15

Looking for clean energy considering LNG assessment to provide energy security in Brazil and GTL from Bolivia natural gas reserves

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This work aims to identify market opportunities for LNG in Brazil as a complement to natural gas supply, characterizing it both on its production and transportation side and analyzing costs and prospects for expanding the supply and use infrastructure so as to ensure that the growing demand of this energy input is met and allow greater flexibility for the natural gas industry and the power sector, with an idea about risk sources and protection mechanisms used to ensure the reliability of power generation, gas market flexibility and the need for LNG supply planning considering the spot and/or long-term market.

Another aspect approached is the economics and the viability of Natural Gas Industrialization in Bolivia, by producing secondary fuels such as GTL-diesel from natural gas (cleaner than the oil byproduct), seeking a clean development from the environmentally correct use of power by this GLT process. Bolivia has resources that could supply these secondary energy resources as from GTL. It is possible to process 30MCMpd of gas obtaining profits from the gas and also from the liquid hydrocarbons that are found in it. The Bolivian GTL would present the following advantages: It would export diesel and/or gasoline and would not have to import it anymore; the GTL-FT exports could reach 35Mbpy, acquiring competitive prices; It would increase productive jobs not only due to GTL itself, but also due to secondary economy linked to the GTL market; The use of GTL-FT diesel would provide a "cleaner" environment especially in the urban areas; Finally, from the macroeconomic perspective, the investment in the plant construction and supporting works would generate a great number of jobs.

Energy resources play a fundamental strategic role in the development of a country and its economic activity. The worldwide tendency of increasing demand for energy, especially in developing countries - such as Brazil and or Bolivia - made energy resources achievement and supply a critical issue for the continuity of socioeconomic growth. To assure the availability of these resources so as to guarantee the future of the economy, of the

environment and of the society as a whole is a constant challenge. In this sense, all the factors involved that determine or make security and availability exist over time must be highly relevant, as well as the planning of energy supply and use.
Natural gas (NG) is a fossil fuel, formed by hydro-carbons that can be found in nature in an isolated way or associated to oil. Formed mainly of methane, its advantage is to have low amounts of contaminants, such as nitrogen, carbon dioxide, sulfur composites and particulates, which make its combustion be considered clean. Moreover, it has high calorific power, allowing its direct use, without the need of refining.
In that sense, a technical and economic analysis of secondary fuels from hydrocarbons is conducted in order to identify the possibility of manufacturing the Bolivian Natural Gas using GTL to produce byproducts. The energy economics analysis of LNG is also made viewing energy security in Brazil. Technically and economically speaking, it is important to identify the industrialization, technology investment amounts and production costs of a GTL and or LNG project. Commercially speaking, the aim is to identify the current and future situations of GTL and LNG in the market and what that represents. From the energy economic point of view, the intention is to determine the financial issues (amounts, interest fees, benefit periods) linked to investments in GTL and/or LNG. Legally and politically speaking, the present legal situation will be compared to the most appropriate regulatory issues related to natural gas conversions, both chemical (GTL) an physical (LNG).

Keywords:
LNG, natural gas, energy, energy planning, power, GTL, Diesel, secondary Fuels, Reserves, Clean Development, Energy Resources, Generation, Gas-Chemical, Gas Byproducts

1. LNG and its Production Chain

A LNG project basically has four stages, also called production chain: natural gas exploration and production (E&P); next come the liquefying process, transportation to the import terminals and, finally, regasification.

1.1 Natural Gas Production

Liquefied natural gas (LNG) is essentially natural gas (NG), cooled at a certain temperature below its vaporization point. Thus, the LNG productive chain starts in the exploration and production of natural gas.
At this initial exploration phase, there is a close relation between the NG and petroleum industries. This occurs because usually, in the same basin, there may be gas together with petroleum, either dissolved or as a gas layer formed in the upper part of the deposit. In this case, it is said that natural gas is “associated” to petroleum. In turn, the so-called “non-associated” gas is the one found in fields where there is very little or no petroleum, allowing only the exploration of gas. This way, the geological research efforts to locate these fields, as well as the drilling, development and exploration technologies may be shared between the two industries.
The exploration process is divided into geological and geophysical research and drilling. In the research phase, an analysis is made on the rocky structures and on the underground of the region where petroleum and/or gas is being sought, which allows selecting the drilling

sites. Drilling is part of proving the existence of compounds (oil and/or gas) and its economic viability for later exploration.
After the discovery of a basin, and the analysis of the economic viability of the field, comes the production process. With similar characteristics and technologies, petroleum and NG prospections are jointly conducted, so as to provide the exploration of the two compounds. During NG production, the primary purification process of the gas also occurs, when liquids (water and others), particulate matter and contaminants (sulfur) are separated, so as to make NG adequate to be conveyed to the processing unit.

