refusal of access must be explicit and shall be communicated by the transport company to the AEEG, to the Competition Authority, and to the Ministry of Economic Development (Global, 2006).

**Regulation of Underground Natural Gas Storage in Russia**

Natural Gas Industry in the Russian Federation is highly influenced by Gazprom (Газпром, in Russian alphabet). Gazprom is a natural quasi-monopoly for gas production and transportation. Its share of the Russian GDP is 8 per cent and Gazprom tax payments comprise more than 20 per cent of all tax revenues of the Russian Federation. Gazprom also produces over 90 per cent of the total Russian gas production (Global, 2006).

Acting as a regulatory authority, the government controls the licensing process, gas prices and gas transportation tariffs. Transportation and storage are controlled by the Unified Gas Supply System – UGSS (Единая система газоснабжения – Ecr, in Russian) that comprises about 155 thousand kilometers of gas pipelines, 268 compression stations and 24 underground natural gas storage sites. Ecr is owned and operated by Gazprom and, in order to operate and maintain the storage sites, it has more than 10 subsidiaries (Global, 2006 and Gazprom, 2006).
To construct a natural gas transportation pipeline a general construction license is required from the Federal Agency for Construction and Housing Infrastructure (the former State Committee on Construction). The Federal Ecology Technology and Atomic Supervision Service – FETASS controls compliance with industrial safety requirements during construction. Transportation of gas through trunk pipelines, use of trunk pipelines and storage of natural gas require licenses from the FETASS. Transportation of gas through trunk pipelines, use of trunk pipelines and storage of natural gas require licenses from the FETASS, which can be issued for five years.

Pursuant to government Regulation No. 858 dated 14 July 1997, Gazprom provides independent suppliers with access to the UGSS subject to the following:

(i) The availability of spare transportation capacity;

(ii) Adequate quality and technical characteristics of the natural gas (in accordance with standards adopted by Gazprom);

(iii) The availability of secondary routes for the supply and offtake of natural gas.

The legislation establishes the following order of priority for independent suppliers when spare transport capacity is not sufficient to satisfy all applications. First, access is granted to those suppliers who sell natural gas to the public utilities and for household needs. Second, to those who supply natural gas on a long-term basis. Applications of other suppliers are to be satisfied in accordance with anti-monopoly legislation or on a pro rata basis.

There is no legal right to demand access to storage facilities. Relations between operators of storage facilities and owners of natural gas are governed by an agreement between them in accordance with government Regulation No. 162 dated 5 February 1998 (GLOBAL, 2006).

5. Brazil and geological natural gas storage: the security of supply

As mentioned before, Brazil still does not have any underground natural gas storage site as part of its gas infrastructure for transportation. However, there are some few studies that search for suitable geological structures and point some reasons for the development of gas storages in Brazil.

The studies published by Appi, Goraieb and Iyomasa (Brazilian researchers), in 2005, searched for geological structures at the Parana Basin, State of Sao Paulo, in the Southeast region of Brazil, along the GASBOL gas pipeline way. Aquifers were the main targets of the research, for this is not a region of oil or gas production, therefore, a place where depleted oil and gas fields cannot be found. For these structures, the researchers analyzed: (i) the distance from the geological site to GASBOL pipeline; (ii) the distance to gas markets; (iii) the storage capacity and (iv) the aquifer’s capability to keep gas within.

Based on these researches and on the characteristics of gas consumption in Brazil, it can be said that storage sites developed in aquifers would have strategic purposes, improving the security of gas supply in case of technical, economical or political emergencies. In the last decade, the Brazilian gas market showed an impressive growth, which resulted in the construction of new pipelines and facilities to treat and transport the gas. In many countries, the growth of gas infrastructure came with measures to improve the security of supply. For example: in order to mitigate risks, Spain established the diversification of gas sources, building regasification facilities and determining maximum percentages of gas imports from a single supplier. Brazil also depends on gas imports, specially on Bolivian gas, and has recently built two regasification terminals, in Rio de Janeiro (RJ) and in São Gonçalo do Amarante, State of Ceará (CE). So, the siting of storage facilities would certainly make the gas network more secure and safe, as a whole.

