MINISTRY OF MINES AND ENERGY
OFFICE OF PETROLEUM, NATURAL GAS AND BIOFUELS

REPORT:

INTERNATIONAL LNG MARKET

Impacts on Brazil

Empresa de Pesquisa Energética

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REPORT
International LNG Market
Impacts on Brazil

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Márcio Félix Carvalho Bezerra

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Technical Team
Luiz Paulo Barbosa da Silva

URL: http://www.epe.gov.br
Headquarter
Esplanada dos Ministérios Bloco U
Ministério de Minas e Energia - Sala 744 - 7º andar
70065-900- Brasília – DF
Central Officer
Av. Rio Branco, n.º 01 – 11º Andar
20090-003 - Rio de Janeiro – RJ

Rio de Janeiro
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Rev.	Date	Notes
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1 EXECUTIVE SUMMARY

The LNG market has become more dynamic, with higher liquidity and tending towards commoditization. As in the previous year, the expectations of a surplus of gas supply in the world in 2017 did not materialize, being offset by the concomitant increase in China's LNG demand. The ability to adapt to adverse market conditions has shown an increasing maturity of the LNG industry. Thus, this report aims at analyzing the LNG market and its future prospects, mainly in terms of prices and future investments required to balance the supply and demand scenario in the medium and long terms. This report also evaluates the possible impacts of the international market and increase in the number of projects of LNG regasification terminals linked to thermoelectric plants over the Brazilian natural gas market dynamics.

Prices, although still relatively sensitive to the price of oil, maintain the seasonal profile affected by the peaks of demand in the European winter periods. In Brazil, the diversification of supply through new terminals does not guarantee an oversupply of gas nor the reduction of prices, given the demand profile to be met. Thus, short-term LNG supply contracts or alternatively cargoes bought in the spot market are preffered in the country, due to their flexibility, so that, when not necessary, the cargoes may be not contracted or may be redirected to other destinations.

This report is supplemented by information on the international natural gas market within the context of the 2018-2027 energy planning studies.

2 LNG GLOBAL MARKET

The natural gas accounts for less than a quarter of global energy demand, of which 9.8% is supplied by LNG (IGU, 2018). Between 2018 and 2035, demand for natural gas is expected to grow at an average of 2% per year, twice the total global energy demand rate. Demand for LNG, meanwhile, is expected to increase by an average of 4% per year, while natural gas will account for more than 40% of the growth in energy demand over the next two decades (SHELL, 2018). This growth is due to a number of factors, including increasing levels of industrialization and energy demand, particularly in Asia and Africa; the continuous transition from coal to gas, especially in China; and the increasing availability of gas reserves at low exploratory cost, in North America and the Middle East (SILVA L. P. B., et al, 2018).

In 2017, global LNG imports recorded the highest annual growth rate since 2010 (+ 12%), reaching 293.1 Mt (million tons). This increase is equivalent to 35.2 Mt more in 2017 over 2016, the second highest increase in history, only behind 40 Mt registered in 2010 over 2009 (IGU, 2018). In addition, only one new country, Malta, joined the group

of LNG importing countries, now totaling forty. The number of exporting countries remained the same, nineteen (SHELL, 2018).

Despite the delays, new liquefaction units began operating in 2017 in various parts of the world, from the United States to Australia, Malaysia and Russia, leading to an increase of 32.2 million tons per year (Mtpa) in global supply capacity of LNG when compared to 2016 (IGU, 2018). Expectations for an excess of LNG supply in the world and, consequently, price depreciation, did not materialize. This is mainly due to increased imports by China, which have contributed substantially to the balance of the market.

The main additions to LNG supply in 2017 came from Australia and the United States, responsible for four of the five new liquefaction trains that came online in this year (Gorgon Train 3, Wheatstone Train 1 in Australia, Sabine Pass Trains 3 and 4 in United States, plus Yamal LNG Train 1 in Russia). According to GIIGNL (2018), the increase in global LNG supply was boosted, as well as the addition of new liquefaction terminals, by the ramp-up of the production of the trains which were commissioned in 2016 in Australia and the United States (totaling +10.7 Mt and +9.6 Mt, respectively), as well as the improvements in performance of existing liquefaction plants in Algeria, Angola and Nigeria (+6.2 Mt). On the other hand, the supply from the Middle East decreased by 2.3 Mt as a result of planned and unscheduled maintenance of the liquefaction plants in Qatar (GIIGNL, 2018).

Another highlight is the start-up of Malaysia's Floating LNG Satu, the world's first FLNG (Floating Liquefaction Unit) project, which began producing along the 2017, a landmark of LNG industry in this year (Figure 1).

On the demand side, most of its growth occurred in Asia, where LNG imports grew by 19.6 Mt, keeping the continent as the largest LNG importing region, with a market share of 72.9% (SHELL, 2018). Japan continued to be the main importing country, with 83.5 Mt or 28.8% of market share, followed by China, 39 Mt (GIIGNL, 2018). China has surpassed South Korea as the world's second main importer, a direct consequence of the Chinese government's efforts in the residential, commercial and industrial sectors to restrict coal penetration to reduce pollution in urban areas. China also contributed substantially to the balance of demand and supply in the LNG market in 2017, increasing its imports by 42.3% (+11.6 Mt), which accompanied the already strong growth of 36.9% in 2016 (GIIGNL,2018).

Figure 1 - FLNG Satu in Malaysia

Source: Petronas, 2018.