1.2 Liquefying

The natural gas liquefying plant is the main stage in the LNG production chain. In it, the temperature of natural gas is reduced to -162º C, which is below the vaporization point of methane. Hence, the methane gas turns liquid and its volume is reduced to 1/600 of the original volume.
The liquefying plant is usually built in coastal areas, in bays, so that it facilitates the production outflow by vessels, thus making it also desirable for the plant to be close to the NG producing fields, as the transportation price via gas pipelines is considerable and, depending on the distance to be covered, it may increase the global costs of the project.
The premises composing the liquefying plant are: a gas processing unit (UPGN) in case the gas has not been previously processed with the separation of components of greater commercial value and the standardization of the product global composition. The gas is then dehydrated and broken down, so that hydrocarbons are separated: processed or dry gas (essentially methane), ethane, GLP (propane and butane) and C5+ components (especially natural gasoline). This way, the natural gas processed is led to the liquefying stage in a set of heat exchangers and LNG storage tanks.
The liquefaction of NG is conducted at several stages of gas cooling until the cooled liquid is obtained in a process similar to that of a conventional refrigerator. A cooling gas extracts heat from the NG by means of heat exchangers in parallel sets, forming liquefying trains until this gas is cooled at a temperature of -162ºC.
Propane is the main cooling gas, leading the NG temperature to -30ºC; the gas will go through other cooling trains in which nitrogen, associated to other hydrocarbons, act as secondary coolers, making NG go below the vaporization temperature.
The technology that uses propane as initial cooling gas is the most commonly used and gained the market along the evolution and diffusion of LNG in the world market, incorporating several technological improvements, mainly concerning cooling compression turbines, which account for a large share of the plants operational cost and their efficiency, allied to increase in power and environmental improvement in the use of cooling gases, besides the development of much more efficient thermal insulating materials, which revest the storage tanks, were essential for the growth in the insertion of LNG as a viable option to natural gas.
The storage of liquefied NG is made in tanks with compression and re-liquefying systems to recover the gases that leak from stocking and resume the gas state; the logistics of liquefying, shipping and transportation forecasts is necessary for minimizing the stored volume, maximizing the LNG production and therefore mitigating losses from re-liquefying and storage.

1.3 Shipping

In order to convey the LNG between the liquefying and regasification plants, specially built vessels for storing gas in its liquid form are used, which count on large reservoirs capable of keeping the gas temperature during transportation. However, losses occur in this process varying from 1% to 3% of the initial volume, according to the distance to be covered, besides the consumption of the gas employed as fuel for the LNG Carrier Ship.

Figure 1 below shows the two types of vessels that convey LNG: the ones that store gas in spherical tanks and those counting on tanks in longitudinal positions; the costs between the two types is similar both in construction and in operation.

Fig. 1. LNG Carrier Ships

In function of its great meaningfulness for the world LNG industry, Japan concentrates a large share of the shipyards that build these types of vessels, and today it has European and Korean shipyards as competitors in this sector. The major producing companies are Daewoo Shipbuilding, Hyundai Heavy Industries, Mitsui Engineering & Shipbuilding, Samsung Heavy Industries, Kawasaki Shipbuilding and Mitsubishi Heavy Industries.

Besides LNG Carrier Ships, LNG can also be conveyed by smaller tanks, by means of trucks or trains generally used to supply peak, temporary or isolated demands when the development cost of a gas pipeline makes the gas supply too expensive.

1.4 Regasification

Regasification plants constitute the importation side in the LNG chain. They are usually located close to the natural gas consumer centers and harbor LNG Carrier Ships in especially built terminals. The plants are formed by LNG storage tanks and heat exchangers where LNG is again transformed into gas for distribution.

1.5 State of the Art of LNG in the World

The greatest world natural gas consumers count on a mature market and fully established infrastructure with maintenance characteristics in the development of both its infrastructure and demand making it necessary to transport natural gas from other producing countries up to the consumer countries. Hence, the LNG technology emerges an alternative to cover great distances.

These facts make an increment in LNG production by competitors be expected, owing to an increase in natural gas prices and to the reduction in LNG costs managed with improvements in the liquefying, storage and transportation technology, making business

with natural gas fields far away from the consumer centers economically interesting, which makes the construction of gas pipelines too expensive.
LNG consumers may use it as a logistic alternative to natural gas in countries that do not count on reserves or physical links with producing regions via gas pipelines, as is the case of Japan, the greatest LNG consumer in the world. Thus, it can be used as a guarantee of power supply in demand peaks, known as *'peak-shaving'* as is the case of the Unites States.

1.6 Major LNG Producers in the World

The EIA (*Energy Information Administration*) divided the LNG exportation industry into three geographical sectors: Pacific basin, Atlantic basin and Middle East basin[1].

1.6.1 Pacific Basin

The producing countries of this Basin are Indonesia, Malaysia, Australia, Brunei, Unites States and Russia, and Indonesia is the world leader in LNG production and export. Table 1 details each country export and its sales markets.
This Basin accounts for approximately 49% of the LNG world production.

Producer	Exports 2002 (TCF)	Exports 2003 (TCF)	Exports 2007 (TCF)	Major Consumers
Indonesia	1.1	1.4	1.4	Japan, Taiwan and South Korea
Malaysia	0.741	0.741	1.1	Japan, Taiwan and South Korea
Australia	0.367	0.572	0.747	Japan
Brunei	0.351	0.351	0.351	Japan, South Korea
Unites States	0.068	0.068	0.068	Japan
Russia			0.234	Unites States
TOTAL	**2.6**	**3.1**	**3.9**	

Table 1. Pacific Basin: LNG Production and Sales Markets

1.6.2 Atlantic basin

The main producing countries in this basin are Algeria, Nigeria, Trinidad and Tobago, Libya, Egypt and Norway, Algeria being the most important country in the LNG production. In Table 2, details of LNG exports in this basin can be observed.
The exporters in this basin produce about 29% of the LNG world production.