In terms of function, it is also important to remark that the seasonal balance, necessary in Europe and North America due to their typical consumption profile (higher consumption during the winter and lower during the summer), would not lead to the development of Brazilian storages. However, as mentioned by Appi, Goraieb and Iyomasa, geological storage could be useful to assure gas supply during peaks of thermoelectric demand. In Brazil, thermo plants operate when hydropower generation is not enough to cope with the need for electricity. During periods of higher levels of water stored in hydropower plants, gas could be stored underground and, during lower levels, gas could be used for electricity generation.

Figure 3, from Appi, Goraieb & Iyomasa studies, illustrates the use of underground natural gas storage for thermoelectric generation, as explained in the previous paragraph. This figure shows, in the left, gas being conducted to a storage site (indicated as ESGN1, the Portuguese acronym for Underground Natural Gas

1 ESGN – Estocagem Subterrânea de Gás Natural (Underground Natural Gas Storage)
Storage) during months without the operation of thermopower plants. During months with thermoelectric generation, gas feeds the thermo plant coming from both the pipeline and the storage site. It is important to notice that this configuration contributes to a more constant flow rate of natural gas in the pipeline, avoiding unnecessary extra-dimensioning of the facilities and allowing smoother operational procedures.

Figure 3 – Underground Storage Sites Operation (ESGN) during months without (left) and with (right) thermoelectric generation.


The natural gas regulatory framework in Brazil, up to the beginning of the current year, was part of the valid existing rules for the petroleum industry, not taking into consideration the typical characteristics of the gas sector. However, on March, the 4th, after about five years of discussion in the Brazilian National Congress, the new Gas Act was issued, obviously respecting the Brazilian Federal Constitution and complementing the existing Petroleum Act (Law number 9.478/97).

The Federal Constitution (FC) determines the borders between federal and state regulation for natural gas. The regulation of the natural gas distribution through pipelines is in charge of state agencies, according to the Article 25 of the FC, while the regulation of exploration, production, treatment, transportation, import and export of gas (as well as petroleum and petroleum products) are under the responsibility of the federal regulatory body, as established by the Article 177. It is important to remark that all sectors of the petroleum industry – including distribution and sales activities, instead of what happens with natural gas, are regulated by the federal agency.

Up to the year of 1995, only state owned companies (like Petrobras, for example) were allowed to carry out the activities of exploration, production, refining, processing, transportation, exportation and importation of petroleum, petroleum products and natural gas. However, the Constitutional Amendment Nº 9 included the term “private companies” to the Constitutional text, also allowing them to carry out those activities. This legal change is considered the implementation of the monopoly flexibility. The Amendment also determined the issuing of a new law to regulate the new proposed industry configuration, and that happened on august of 1997, when the Law nº 9.478/97, The Petroleum Act, was published.

The Petroleum Act is the last decade’s most important regulatory mark for the fossil fuels industry in Brazil. This Law defined the National Council of Energy Policy (CNPE), created the federal regulatory body – The National Petroleum, Natural Gas and Biofuels Agency (ANP), among other establishments, like setting rules for the concession of areas to be explored and destined to production, as well as the distribution of governmental takes. The Act also brought new concepts, like the unbundling of production and transportation activities and the open access to transportation facilities (Articles 56, 57 and 58, Chapter VII – On The Transportation of Petroleum, Petroleum Products and Natural Gas). Finally, specific activities, like, for example, the requirements for the construction and operation of an oil pipeline, the quality standards for gasoline, the conditions for building an oil refinery, among others, are regulated by Orders issued by ANP (Brazil, 1997).

As a result of the increase of natural gas participation in the Brazilian energy matrix and, consequently, the growth of gas infrastructure, it was perceived the need for specific and strong rules for the gas sector. Precisely, a new Natural Gas Act or Law that could be able to promote new gas projects and investments, by
the setting of clear and suitable rules for the growth and competitiveness of the sector. According to that philosophy, some Act Proposals were debated at the Brazilian House of Representatives and Senate and one of them, proposed by the Ministry of Mines and Energy (MME), prevailed and was approved by the Brazilian House at the end of 2007 and by the Senate at the end of 2008. Finally, on March, it was signed by the President of the Republic and published as Law nº 11.909/09, also called the “Gas Act”.