In Europe, net LNG imports increased by 7.5 Mt (+19.5%), driven mainly by demand for gas in the power generation sector. A combination of low hydroelectric generation, low nuclear production in France and hot summer weather led to an increase of 9.1 Mt in southern European countries (France, Greece, Italy, Portugal, Spain and Turkey), while net imports in the North European countries (Belgium, the Netherlands and the United Kingdom) declined by 2.1 Mt. The decline is attributed to the United Kingdom, which experienced a sharp decline (-2.6 Mt) in LNG consumption. Despite the increase in imports in 2017, Europe's share of global LNG imports has fallen almost 50% since 2010 (from 29.4% in 2010 to 15.9% in 2017), mainly due to a decline in gas demand and competition with pipeline imports (SHELL, 2018).

Imports in the American region ended the year higher (+ 4.1%) than in 2016. Mexico accounted for most of the region's growth due to restrictions on imports by U.S. pipelines. LNG imports to Puerto Rico declined 0.3 Mt, partly due to the impact of Hurricane Maria in last September (GIIGNL, 2018).

The Middle East was the only region where imports decreased as a whole in 2017, with deliveries falling 9.1% (-1.6 Mt), mainly due to the start of the production of new gas fields in Egypt. Demand from emerging importer countries (Colombia, Jamaica, Jordan, Malta, Pakistan, Poland) increased by a total of 2.7 Mt, of which 1.7 Mt was in Pakistan (GIIGNL, 2018).

At the end of 2017, the total fleet of LNG tankers was composed of 511 vessels, of which 28 were FSRUs. In addition, there are now 12 FSRUs ordered, 5 of which are expected to be delivered by 2018 (GIIGNL, 2018). Spot market charter rates have ended the year on the rise driven primarily by the demand for LNG vessels to carry LNG from the US. In 2017, the average spot market charter rate for 160,000 cubic meter tankers was US$ 46,058 per day, compared to an average of US$ 33,528 per day in 2016 (GIIGNL, 2018).

Finally, it should be highlighted that the development of the small-scale LNG market has been gaining strength in recent years. The distribution of LNG by trucks has been growing, with several LNG regasification terminals developing solutions for loading trucks, including transportation, energy and industrial uses. In addition, the use of LNG as a fuel for ships is increasing, with more than 220 ships in service and under construction worldwide by the end of 2017 (GIIGNL, 2018). LNG trucks have also become a trend in countries such as China, the United States and some European countries, and have proven to be much more efficient than CNG, especially for long distances and countries with natural gas infrastructure deficits.

2.1 Commercial Flows and LNG Comoditization

From the global LNG demand, 26.7% is provided by volumes supplied by Qatar, and about 45% by the Pacific basin (SHELL, 2018). The growing demand in Asian markets coupled with the increasing availability of Australian LNG volumes contribute to maintaining most of the LNG trade flows within the Pacific itself, 44% of the world flow, followed by the Middle East / Pacific, 22% (GIIGNL, 2018). Figure 2 shows the higher trade flows in the year 2017. It should be noted that, although not represented in the figure, there has been considerable increase in the Atlantic / Pacific flow, driven by deliveries from the US to Asia, in particular to China, South and Japan (SILVA L. P. B., et al, 2018).

With regard to LNG contracts, buyers continue to sign shorter contracts. The average time of the contract in 2017 was less than 7 years. Spot market (charges delivered up to 90 days from the date of the transaction) and short term (volumes delivered for contracts with a duration of 4 years or less) imports increased by 2.1 Mt and reached 77.6 Mt in 2017, compared to 75.5 Mt in 2016 (GIIGNL, 2018). The percentage of these transactions in total LNG imports remained stable, accounting for about 27%. Countries such as China and South Korea increased contracting in the spot and short term markets in the order of 3.0 Mt and 4.1 Mt, respectively. Japan, on the other hand, had the largest decline, -2.8 Mt, although the total import volume remained stable, followed by Jordan, -1.9 Mt, and the United Arab Emirates, -1.7 Mt (GIIGNL, 2018).