[1] The division of the LNG industry was made by EIA by means of *The Global Liquefied Natural Gas Market*, site: http://www.eia.doe.gov/oiaf/analisispaper/global/

Producer	Exports 2002 (TCF)	Exports 2003 (TCF)	Exports 2007 (TCF)	Major Consumers
Algeria	0.935	1.1	1.1	France, Belgium, Spain, Turkey and the Unites States
Nigeria	0.394	0.463	0.863	Turkey, Italy, France, Portugal, Spain and Unites States
Trinidad & Tobago	0.189	0.482	0.735	Unites States, Puerto Rico, Spain, and Dominican Republic.
Libia	0.021	0.021	0.021	-
Egypt			0.594	Italy and the Unites States
Norway			0.200	Spain, France, and the Unites States.
TOTAL	**1.5**	**2.1**	**3.5**	

Table 2. Atlantic basin: LNG Production and Sales Markets

1.6.3 Middle East

The producing countries in this basin are Qatar, Oman and the United Arab Emirates, and Qatar is the most important, as shown in Table 3.
The Middle East exporters produce about 23% of the LNG production.
Today, with the largest gas reserves ever found, Iran has great potential to export gas to markets in Europe, Asia, and India, both by gas pipelines and LNG.

Producer	Exports 2002 (TCF)	Exports 2003 (TCF)	Exports 2007 (TCF)	Major Consumers
Qatar	0.626	0.726	1.184	Japan, South Korea, Unites States and Europe
Oman	0.356	0.356	0.517	South Korea, Japan
Arab Emirates	0.178	0.278	0.278	Japan
TOTAL	**1.2**	**1.4**	**2.0**	

Table 3. Middle East: Production and LNG Sales Markets

1.7 Major LNG Consumers in the world

The LNG world market can be divided into two large zones; the Pacific and the Atlantic Basins.
Japan, South Korea and Taiwan are the main consuming countries in the Pacific Basin, which means about 68% of global imports; LNG is used to supply about 90% of the natural gas needs in these countries, making this type of fuel of vital importance for energy supply and security.

Fig. 2. Europe: Regasification Terminals for LNG Imports
Source: Energy Information Administration (EIA), The Global Liquefied Natural Gas Market

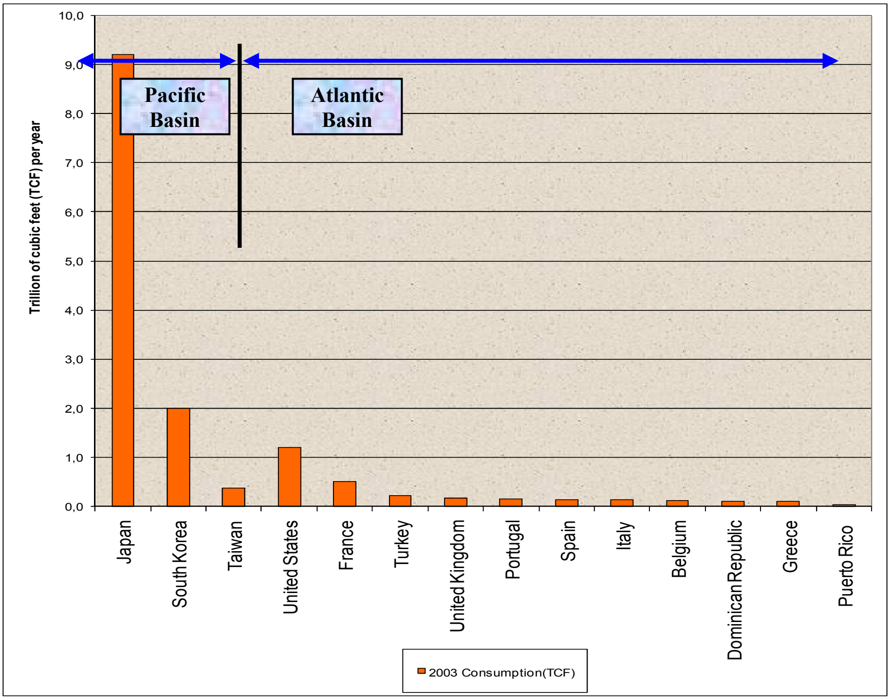

Fig. 3. World: LNG Consumers per Basin

Japan is the largest world consumer, importing around 48% of the world production, counts on 23 LNG regasification terminals, which represent 12% of the power and 95% of the natural gas used by the country. South Korea is the second largest world importers with 3 regasification terminals.
In the Atlantic basin, seven European countries share 28% of the world imports, including the European Union. In this set, the number rises to 32% of the global imports with 11 regasification terminals (Figure 2).

2. Analysis of the Production Costs in the LNG Chain

2.1 Liquefying

Along the last two decades, the specific cost (cost per unit of LNG produced) of the natural gas liquefying plants has significantly been reduced. This cost reduction was possible mainly owing to the technological improvement of the process and to the scale gains, obtained after the manufacturing of trains with greater capacity, but also in function of a greater competition among the companies acting in the liquefying plants design and construction.

