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CURRENT OVERVIEW AND FUTURE FORECASTS OF NATURAL GAS IN THE WORLDWIDE ELECTRICAL MATRIX

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Abstract. *The share of natural gas in electricity generation in the world between 1973 and 2014 went from 12.1% to 21.6%, becoming the second largest energy source with a share in the world's electricity generation grid, behind only coal, which has a 40.8% share.. It is estimated that by 2040 there will be an increase in installed natural gas capacity of 2.2% per annum, so that the share of natural gas in the electricity matrix increases from 22% to 28% in that period. Some countries have chosen for the replacement of coal by natural gas in the generation of electricity, especially in the United States, which has seen a decrease in the use of coal since 2007 and a steeper growth in the use of natural gas. It can be also mention the United Kingdom, which started to exploit natural gas as a source of electricity in the middle of 1990 and not coincidentally, showed a decline in the use of coal. The objective of this work is to present an increase in the share of natural gas in the world energy matrix through the expansion of infrastructure (liquefaction and regasification plants) and it transportation. The work also aims to focus on the main characteristics referring to the generation of electric power by this source such as: CO_2 emission indices, efficiencies, costs and capacity factor.*

Keywords: *Natural Gas, Energy Generation Expansion, World Electrical Matrix, Liquefaction Plants, Regasification Plants*

1. INTRODUCTION

According to the IEA (2016a), about 80% of the world's primary energy supply comes from fossil fuels (coal, oil and natural gas) and within the primary energy sphere, the electric power generation sector currently has a share of 66.7% of fossil fuels, with coal contributing 40.8%, oil 4.3% and natural gas 21.6%.

According to the EIA (2016), through its annual International Energy Outlook report, global energy consumption is estimated to increase by all energy sources until 2040. EIA projections show that renewable energy sources are the fastest growing in this period (2.6% a.a.), followed by nuclear energy with an increase of 2.3% a.a. during the same period.

Although fossil fuels show lower growth than non-fossil fuels (nuclear and renewables), they will still represent 78% of the energy matrix in 2040, with natural gas being the fastest growing fuel with an increase of 1.9% a.a. (EIA, 2016).

Figure 1 shows the energy demand by sector (Transportation, Residential / Commercial, Industrial and Electric Power Generation), and it indicates that the use of natural gas is expected to grow in all segments. Global demand for natural gas is expected to grow by 45% (EXXONMOBIL, 2017a), and the eletric power generation is the area of greater growth in energy demand.

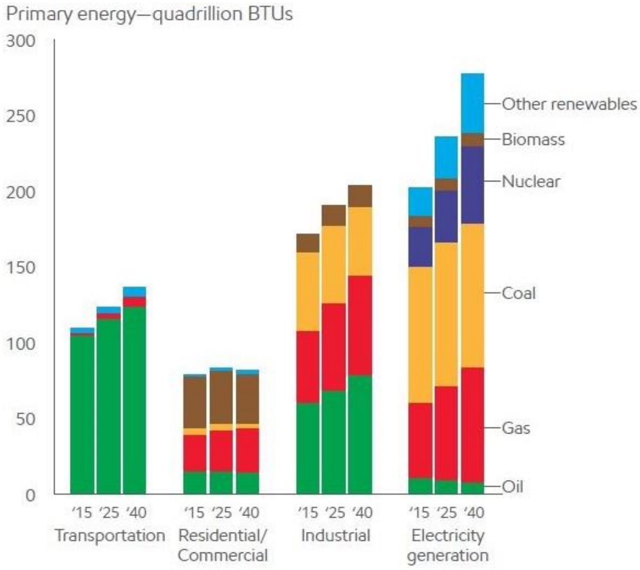

Figure 1. Energy Demand Varies by Sector
Source: ExxonMobil (2017a)

By source of energy, natural gas is the fuel that constitutes the largest increase in primary energy consumption, having a fundamental participation in the electric energy sector. The supply of natural gas is stimulated by the fact that it has favorable characteristics that make it competitive as abundant fuel resources and robust production. Its use in the generation of electric power is attractive, since new ventures of natural gas plants have a moderate cost of capital, they have a good efficiency compared to the coal plants (mainly the combined cycle) and, among the fossil fuels, natural gas is the cleanest.

A The plants that use natural gas do not emit sulfur dioxide or particulates and their emissions of NO_x e CO_2 are, respectively, about 90% and 60% lower than the coal-fired power plants per kWh (WILLIAMS, 2000; EXXONMOBIL, 2017b). In this way, natural gas can help to achieve the goals of reducing pollutant emissions in many countries.

To meet the growing demand for natural gas projected until 2040, world producers of it would increase supply by about 69% from 2012 to 2040. The largest increases in natural gas production are projected in Asian non-OECD countries, the Middle East, the United States and Canada (EIA, 2016).