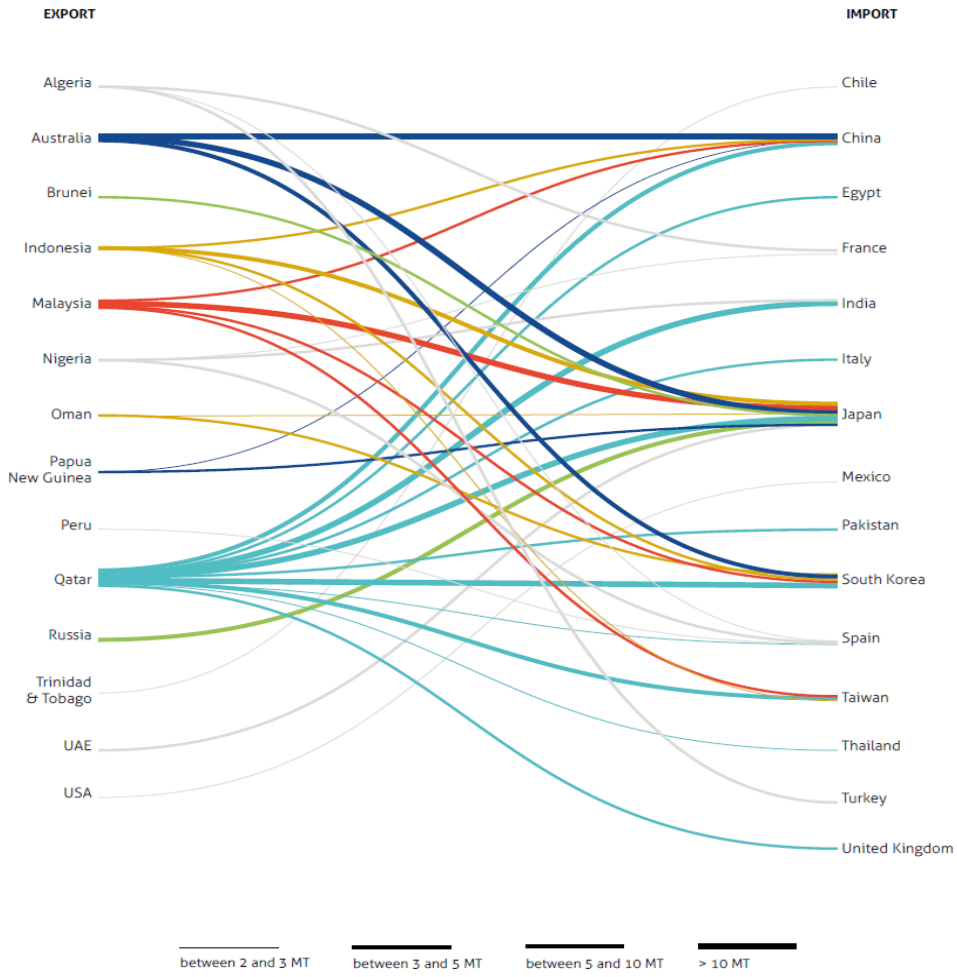

Figure 2 - Commercial Flows of LNG.

Source: GIIGNL, 2018.

Spot market imports were facilitated by LNG contracts with destination flexibility, by the increase in contracting by portfolio exchange and by the growing volume of traders. However, re-exports fell worldwide as a result of lower price differentials between markets and due to the increased availability of flexible LNG cargoes (SILVA L. P. B., et al, 2018).

Growth in LNG supply has led to an increase in LNG market liquidity in 2017. Recent figures from the Intercontinental Exchange (ICE), for example, show that JKM (Japan Korea Marker) commercial swaps maintained high growth levels until 2017, indicating greater liquidity and commoditization of the LNG market. The trend is that this process will continue, and perhaps even accelerate in 2018, as the growth rate of LNG supply increases and the volumes of LNG cargo traded in the spot market and in the short term increase.

However, to ensure the stability of this market, new Final Investment Decisions (FIDs) are needed in order to complete the supply and demand balance projected for the coming decades. Following the wave of investments from 2011 to 2015, FIDs in LNG

projects have dropped dramatically. Only two FIDs were carried out in 2016, while in 2017 only one project, Coral FLNG, was signed in Mozambique, with capacity to supply 3.4 Mtpa, the first LNG project to be developed in East Africa (GIIGNL, 2018). Another major investment announcement of 2017 was Qatar's intention to expand its existing LNG supply capacity from around 80 Mtpa to over 100 Mtpa by 2024 (GASSTRATEGIES, 2018).

Chart 1 below shows the mismatch between global LNG supply and demand starting from 2022. It can be noticed that, based on the FIDs available to date, it will be necessary to incorporate new LNG liquefaction projects to match the expected demand during the assessed period. It should be noted that the graph, however, only signals the current scenario of FIDs and it is expected that, until the signaled period of shortage of supply, several other liquefaction projects still in conceptual phase at the moment shall reach sufficient maturity to receive FIDs and come to fill the gap shown in the chart until the 2030 horizon.

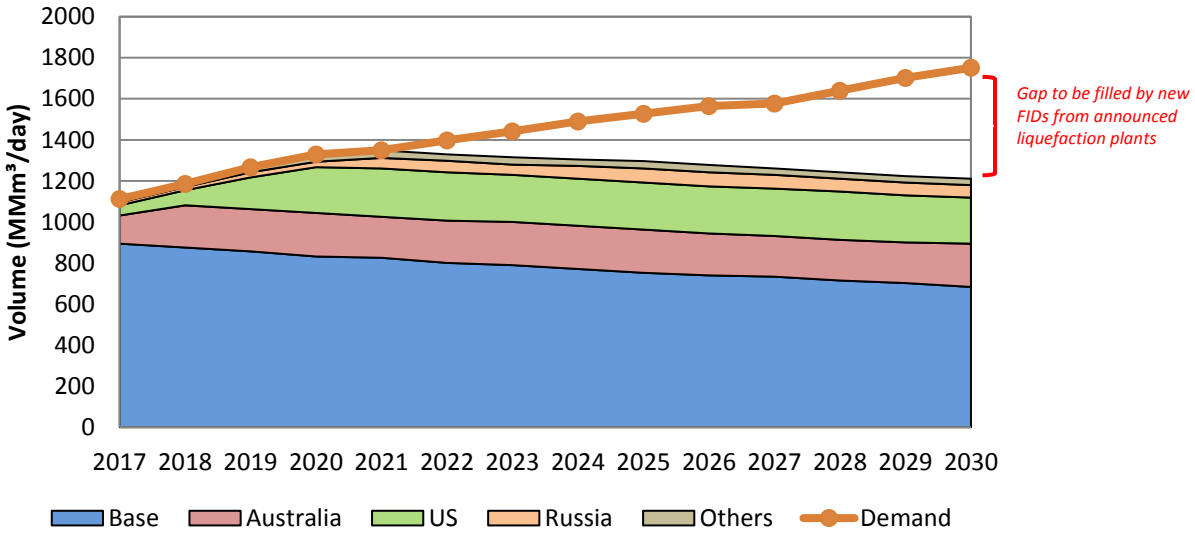

Chart 1 - LNG supply and demand forecast

Source: EPE, based on Miro Advisors (2016) and FGE (2016).