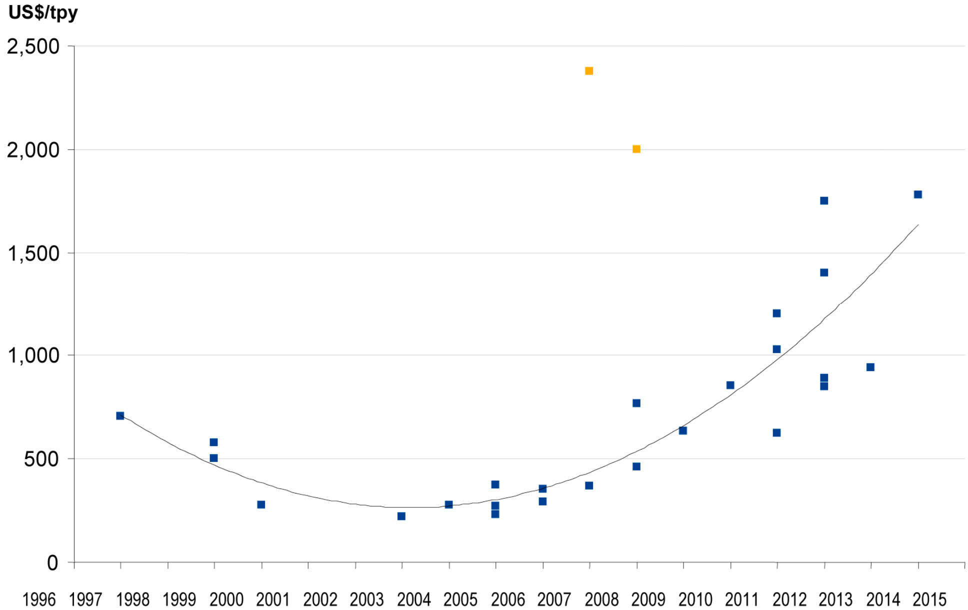

Fig. 4. Specific cost of the liquefying plants

While the first LNG producing plants, built in Algeria in the 1970s, counted on six liquefying trains to reach a capacity of 8 million tons of LNG per year (mtpa), the new projects for expanding the Qatargas and RasGas plants – the major LNG exporters in Qatar and two of the major in the world have about the same production level from a single train.

Since 1964, when the first liquefying plant started operating in Algeria with a single 1.1 mtpa train, the average size of the trains has increased along the years, reaching fourfold greater levels now.

Plant	Location	Started Operation	Capacity (millions of tons per year)	Estimated cost (billions of dollars)	Specific cost
Gladstone	Australia	2014	3.5	6.2	1780
Sunrise LNG	Australia	2013	5.0	4.7	940
Gassi Touil	Algeria	2012	4.0	7.0	1750
Brass LNG	Nigeria	2012	10.0	8.5	850
Soyo	Angola	2012	5.0	7.0	1400
Olokola	Nigeria	2012	11.0	9.8	891
South Pars	Iran	2011	10.0	12.0	1200
Gorgon	Australia	2011	16.0	19.2	1200
Qatargas 4	Qatar	2011	7.8	8.0	1026
Skikda	Algeria	2011	4.5	2.8	622
Pluto	Australia	2010	4.3	9.6	2233
P. Malchorita	Peru	2010	4.5	3.8	854
Qatargas 3	Qatar	2009	7.9	5.0	634
Sakhalin-2	Russia	2008	9.6	19.2	2000
Qatargas 2	Qatar	2008	15.6	12.0	769
NW Shelf T5	Australia	2008	4.4	2.0	460
Snohvit	Norway	2007	4.0	9.5	2375
EGLNG	Equatorial Guinea	2007	3.8	1.4	368
Rasgas 2T345	Qatar	2006	14.1	5.0	355
Darwin	Australia	2006	3.7	1.1	292
Atlantic LNG T4	Trinidad e Tobago	2005	5.2	1.2	231
Egyptian LNG1	Egypt	2005	3.6	1.4	375
Segas	Egypt	2005	4.8	1.3	271
Rasgas 2T3	Qatar	2004	4.7	1.3	277
MLNG Tiga	Malaysia	2004	6.8	1.5	221
Oman LNG	Oman	2003	7.3	2.0	274
NLNG 1-2	Nigeria	2000	6.6	3.8	576
Rasgas	Qatar	1999	6.6	3.3	500
Qatargas 1	Qatar	1997	9.9	7.0	707
MLNG Dua	Malaysia	1995	7.8	1.6	205

Table 4. Existing and planned gas liquefying projects

Despite the reduction in the LNG production costs observed in the last decades, recent contracts for building new liquefying plants have shown an inversion in this trend. Figure 4 shows the evolution in the capital cost per ton per year of some existing liquefying projects and under planning for the next years. The projects are listed in Table 4 further on.
Some factors have to be analyzed in order to understand the rising cost for building LNG plants observed since 2003. Firstly, in the last years, the global demand for energy has grown at record levels, partly due to the strong economic growth in China and in India, but also due to the development of other emerging markets – in which Brazil is included – and this growing demand has generated a world boom in the building sector for energy infrastructure. Moreover, few companies have expertise for LNG designs and, with so many enterprises under planning to start operating in five years, the costs for hiring these companies has significantly risen.
Another aspect is that of the labor costs and the raw material used in LNG designs, such as steel, cement and nickel, the prices of which have substantially and systematically risen in the foreign market along the years.