One of the most important changes brought by The Gas Act is the establishment of the concession regime, preceded by bidding, for the construction and operation of new gas pipelines. Before the Law nº 11.909/09, all natural gas pipelines were authorized by the ANP, but, now, the authorization regime is an exemption: only natural gas pipelines involved in international agreements are subject to authorizations. Taking into consideration that restriction, the definition on which regime will be applied is in charge of the Ministry of Mines and Energy (MME). Besides, the Gas Act determines the authorization regime to any gas pipeline project that had already applied for an environmental license before the issuing of this Law. In that case, the authorization is given by the ANP.

Concerning pipelines, it is important to remark that the Brazilian Gas Act:

(i) establishes that the MME, after hearing the ANP, will determine the period of exclusive use of the transportation facilities by the original gas producers or owners that made the construction of the pipeline possible (of the Article 3rd. 2nd paragraph);
(ii) establishes that the authorization or the bidding process that precedes the concession for the activity of transportation of natural gas will only occur after a public call that will determine the facility capacity as well as the effective demand (Article 5th);
(iii) determines that the authorizations and concessions will last for 30 years (Articles 10 and 26);
(iv) establishes that liquefaction or regasification units will be authorized by the ANP (Article 44);
(v) does not repeal the articles of the Petroleum Act (Law nº 9.478/97) that refer to gas exploration and production;
(vi) changes the Article 58 of the Petroleum Act, including LNG Terminals as exemptions for the open access rule;
(vii) comprises geological or underground storage (Chapter IV, Articles 37 to 42);
(viii) comprises contingency (Chapter VII).

Finally, it is important to mention that some articles of the Gas Act will only be effective after the issuing of a specific Decree of the President of the Republic, already under discussion.

7. Underground Natural Gas Storage and the Law nº 11.909/09

Up to the issuing of the Gas Act, there were few mentions about geological natural gas storage in the Brazilian regulatory framework. One of them is among the definitions of the Petroleum Act (Article 6 of the Law nº 9.478/97) where “Natural Gas Storage” is defined as Storage of natural gas in reservoirs, natural or artificial structures. The Law nº 11.909/09, on the other hand, dedicates an entire chapter on geological storage, deeply introducing the theme in the Brazilian legislation, even before the existence of any facility in the country.

The first mention on geological storage in the new Gas Act is, as in the Petroleum Act, among the definitions and the text used to define “Natural Gas Storage” in the Law nº 9.478/97 is slightly changed in the Law nº 11.909/09 as following: Storage of natural gas in natural or artificial reservoirs. Then, there is an entire chapter dedicated to gas storage entitled Chapter IV: On the Storage and Packing of Natural Gas. The Article 37, within this chapter, determines that the activity of natural gas storage will be carried out by a company or consortium of companies, established under the Brazilian laws, having their headquarters and administration in Brazil, at their own expense and risk, through concession, preceded by bidding process, or through authorization. Articles 38 to 40 indicate if a storage site will be conceded or authorized. According to Article 38, if gas is stored in a hydrocarbon reservoir returned to the Brazilian Union (usually after getting exhausted during the period they were conceded to any company to produce oil or gas), then the activity is under the concession regime, as well as if the storage is carried out in a non-hydrocarbon geological structure, like, for example, an aquifer. Article 40 determines that any storage carried out in different structures from those indicated at Article 38 will be authorized by the ANP. It can be inferred that Article 40 refers to salt caves or domes.

The choice of the structures that will take part in a bidding process will be determined by the MME or by ANP, if delegated by the Ministry. The bidding itself, will be organized by the ANP, that, by delegation of the MME, will also sign the concession contracts.
The 4th paragraph of the Article nº 38 determines that the MME, after hearing the ANP, will define the period of exclusive use of the facilities by those companies whose contracted capacity have made the implementation of the storage possible. This paragraph, therefore, introduces the concept of open access to underground natural gas storage in Brazil.