Although no megaproject is planned for 2018, projects such as Fortuna LNG, Corpus Christi and the first part of the expansion of Qatar's liquefaction capacity are expected to add around 15 Mtpa to the market. This is roughly the new capacity required annually to sustain the industry's expected average growth rate in the long run over the next decade. Maintaining this level of new FIDs in the coming years would signal the industry's ability to maintain the required investment rate, despite adverse market conditions (GASSTRATEGIES, 2018).

The current hiring and pricing environment has been a challenge to obtain financing for new ventures in liquefaction plants. Most suppliers are still seeking long-term contracts to secure financing. However, LNG buyers are increasingly seeking shorter, smaller and more flexible contracts to stay competitive in the downstream energy and gas markets in which they operate. Since LNG projects generally take more than four years to start production, the concern is that the new supply will not be ready until the next decade.

As a form to get around the current market situation, the latest US liquefaction plants are seeking to innovate in the form of hiring. Most US exporters have recently been offering more flexible terms, such as shorter contracts at fixed prices, prices linked to the index chosen by the buyer, or the possibility of a combination of indexes. In addition, US export contracts do not have destination clauses, which means that buyers are allowed to renegotiate the bought LNG. In addition, a new North American LNG company, Tellurian, is developing a new business model in which buyers take an equity stake in projects in return for receiving LNG at cost price (WOOD, A.; VISCIDI, L.; FARGO, J, 2018).

2.2 Prices and trends

In 2017, spot LNG prices followed a seasonal profile as in 2016, although the increase in the last weeks of the year was more intense than in the previous year due to higher than normal Chinese demand. The prices of medium and long-term LNG contracts also increased moderately, following their main indexes. According to IGU (2018), Asian average LNG prices increased by US$ 1.33 / MMBtu compared to 2016 due to high oil prices and strong demand from the Pacific basin.

During 2017, as new supply came on stream and slightly surpassed demand, LNG prices fell throughout the world during the summer in the Northern Hemisphere and then steadily increased in the second half of the year, with the arrival of winter. As shown in Chart 2, after falling to US$ 5.28 / MMBtu in August 2017, spot prices in Northeast Asia reached an average of US$ 9.88 / MMBtu in January 2018, due to the effects of winter and the strong demand because of Chinese environmental regulations. The National Balancing Point (NBP) also experienced significant variations during the year, rising from a low of US$ 4.46 / MMBtu in June to a high of US$ 7.76 / MMBtu in December (IGU, 2018).

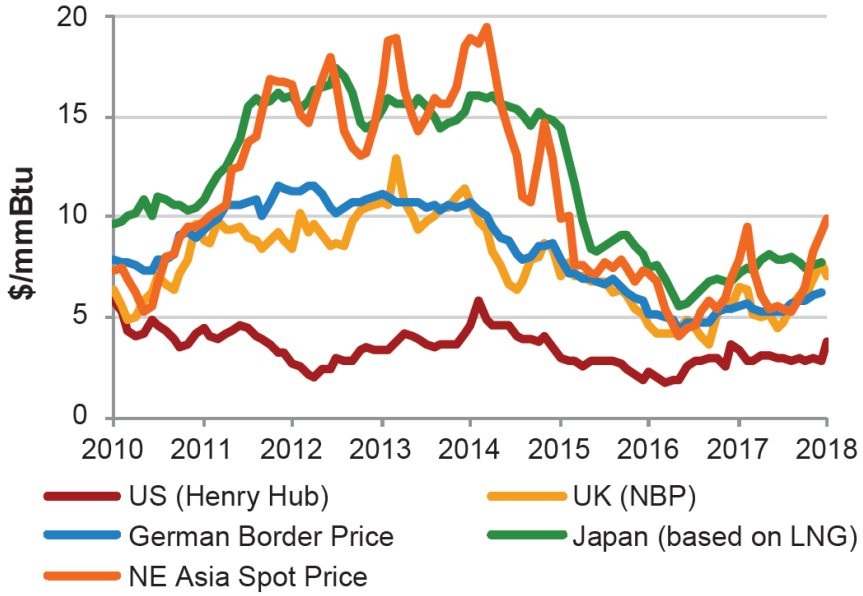

Chart 2 – History of the main indexes of prices of natural gas in the world

Source: IGU, 2018.

As shown in Chart 2, gas prices in the US Henry Hub maintained a similar trajectory to that of 2016, trading at around US$ 3.00 / MMBtu. The difference of about US$ 4.00 / MMBtu at the end of March 2018 between East Asian and US spot gas prices would provide a profit for new US export projects, which seek to send surplus volumes beyond the Atlantic (SILVA L. P. B., et al, 2018).

In the beginning of 2018, at the end of February, the gas market in northwestern Europe was hit by a period of cold weather called "The Beast of the East," caused by the cold front from Siberia. As a result, the price of gas in the NBP and in the TTF (Title Transfer Facility) increased, reducing the difference between the prices facing East Asia. In the short-term market, gas prices for immediate delivery in Europe have risen well above the East Asian price, causing many countries to consume much of their gas reserves stored in LNG terminals or in underground storage. As the cold period passed, the price gap remained quite narrow at the end of the first quarter, with East Asian prices continuing to decline, but with European hubs needing to import large volumes of gas to replenish storage facilities (ICIS, 2018b).