Some projects are particularly more expensive, most of the time for being located in regions in which there are difficulties to conduct works due to climate conditions, as is the case of the Snohvit projects in Norway and Sakhalin-2 in Russia. Both are located in regions of extreme cold, which implies greater design costs.

2.2 Shipping

After the natural gas liquefying process, large LNG Carrier Ships are filled and convey it to regasification plants, making the shipping by LNG Carrier Ships a crucial element for their flexibility in serving diversified markets all over the world.
The LNG commercial transportation started in 1964, taking LNG from Algeria to the United Kingdom, and since then, the LNG industry has substantially developed, presenting great reliability in terms of security, process technology and operational procedures.
The LNG transportation by LNG Carrier Ships represents from 10% to 30% of the total cost considering the chain from natural gas prospection up to the regasification in the import terminals. The value of the freight represents nearly 70% of the total LNG transportation cost, the rest being related to fuel price, insurance, among others, and the costs for building LNG Carrier Ships exert great influence on the total value for LNG transportation.
Despite the important representativity on the total costs of the LNG chain, shipping becomes more competitive in relation to gas pipelines since the distance run increases. Figure 5 presents a cost comparison between the transportation of natural gas via gas pipeline and the transportation by LNG Carrier Ships, in relation to the distance; it can be verified that the transportation of natural gas via LNG is more advantageous than by sea gas pipeline for distances longer than 700 miles and more advantageous than by land gas pipeline as from 2,200 miles.

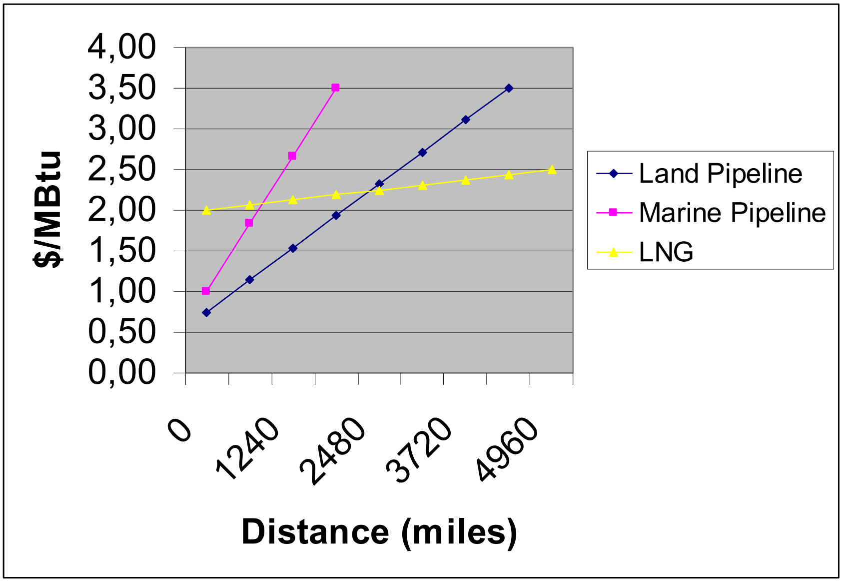

Fig. 5. Comparison between gas pipeline and LNG, in function of distance

In the 1990s, when the LNG industry started to grow more significantly, the number of shipyards with capacity to build LNG Carrier Ships grew and the competition between shipyards led to technological improvements and price reduction, aided by the devaluation of the Japanese and South-Korean currencies, major builders of these LNG Carrier Ships, as related to the American dollar.

However, in more recent years, with so many LNG projects under development, there has been a significant increase in demand for LNG Carrier Ships, leading to an increase in their price.

In the last decade, LNG production grew more than 50% all over the world. During this period, China and India started to import LNG, the United Kingdom resumed LNG imports after 40 years and other LNG markets, such as Spain, South Korea and Taiwan presented an expressive growth.

Due to this growing demand, the fleet of LNG conveying vessels grew from 130 in the early 2002 to about 250 in the late 2007, and by 2011, the number of LNG Carrier Ships may reach 380.

Figure 6 presents the number of LNG Carrier Ships delivered per year since 1993. Figure 7 shows the price evolution per capacity of these LNG Carrier Ships in the delivery year. The graphs show how the demand for LNG Carrier Ships is increasing and the combination of this increase and also the growing cost of raw material and labor led to a strong rise in LNG Carrier Ship prices.