Consequently, world trade in natural gas, both by pipeline and liquefied natural gas (LNG), is likely to increase in the future. The forecast for world LNG trade will be more than doubling between 2012 and 2040, with most of the increase in liquefaction capacity occurring in regions of Australia and North America, where a number of liquefaction plant designs are planned and under construction (EIA, 2016).

Despite the large LNG growth, pipeline trade still accounts for the bulk of the world market for natural gas, which is likely to grow with the construction of new long-distance pipelines and the expansion of existing infrastructure. The largest volumes of natural gas traded internationally through gas pipelines are in Europe and between the United States and Canada (EIA, 2016).

Given this scenario is evident the importance of natural gas in the world energy matrix, whether in the generation of electricity or other sectors. This means that it is essential to use it efficiently, with special attention to the environment.

2. OVERVIEW OF THE USE OF NATURAL GAS IN THE WORLD

British Petroleum-BP, in its annual report entitled BP Statistical Review of World Energy, publishes some data on the reserves, production and consumption of natural gas in different regions of the world (Tab. 1). According to BP (2017) at the end of 2016 the total of the world's reserves of natural gas reached 186.6 trillion cubic meters, a slight increase of 0.6% compared to 2015. The largest reserves are found in Iran, Russia and Qatar.

Table 1. Reservas, Produção e Consumo de Gás Natural por Região

Região/Continente	Reservas [10^{12} m³]	Produção [10^{12} m³]	Consumo [10^{12} m³]
Africa	14.3	0.208	0.138
Asia Pacific	17.5	0.580	0.722
Europe & Eurasia	56.7	1.000	1.030
Middle East	79.4	0.638	0.512
North America	11.1	0.948	0.968
Sul & Central America	7.6	0.177	0.172

Source: BP (2017)

Regarding the world production of natural gas, in 2016 reached 3.551 trillion m³, registering a rise of 0.6% in the previous year, highlighting the United States and Russia as the countries with the highest productivity.

In relation to the total consumption of natural gas, from 2015 to 2016 there was an increase of 1.8%, reaching 3.542 trillion m³ consumed, once again the United States and Russia as the countries of greatest relevance in this area.

In addition to the aspects of natural gas reserves, production and consumption, there is also the issue of infrastructure and transportation of this fuel. Due to storage difficulties, natural gas needs to be transported immediately to its destination after production. There are several options for the transport of natural gas, with the pipeline and LNG being the main existing and growing ones (MOKHATAB et al., 2006). The combination of the expansion and construction of new gas pipelines and the growth of LNG infrastructure substantially increases accessibility, flexibility and security of supply.

The largest volume of natural gas transported is by pipelines due to a network of infrastructures of natural gas pipelines of highly developed and in continuous expansion in existence nowadays. This broad pipeline network enables natural gas to be easily transported from its production site to the consumer markets. Table 2 shows an overview of the natural gas trade in the years 2015 and 2016 through pipelines and LNG of the different regions of the world where there is volume of imports and exports of this fuel. The increase in the use of natural gas is observed in both scnearios.

Table 2. Gas Trade in 2015 and 2016

	2015				2016			
Billion cubic metres	Pipeline imports	LNG imports	Pipeline exports	LNG exports	Pipeline imports	LNG imports	Pipeline exports	LNG exports
US	74.4	2.6	49.1	0.7	82.5	2.5	60.3	4.4
Canada	19.2	0.6	74.3	†	21.9	0.3	82.4	†
Mexico	29.9	7.3	†	–	38.4	5.9	†	–
Trinidad and Tobago	–	–	–	16.9	–	–	–	14.3
Other S. & Cent. America	19.9	19.8	19.9	5.1	16.8	15.5	16.8	6.1
France	31.8	6.8	–	0.6	32.3	9.7	–	1.5
Germany	102.3	–	32.7	–	99.3	–	19.3	–
Italy	55.7	5.4	0.2	–	59.4	5.7	–	–
Netherlands	33.6	2.1	47.1	1.3	38.0	1.5	52.3	0.7
Norway	†	–	109.6	5.9	†	–	109.8	6.3
Spain	15.2	13.1	0.5	1.8	15.0	13.2	0.6	0.2
Turkey	38.4	7.7	0.6	–	37.4	7.7	0.6	–
United Kingdom	29.0	13.1	13.4	0.3	34.1	10.5	10.0	0.5
Other Europe	94.7	6.9	13.8	1.5	100.2	8.2	15.0	1.3
Russian Federation	21.8	–	179.1	14.0	21.7	–	190.8	14.0
Ukraine	17.3	–	–	–	11.1	–	–	–
Other CIS	27.0	–	72.3	–	27.9	–	74.0	–
Qatar	–	–	20.0	101.8	–	–	20.0	104.4
Other Middle East	29.6	10.2	8.4	18.8	26.9	14.2	8.4	18.1
Algeria	–	–	26.3	16.6	–	–	37.1	15.9
Other Africa	9.0	3.7	11.0	30.0	8.8	10.2	8.5	29.6
Australia	6.4	–	–	38.1	8.3	0.1	–	56.8
China	33.6	25.8	–	–	38.0	34.3	–	–
Japan	–	110.7	–	–	–	108.5	–	–
Indonesia	–	–	9.3	20.7	–	–	8.8	21.2
South Korea	–	43.8	–	0.2	–	43.9	–	0.1
Other Asia Pacific	20.3	46.0	21.4	51.4	19.3	54.8	22.7	51.1
Total World	**709.0**	**325.5**	**709.0**	**325.5**	**737.5**	**346.6**	**737.5**	**346.6**