In the second half of 2018 spot prices were closer to normal winter levels and were the highest spot prices seen in the summer since 2014. The strength of the crude oil market was one of the main drivers of the upward trend in gas prices of East Asia. Oil was trading at around US$ 11.60-13.80 / MMBtu in the second quarter of 2018, compared to US$ 7.80-9.70 / MMBtu in the previous year (ICIS, 2018c).

This relationship between LNG and crude oil prices rises as many Asian companies still have substantial long-term import contracts linked to the price of oil (ICIS, 2018c). They can arbitrate between taking extra charges on long-term petroleum contracts or buying extra gas in the spot market. As the price of oil increases by a certain amount,

spot loads become more competitive. Thus, by increasing demand, this contributes to the increase in spot market prices towards the price levels of long-term contracts (ICIS, 2018c).

By mid-June 2018, as shown in Chart 3, the East Asian market index in the International Chemical Information Service (ICIS), the EAX (East Asia Index) peaked in the summer, only in the second half of the month. As the market focus moves from cargoes to delivery in August towards September / October delivery loads, demand tends to fall between peak demand periods for air conditioning in the summer and for heating in the winter. This suggests that there may also be a temporary drop in prices before the market begins to strengthen again at the end of the next quarter.

Even though there has been a downward trend in the last days of June, LNG prices are still higher than last year. Chart 3 shows that EAX was slightly below US$ 9 / MMBtu in the second quarter of this year, compared to US$ 5.50 / MMBtu last year, and the strength of the market this quarter was not something expected. Last year, global spot markets remained stable from April to June, but by 2018 East Asian spot prices rose sharply in the second quarter, opening a wide gap to the European gas markets (ICIS, 2018c).

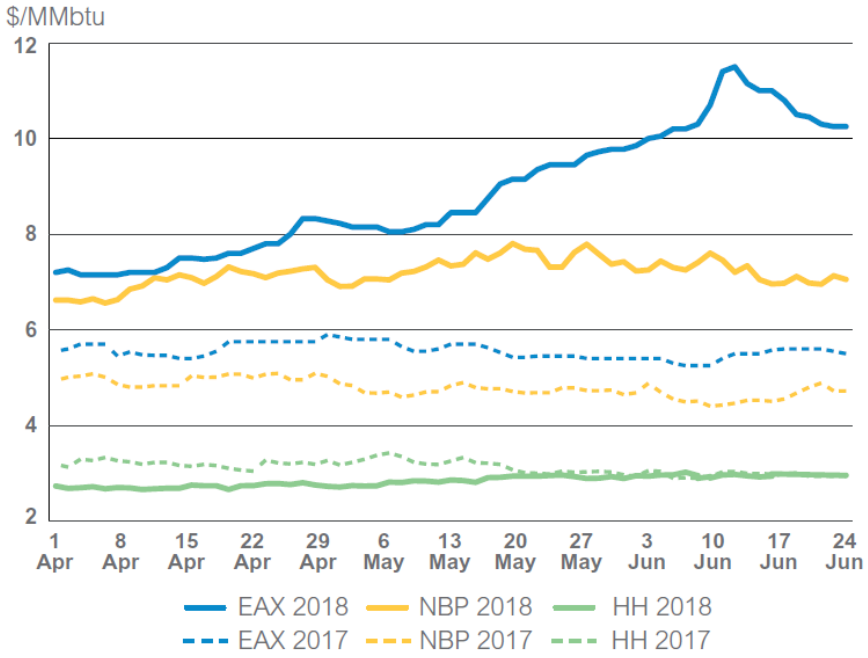

Chart 2 - LNG Price Indexes in ICIS

Source: ICIS, 2018c.

Most of this price trends is due to China, which has been in the spotlight after the unexpected surge in demand last winter, when district heating systems have shifted from coal to gas to help fighting the air pollution that affects major cities. The country's demand remained strong in the second quarter of 2018 at 11.3 Mt, an increase of 40% over the previous year (ICIS, 2018c). It also retreated far less compared to the

first quarter of 2018 than its neighbours Japan and South Korea, raising expectations of an even greater demand next winter, given its already strong demand in the summer of 2018. China will continue to play a large role in influencing demand and spot prices throughout the year, as well as determining the overall LNG market balance.

Efforts to reduce pollution and increase air quality are not unique to China. In India, in the region of New Delhi, where the use of petroleum coke was banned in November 2017, emission reduction policies are also beginning to gain strength. The increased influence of environmental issues could begin to tip the gas balance in those countries by 2018, overcoming the tendency of buyers to opt for the cheapest fuel available (GASSTRATEGIES, 2018).

Meanwhile, Japan and Taiwan continue to work in the sense of reactivating nuclear power plants, which could reduce their demand for gas to fuel power generation. Imports from Japan in the second quarter of 2018, at 17.9 Mt, already show a decrease of 6% compared to the second quarter of 2017. In recent months, the country has resumed the operation of about 4,800 MW of nuclear power generation in the units Ohi 3 and 4 from Kansai Electric and Genkai 3 and 4 units from Kyushu Electric (ICIS, 2018c).

The return of these nuclear plants can lead to significant reductions in gas power generation and, therefore, in LNG imports. The generation of 1,000 MW of gas-fired power generation at the base would require some 1.6 billion cubic meters of gas per year or 1.1 Mt of LNG. Thus, substituting gas thermoelectric plants with nuclear power generation plants could lead to an annual reduction in demand for LNG imports of around 5 Mtpa (ICIS, 2018c).