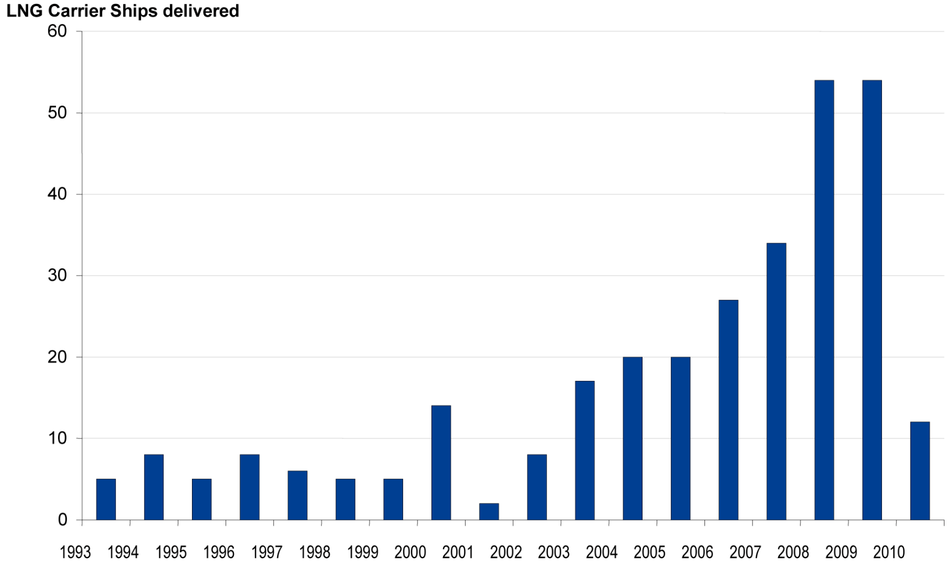

Fig. 6. Number of LNG Carrier Ships delivered

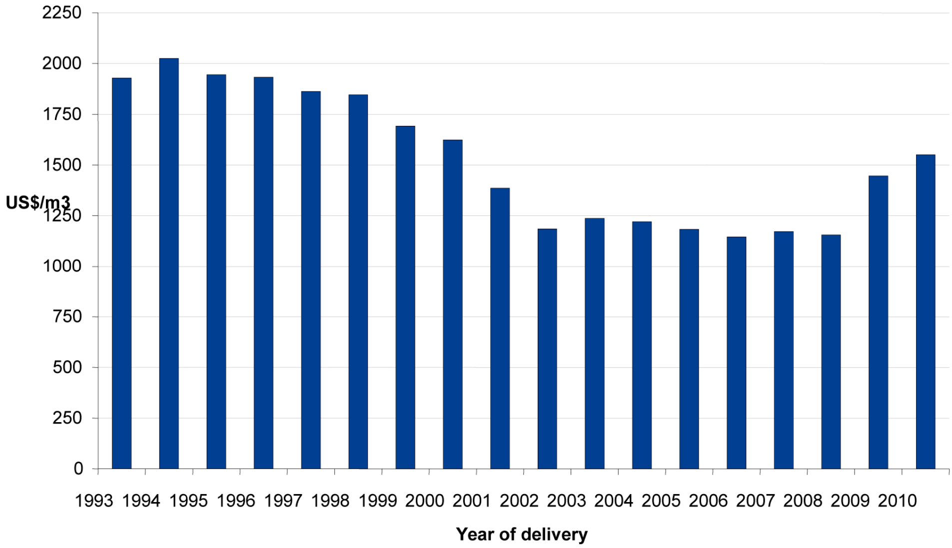

Fig. 7. average price per LNG Carrier Ship capacity

The standard size of the tanks has also changed along the years, in function of the growing demand for greater efficiency and cost reduction in LNG transportation, with scale gains. Whereas in the 1970s and 1980s the average capacity of the LNG Carrier Ships was 125,000 m^3, in the 1990s this average increased to almost 135,000 m^3 and is still growing.
The average capacity of the LNG Carrier Ships delivered in the last years was around 150,000 m^3, and there are at least 40 vessels with a capacity over 200,000 m^3. Figure 8 shows how the average capacity of the LNG Carrier Ships increased since the 1970s.

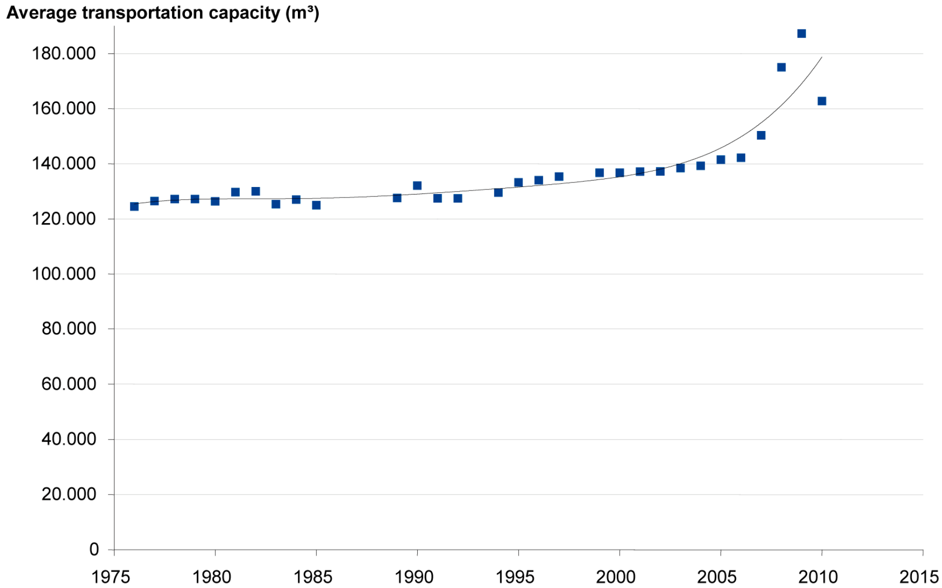

Fig. 8. Evolution in the average capacity of LNG Carrier Ships

Although there is a clear trend for increasing the LNG Carrier Ships capacity, some issues have to be considered to assess whether the LNG Carrier Ships size will keep growing. There is a limiting factor, since only some terminals are able to harbor vessels with capacity higher than 200,000 m^3. Hence, this increase in the number of large vessels may affect the design of new liquefying plants and regasification terminals.
Conversely, these new very large vessels are dedicated to specific projects, exerting their cost advantage with scale gains when sailing in regular routes, carrying regular LNG volumes. In the last years, the markets that have mostly grown are the ones of short and medium-terms, which use standard LNG Carrier Ships from 145,000 m^3 to 160,000 m^3.