Other important determinations of the Law, regarding underground natural gas storage, include (Brazil, 2009):

(i) The volume of natural gas stored is not property of the Brazilian Union. This is a particularly important text of the 5th paragraph of Article nº 38, because the Brazilian Federal Constitution determines that the hydrocarbons reserves or any other natural resource of the subsoil is owned by the Brazilian Union. However, natural gas stored has obviously not originated in the structure it is kept within, being, therefore, not a property of the Union;

(ii) The ANP will provide, after payment, geological data of the structures to be analyzed and to confirm whether the structures are suitable for gas storage;

(iii) Exploration and researches for the assessment of sites may only occur after being authorized by the regulatory body (ANP). Data obtained during the research will be gratuitously given to the ANP;

(iv) Exploration and production of methane associated to coal will be under the concession regime and the contracts will be signed by the ANP and by the company who has the right to explore the coal reserve (new paragraph introduced by the Gas Act in the Article nº 23 of the Petroleum Act);

(v) The packing of natural gas or, in other words, the storage of natural gas in tanks or trucks, for example, will be regulated by the ANP (Articles 41 and 42).

8. Conclusion

The issuing of the Gas Act is very recent and, therefore, the results of the new framework for the natural gas industry cannot yet be assessed. On the other hand, it can be said that, after the publishing of the Law nº 11.909/09, Brazil has established clear and strong rules that are, for many companies, either Brazilian or foreigners, a prime requirement for huge investments.

It is important to remark that the open access, already part of the US and Europe’s regulatory framework have been included in the Brazilian Gas Law (Article 38). Other interesting characteristics, already existing in the Petroleum Act (for exploration and production of oil and gas) as well as in the Italian laws, is the concession regime for geological storages. This regime establishes obligations between the investor and the conceder (the Brazilian Federal Union), while the authorization regime, in Brazil, is a unilateral administrative act of a government authority. The concession regime in Brazil is considered therefore, safer and clear for companies, who will have the right to explore the activity with conditions previously agreed during a determined period of time, and for the government, for the storage will be implemented. It is important to remark that the authorization regime does not obligate the company to effectively construct and operate any facility.

Regarding unbundling, for pipelines, the 3rd paragraph of the 3rd Article of the Gas Act establishes that the company or the consortium of companies, either authorized or concessionaires for the transportation of natural gas, can only execute the activities determined by the Article 56 of the Petroleum Act (that refers to petroleum, petroleum products and natural gas transportation by any modal), storage, biofuels transportation, construction and operation of terminals. So it seems clear that, according to this limitation, imposed by the 3rd Article of the Gas Act, it is not allowed to gas companies to execute other activities like, for example, the exploration and production of oil or gas. Therefore, it can be said that the unbundling concept is included in the Gas Act for pipelines.

On the other hand, the chapter of the Law nº 11.909/09 that contains the articles on underground or geological natural gas storage (or simply “storage”, for the Gas Act) does not seem to limit or make any restriction to companies that become storage concessionaires in terms of the execution of other activities. However, it is early to say whether the activities of production and storage or even transportation and storage will be unbundled. It will be necessary to wait for the President’s Decree, as well as for regulatory orders (both from the MME and the ANP) and legal interpretations that may come with the first companies’ applications for the siting, construction and operation of storage sites.

Finally, it can be said that the most important and strong legal part of the regulatory framework regarding geological storage, the Gas Act already issued, can be considered one of the most important incentives and
requirements for the huge investments usually necessary to implement natural gas storage sites. However, the first applications for storage projects will also depend on economic and politic matters and on situations when the volume of gas produced plus the volume of gas imported is higher than the volume of gas consumed. Nowadays, Brazil still strongly depends on the imports of natural gas\(^2\), but that may change after the recent discoveries of huge oil and gas reserves in the Brazilian ocean platform. Besides, storage may be important to strengthen Brazilian natural gas infrastructure, providing gas if any pipeline operational failure occurs or if supply is threaten by any other reason, like operational problems in the production fields or political/economical issues.

After the issuing of the Petroleum Act, last decade, the production of oil and oil reserves discovered have grown more than 100% and 78%, respectively. Similar results are expected after the establishment of specific rules for Natural Gas sector. Today, there are approximately 8,000 km of gas pipelines in Brazil, a small number, if compared to mature gas markets.

\(^2\) During 2008, Brazil had to import about 29.7 millions of m\(^3\)/day of natural gas. Almost all of that volume came from Bolivia, but there are already two LNG terminals under operation that are able to provide about 21 millions of m\(^3\)/day (ANP, 2009 & MME, 2009).
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