In view of a possible LNG price decline due to the reduction of volumes imported by Japan, other demands could offset some of this reduction. This is the case of Indian LNG demand that has proven to be very price sensitive. Having increased by about 30 percent in 2016 due to low spot LNG prices, India's LNG demand remained stable in 2017. A drop in LNG prices could again stimulate additional demand in India (GASSTRATEGIES, 2018).

2.3 South America

South America currently accounts for around 5% of global LNG demand. The disparity between demand and domestic production in Brazil, Colombia, Argentina and Chile led the four countries to depend on LNG in different grades (WOOD, A., VISCIDI, L., FARGO, J., 2018). Figure 3 shows the location of the LNG terminals in South America.

Figure 3 - LNG Terminals in South America

Source: EPE.

In Brazil, LNG demand increased slightly (+0.3 Mt) in 2017 mainly due to the beginning of the country's economic recovery and the increase in thermoelectric demand, especially in the second half of the year (IGU, 2018). Although there is growth in LNG demand (+ 32.5%), imported volumes remain well below the maximum regasification capacity of LNG terminals in Brazil (MME, 2018b). The country has a high penetration of renewables in its energy matrix and, as a result, has made use of LNG as the main

source of gas for backup power generation to complement renewable energies. The Brazilian scenario will be further detailed in a specific section later in this document.

Colombia, as well as Brazil, also has a high share of renewable energy sources in its energy matrix, with dependence on hydropower to generate about 85% of the country's electricity. Natural gas production reached its peak in 2013, but has fallen since then, with stagnation in upstream companies' investments after the 2014 fall in oil prices. As a result, Colombia has gone from a net exporter to a net importer of natural gas. Venezuela's import gas pipeline plans have been under discussion since 2012, but due to political turbulence in Venezuela and difficulties in the energy sector, gas is unlikely to flow anytime soon (WOOD, A., VISCIDI, L. , FARGO, J., 2018).

In 2016, the only existing LNG terminal in Colombia, in the Caribbean port of Cartagena, came into operation. LNG has been purchased on the spot market and stored in two land storage tanks, which are used to supply intermittently power generation plants, compensating reductions on hydropower availability. However, despite investments, Colombia has not yet begun to import LNG on a consistent basis, with only one LNG cargo delivered in 2017 (IGU, 2018). The government also plans to encourage the construction of a second terminal in the Pacific coast region. However, this terminal, planned to be in Buenaventura, faces significant obstacles due to lack of sponsors and financial support (ICIS, 2018a).

In Argentina, the slight drop in the average domestic gas production in 2017 was offset by the increase in imports from Bolivia, which ended up reducing LNG imports (-0.4 Mt) for the fourth consecutive year through two regasification terminals (MME, 2018b; IGU, 2018). In addition, as in 2016, Argentina continued to import a portion of gas from Chile to serve specific regions in the Andean region during the winter. This flow is the result of a recent agreement signed between Argentina and Chile that will allow the exchange not only of natural gas, but also of electricity between the two countries (ICIS, 2018a).

In the first quarter of 2017, Argentina's government also renewed a program aimed at increasing production of non-conventional resources, raising the price of gas at the wellhead (IGU, 2018). Although the impact has not been strongly reflected in the average production in 2017, domestic production is expected to increase further, as is already noticed in the first quarter of 2018. According to ICIS (2018a), the increase in national production of the vast gas reserves from Vaca Muerta in the province of Neuquen is expected to contribute to a 2% drop in market share of LNG imports by 2018. In this way, it is expected that LNG will increasingly play the role of meeting short term demands in the country.

In Chile, LNG imports in 2017 increased slightly due to higher thermoelectric demand, +0.1 Mt (IGU, 2018). Coal and hydropower together feed most of Chile's power generation, but 61% of imported natural gas goes into the energy sector (WOOD, A., VISCIDI, L., FARGO, J., 2018). Chile is likely to continue expanding LNG imports, with the power generation tending to be increasingly more clean. Public opposition to large-

scale hydroelectric projects will also lead Chile towards greater dependence on gas-fired power plants, while residential and industrial demand for natural gas is expected to grow as well (WOOD, A., VISCIDI, L., FARGO, J., 2018).

However, efforts to develop a third import terminal in the south of the country are suspended. The consumer market that was intended to be served by new terminals in the region will probably be attended briefly through swap with Argentina. The Penco Lirquen FSRU project, developed jointly by Cheniere Energy and its Chilean partners, suffered significant delays in early 2017. This was due to the revocation of an environmental license, after the Chilean Supreme Court ruled in favor of the local indigenous group that was opposed to the project in January 2017. A second project planned for Chile's southern region, Talcahuano LNG, has not advanced since it received approvals from Chile's regulatory agency in July 2017 (ICIS, 2018a).

Uruguay was historically the fifth country in South America to enter the LNG market. However, the construction of the first FSRU project in the country still faces uncertainties, since a supply agreement between Uruguay and Argentina has not yet been reached. The MOL company chartered the vessel in Turkey for the short term and Argentina is unwilling to commit to the long-term purchase of gas needed to anchor the project. Thus, the progress of this project has been stagnant until then (IGU, 2018).