2.3 Regasification

Regasification is the final process in the LNG chain, when it is unloaded from the LNG Carrier Ships, reheated and again transformed into gas. By the end of the 1990s, 75% of the LNG regasification capacity was found in Asia, mainly in Japan, where the LNG industry developed early owing to the limited access to gas pipelines and the lack of other local natural resources. However, in the last years, LNG imports have grown especially in Europe and in North America.

Since 2000, most of the LNG new import terminals projects were built in Europe, where the dropping North Sea reserves, the high production costs and liberalization of the power and natural gas markets generated new opportunities for LNG. There are now more than 100 new regasification terminals or expansion projects to start operating in the next years in the world, as a response to the increase in the demand for LNG, and at least 70 of these are in Europe or North America. According to Table 5, only 16% of the new regasification projects will be built in Asia.

	Europe	Asia	America (Atlantic)	America (Pacific)
2000	15%	75%	11%	0%
2000 to 2007	45%	37%	19%	0%
2007 -	30%	16%	47%	8%

Table 5. Regasification capacity in different periods

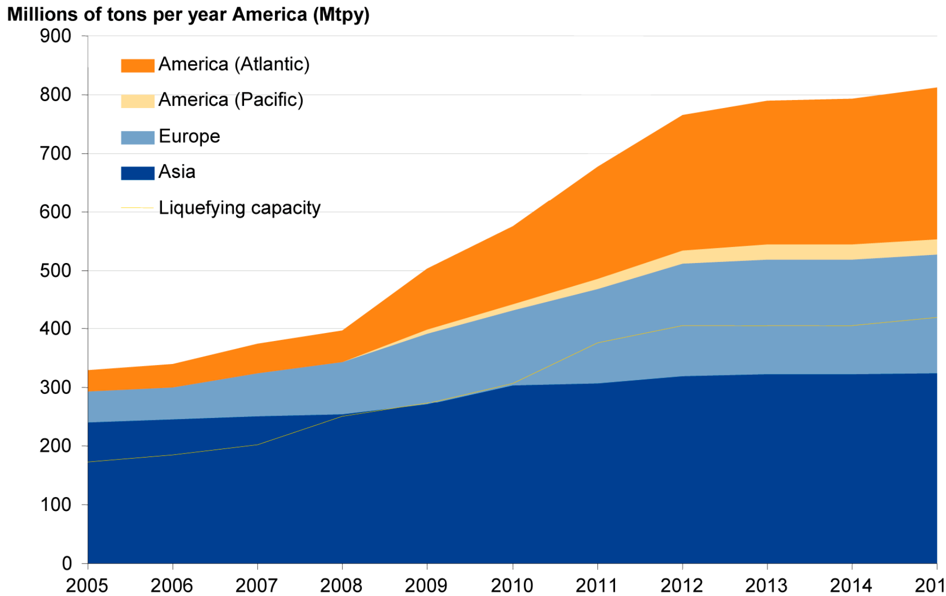

Fig. 9. Expected liquefying and regasification capacity

Figure 9 shows that the new terminals will substantially increase the global regasification capacity that will keep growing until it reaches 800 mtpa in 2015. The graph also shows how the regasification capacity operates with low use rate; it can absorb practically twice the total LNG produced and is growing faster than the liquefying capacity. This disparity reflects a smaller cost as compared to the other segments in its production chain.

The costs for building regasification terminals are very specific for each project, depending on several factors, such as location, cost of the land, type and number of storage tanks, harbor infrastructure, among others. Thus, the costs for building these terminals present great variation and do not follow any trend along the years, as shown in Figure 10.