(†) Less than 0.05.

Source: BP (2017)

In the circumstance that natural gas can not be transported by means of gas pipelines, LNG transport becomes a good option, making it possible to overcome the gap between supply and demand and allowing markets to increase flexibility and security of supply.

LNG is the liquid form of natural gas. Its change from the gaseous state to the liquid occurs by cooling it to a temperature of minus 162 °C, which results in a volume reduction of about 600 times (MOKHATAB et al., 2006), facilitating and making it economically feasible to transport ships built for this purpose..

LNG currently plays an important role in the supply of natural gas in the world, and this share has a steady growth trend. In the final consumer the LNG is submitted to temperature rise in the regasification terminals, returning to the LNG in its gaseous form, being possible from there to be transported through pipelines.

From 2011 to 2016, total trade in liquefied natural gas reached a volume of 258 Mt per year (IGU, 2017), an increase of 13.1 Mt over 2015 as shown in Fig. 2.

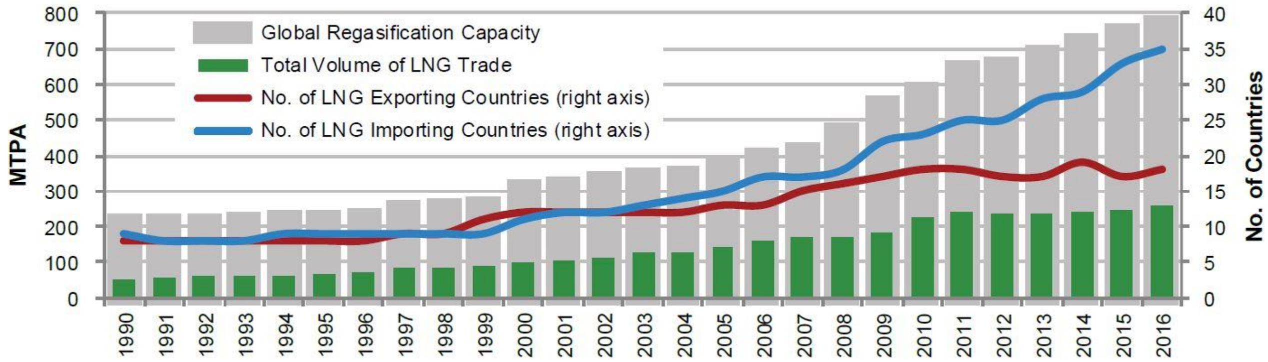

Figure 2. Commercial Volume of LNG from 1990 to 2016
Source: IGU (2017)

In 2016 it was recorded that 18 countries were exporting LNG. Among the major exporters are Qatar, which has been the largest LNG exporter for more than a decade with a total volume of 77.2 Mt, followed by Australia and Malaysia, which occupy the second and third places respectively. A highlight was Australia, which gained ground in the volume of LNG exported with an increase of 14.9 Mt.

Although Qatar is the largest LNG exporting country, Asia-Pacific is the region that contributes most to the volume of exports, accounting for about 38.6% of total exports compared to 35.2% of the Middle East.

There was also a decline in Trinidad's exports for the third consecutive year, since the shortage of Atlantic LNG raw material persists. The decline was also observed in Nigeria due to problems in the Niger Delta region where facilities were subjected to prolonged maintenance during the first half of 2016.

Table 3 shows the world outlook for 2016 exports along with increased sales and percentage change over 2015 (IGU, 2017).