On the supply side, Peru is the only country in South America that has a LNG liquefaction plant. The country has abundance of gas, mainly in the Camisea region, and a low national demand, which motivated investments in the sense of exporting much of the gas through an LNG terminal. Its liquefaction plant in Pampa Melchorita was inaugurated in 2010 with a nominal capacity of 4.4 Mtpa, and also has two storage tanks with capacity for 130,000 m^3 of LNG and a marine terminal (PERU LNG, 2010). In 2017, its exports have increased (+0.4 Mt combined with Trinidad & Tobago), accompanying the higher production of the fields connected to the terminal (IGU, 2018). The increase in gas production on the Camisea region has also motivated the transition from power generation based on diesel, coal and firewood to natural gas thermoelectric plants. Many are medium-term thermal projects aimed at meeting not only the domestic market, but also the countries neighboring Chile.

2.4 Brazilian Scenario

Currently, natural gas produced in Brazil and imported from Bolivia have been sufficient to reach the non-thermoelectric national demand. Thus, the use of regasification terminals has been restricted almost exclusively to the service of thermoelectric plants, mainly in periods of dry season, with lower hydroelectric generation. For this reason, Brazil only buys LNG in the spot market when it needs to. In 2017, imports of natural gas via LNG averaged 5.05 million m^3 / day, and by May 2018 the average for the year was 2.22 million m^3 / day (MME, 2018b).

Petrobras is currently the only Brazilian LNG importer, with two FSRUs operating in three terminals: Pecém / CE, Baía de Todos os Santos / BA and Baía de Guanabara / RJ. As a result of the low domestic gas demand, Petrobras anticipated by June 2017 that the contract of the Golar Spirit FSRU, one of the three regasification vessels on the Brazilian coast, would be terminated, which would occur only in November 2018. The Golar Spirit operated in Pecém, and now the vessels of the two other contracts (Golar Winter and Experience) started operating at the three existing LNG terminals in the country, in accordance with Petrobras' logistics strategy and regional demand (SILVA L. P. B., et al, 2018).

Chart 4 shows the evolution of LNG prices purchased in the spot market in Brazil (green line) compared to other natural gas prices in the country and in the world.

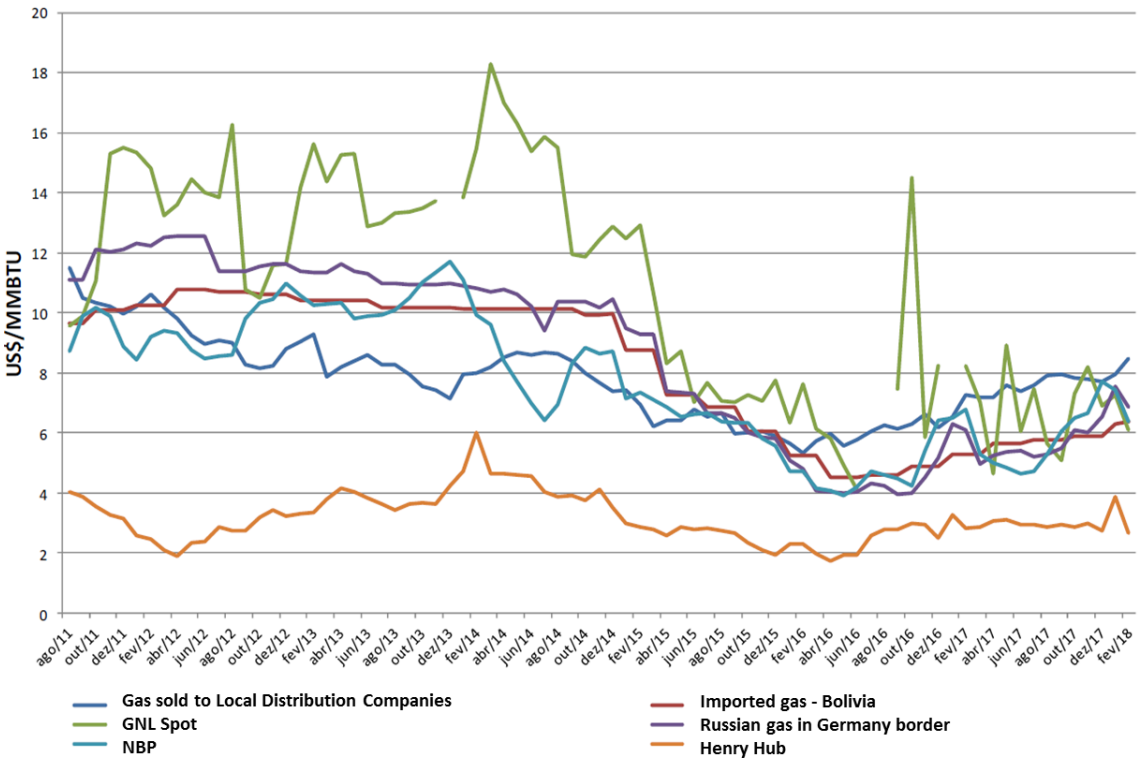

Chart 3 - Natural gas prices (LNG Spot FOB delivered to Brazil)

Source: MME, 2018a.

Note that in the last two years the price of LNG paid by Brazil (FOB price) has converged to levels close to the main reference prices in the world, with the exception of the Henry Hub in the USA. During this period, average import prices in Brazil remained at US$ 6.5 / MMBtu, close to the world average. With the recovery in the price of oil, prices in the first five months of 2018 in Brazil rose to the average level of US$ 7.5 / MMBtu (MME, 2018b).