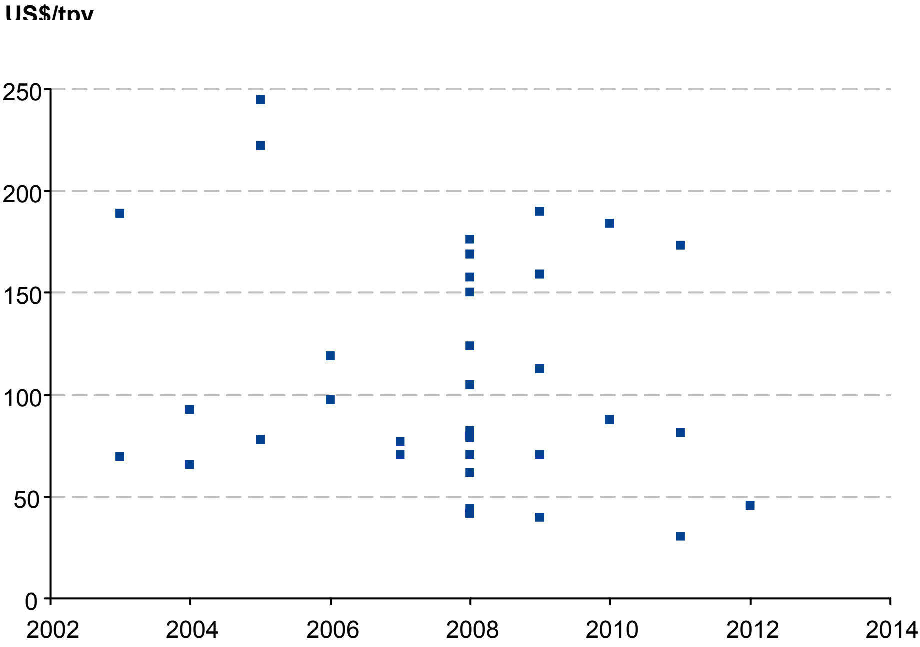

Fig. 10. Specific cost for building regasification terminals

2.4 Investments at each stage of the LNG production chain

Projects in the LNG area require heavy investments and the capital invested at each stage of the production chain may vary significantly. The information found in the media is usually sparse; hence, concrete data and specific details of contracts are difficult to obtain. It is possible, however, to estimate an average of the costs per unit at each stage of the chain in a period.

Figure 11 presents how the costs are divided at each stage, from natural gas prospection to LNG regasification for the projects that started operating recently and for those that are to start operating by 2011. From 2002 to 2007, the gas liquefying process showed to be more expensive, accounting for 44% of the total cost. This fact represents an expressive increase in the chain total cost for the next years, seeing the growing costs of the liquefying plants. The graph also shows that in the period analyzed, the average costs of gas exploration did not suffer great alterations and regasification has a smaller impact on the LNG chain total cost.

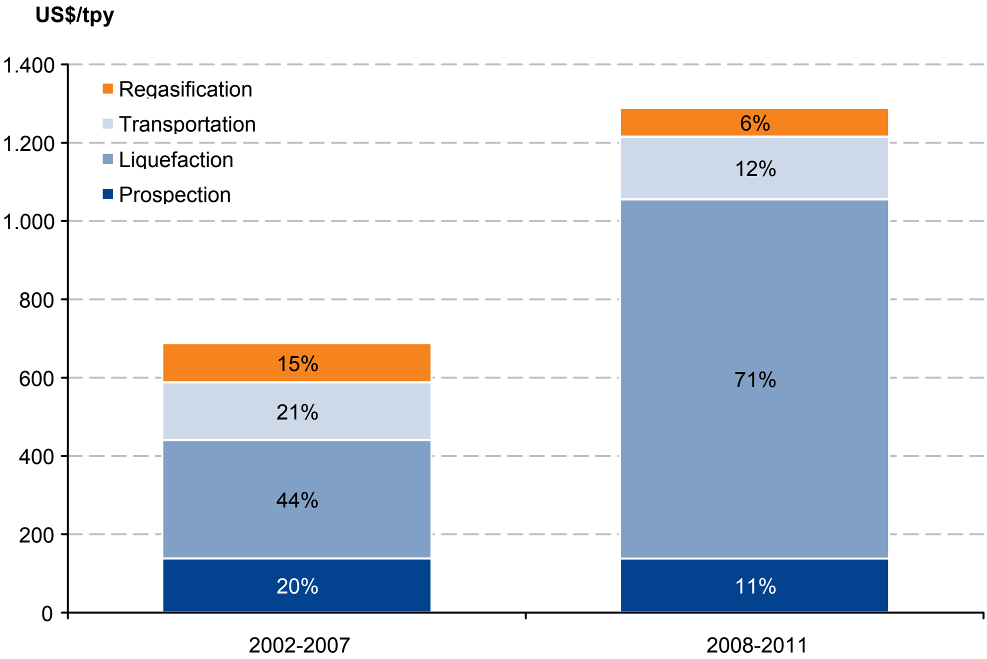

Fig. 11. Average cost per unit of the production chain in different periods

3. Perspectives for LNG in Brazil

3.1 Natural Gas Context

Today the gas volume available is of about 65.5 MMm³ a day; 30 MMm³ come from Bolivia, 21.5 MMm³ from the Southeast and 14 MMm³ the Northeast. The gas produced in Brazil comes mainly from off-shore platforms (61%), from depths varying between zero and 300m (33%), 1500m (62%) and only a small parcel from depths greater than 1500m (5%). Brazil presents three main and independent production and transportation networks, depicted in Figure 12: one in the North region, one in Northeast region and one in the South cone (S-SE-CO). The South cone network connects Southeast Center-West and South States, and the Northeast network connects the Northeast States from Ceará to Bahia. These two networks will be connected by Gasene, foreseen for the first half of 2010.

The Petrobras main expansion programs to supply natural gas are Plangas, mainly destined to the industrial market in the Southeast and TC - Term of Agreement – a program based mainly on LNG and guided towards thermoelectric consumption.

Fig. 12. Natural Gas Networks in Brazil

The expansion of supply in the short-term occurs mainly with the natural gas from the Espírito Santo Basin and in medium and long-term, the gas used comes from the Santos Basin.

3.2 Recent History

Even though natural gas thermal generation has been stimulated by the government since 2000, by the PPT (Priority Program for Thermoelectric Plants), aiming at the consumption of large volumes for paying the take-or-pay (contracting modality in which, in case the consumption is smaller than the volume contracted, the contracted value is paid; in case it is higher, the measured volume is paid) of the Bolivian gas, the investments foreseen did not