Although Brazil has had an idle installed regasification capacity of more than 30 million m^3/day in the last three years, there have been announced many projects for LNG

regasification terminals that emerge together with the gas-to-power solution in an attempt to make thermoelectric plants feasible in the Brazilian coast. Three of them are already in the process of developing their business plan, which included the contracting of energy in the new energy auctions: UTE Porto do Sergipe I, in Barra dos Coqueiros / SE, with a regasification terminal with a maximum capacity of 14 million m^3 / day; and the GNA I (formerly Novo Tempo UTE) and GNA II UTEs with a regasification terminal with a capacity of 14 million m^3 / day at Açu Port, in São João da Barra / RJ.

Despite the anticipation of the entry of new LNG terminals (Barra dos Coqueiros / SE in 2020 and São João da Barra / RJ in 2021), it is emphasized that the increase in the import capacity will not imply an oversupply of natural gas in the Brazilian market and, therefore, a possible fall in the level of national natural gas prices. This is because, on one hand, the country is a price taker in the international LNG market (always buying at the spot market price) and, on the other hand, the import capacity has not been used at its full capacity, but rather provides operational flexibility and modulating LNG imports due to the need to reach the national thermoelectric demand. The entry of new regasification terminals may increase the influence of the international LNG market on the dynamics of natural gas price formation in the country. However, it is observed that LNG prices, both spot and forward, are still higher than domestic natural gas prices, mainly due to freight and regasification parcels added to FOB prices.

It is also worth mentioning that the viability of many thermoelectric projects associated with LNG terminals lies in the companies' ability to obtain advantageous supply contracts. Within a constantly expanding LNG market, especially in the Americas, the possibility of ensuring a feasible business model is in a favorable environment. The USA attempt, for example, to be among the leading LNG exporters in the coming years, flexibilizing the contracting of cargoes in a variety of ways, comes to match the need for flexibility that the investors need to comply with the current policy of dispatching thermoelectric plants in the Brazilian electricity sector.

Within the framework of the Gas to Grow initiative and the improvement of the Legal Framework of the Electric Sector, improvements are envisaged that would provide more attractive business opportunities for the investors. As such improvements, in order to improve synergy between the electric and natural gas sectors, we can mention: (i) some recent changes in the contracting of thermoelectric power plants in energy auctions, such as the possibility of declaring seasonal inflexibility (maintaining a maximum average of 50% over the year) and the flexibility of the contracting parameters; (ii) the implementation of hourly energy prices, which may lead to the development of a contracting market for peak load (open cycle) gas-fired power plant; (iii) the possibility of third party access to LNG regasification terminals (including Substitute to Bill 6.407 of 2013, with the addition of Bill 6.102/2016). These changes may promote greater financing for LNG terminals and thermoelectric power plant projects, as they pose opportunity for greater revenue predictability and capacity optimization with multi-agent access.

Another point that directly influences the financability of a project is using the installed capacity of the terminal to reach also the non-thermoelectric demand. Although located miles away, some projects can directly influence the viability of the others, leading to attempts to make one project feasible before the others in order to ensure a captive consumer market. However, while the redundancy of terminals in a region at first may seem a limiting factor and imply on idleness of installed capacity, in an open market this can become a competitive advantage, ensuring security of supply.

Finally, it should be noted that, even with the outlook of expanding the natural gas supply from the pre-salt, LNG will continue to play an important role in the Brazilian market by ensuring flexibility to reach demand (intermittence of non-dispatchable sources, seasonality and peaks). In addition, in this more open and competitive market environment, LNG will play a double role. On one hand, it will have the role of backup in situations of impossibility of service by the shipper, as in scheduled and unplanned stops of gas processing plants or in associated gas fields. On the other hand, it will have the role of guaranteeing flexibility to the carrier, increasing its portfolio of supply and improving its risk management in situations that need, for example, to guarantee System Use Gas during service failure in the integrated network of transmission pipelines, in order to ensure robustness, resilience and ensure network balancing.

3 Final Remarks

LNG international market keeps attracting new entrants, mainly due to the dynamics that the FSRUs have been providing, and diversifying the origin of the offer with new discoveries and technology advances. However, the LNG market is becoming increasingly diverse and more complex, signaling that trade and regulatory challenges still need to be overcame for new importers to develop LNG import infrastructure.

However, despite growing liquidity, new investment decisions must preferably be made in advance to prevent any expected market imbalance from the next decade. The addition of scheduled liquefaction capacity for the year 2018 is close to the new capacity required annually to sustain the expected average growth rate of the industry in the long run over the next decade. Thus, maintaining these levels of investments in the coming years would be a positive sign for the LNG industry, signaling its greater maturity, even in the face of adverse market conditions.

In Brazil, the price of natural gas from LNG will be affected by the price of the international market and not by the expansion of LNG supply in the country, since the country is a price taker. The role of LNG may remain restricted to markets that require gas supply flexibility (such as the electricity sector, today) or be expanded, reaching

firm markets (such as the industrial), depending on the price level that consolidates in the global LNG market and the prices of substitute fuels in Brazil.

In addition, changes in the regulatory framework arising from the Gas to Grow initiative, especially with the entry of new agents and increased investments in the sector, may alter the regional market of natural gas in Brazil, as well as the access of the domestic market to LNG supply. In this sense, for operational and commercial safety reasons, LNG will play a leading role in Brazil. This is expected to happen concomitantly with the great volumes and the competitiveness of the pre-salt gas, given the flexibility and robustness that LNG can bring to the natural gas market and to the operation of the integrated pipeline network.

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