Table 3. LNG Exports in 2016

Country	Trade Volume 2016 [Mt]	Increase 2015-2016 [Mt]	Variation 2015-2016 [%]	Share [%]
Qatar	77.2	-0.6	-0.77	29.93
Australia	44.3	14.9	50.68	17.18
Malaysia	25.0	0.0	0.00	9.69
Nigeria	18.6	-1.8	-8.82	7.21
Indonesia	16.6	0.5	3.11	6.44
Algeria	11.5	-0.6	-4.96	4.46
Russia	10.8	-0.1	-0.92	4.19
Trinidad	10.6	-1.9	-15.20	4.11
Oman	8.1	0.3	3.85	3.14
Papua New Guinea	7.4	0.4	5.71	2.87
Brunei	6.3	-0.3	-4.55	2.44
UAE	5.6	0.0	0.00	2.17
Norway	4.3	0.1	2.38	1.67
Peru	4.0	0.3	8.11	1.55
Equatorial Guinea	3.4	-0.4	-10.53	1.32
USA	2.9	2.6	866.67	1.12
Angola	0.8	0.8	-	0.31
Egypt	0.5	0.5	-	0.19

Source: IGU (2017)

With regard to imports, it was noted that 35 countries purchased LNG in 2016, with the largest consumer market being Japan with a volume of 83.3 Mt.

Asia and the Asia-Pacific markets accounted for the largest import movement in 2016, with a 72.4% share, particularly in the Chinese and Indian markets, which grew respectively by 7 Mt and 4.5 Mt in the volume of imported LNGSmaller markets (Thailand, Pakistan and Singapore) showed moderate growth and play an important role in global trade.

European imports showed a slight increase (0.6 Mt compared to 2015). Markets in north-western Europe (UK, Belgium and the Netherlands) decreased LNG import volumes by 3.4 Mt, due to the supply of natural gas through gas pipelines from Russia and Norway. In contrast, more recent markets such as Poland and Lithuania showed combined growth of 1.4 Mt. Gas-fired power generation in Spain, Italy and Greece also helped the demand for LNG in Europe.

In Africa, Egypt was the only LNG importing country, where it had a market growth of 143% compared to 2015 which represented an increase of 4.3 Mt in LNG volume.

The combined imports of LNG in Latin and North America showed a decrease of 5.8 Mt. Among the factors that contributed to this decline are the increased availability of supply through pipelines in Mexico and the generation of energy by hydroelectric plants improved in Brazil in 2016. Chile, Colombia and Jamaica were the only countries in the America that showed an increase in LNG imports.

Table 4 shows the world outlook for 2016 imports as well as their increase and the percentage variation in relation to 2015 (IGU, 2017).

Table 4. Imports of LNG in 2016

Country	Trade Volume 2016 [Mt]	Increase 2015-2016 [Mt]	Variation 2015-2016 [%]	Share [%]
Japan	83.3	-2.3	-2.69	32.29
South Korea	33.7	0.3	0.90	13.06
China	26.8	7.0	35.35	10.39
India	19.2	4.5	30.61	7.44
Taiwan	15.0	0.4	2.74	5.81
Spain	9.9	1.0	11.24	3.84
Egypt	7.3	4.3	143.33	2.83
UK	7.4	-2.4	-24.49	2.87
France	5.6	1.1	24.44	2.17
Turkey	5.6	0.0	0.00	2.17
Italy	4.5	0.3	7.14	1.74
Mexico	4.1	-1.0	-19.61	1.59
Argentina	3.6	-0.6	-14.29	1.40
Kuwait	3.3	0.4	13.79	1.28
Chile	3.3	0.3	10.00	1.28
Jordan	3.0	1.2	66.67	1.16
UAE	2.9	0.9	45.00	1.12
Pakistan	2.7	1.6	145.45	1.05
Thailand	2.9	0.3	11.54	1.12
Other	13.9	-4.1	-22.78	5.39

Source: IGU (2017)

According to the IGU (2017), global liquefaction capacity increased from 304.4 Mt in 2015 to 336.1 Mt in 2016, and in January 2017 reached the level of 339.7 Mt. Data from the same report indicates that the increase in the liquefaction capacity is expected to increase in the coming years, as there is 114.6 Mt of nominal capacity under construction.

Six countries (Qatar, Australia, Malaysia, Algeria, Nigeria and Indonesia) account for almost 70% of the nominal liquefaction capacity in the world. Qatar, for example, alone holds almost a quarter of the total. The total number of countries with liquefaction capacity is 19, and since 2014, with the construction of a plant in Papua New Guinea, there was no the inauguration of any other plant. The average utilization of these plants was 82% in 2016, with a strong use in countries such as Qatar, Australia, Malaysia, Russia, PNG, UAE and Norway.

In contrast, Egypt and Yemen helped pull this percentage down, with Yemen demonstrating a percentage of zero use. In This area the LNG production was interrupted in early 2015 and remained so due to the ongoing civil war in the country, and that remained offline due to limited gas production.

Most of the 114.6 Mt of nominal liquefaction capacity under construction is located in the USA and Australia, which together will be the main contributors to the new liquefaction capacity with respectively 57.6 Mt and 31.1 Mt. Other projects under construction are located in Russia (16.5 Mt), Malaysia (2.7 Mt), Indonesia (4.3 Mt) and Cameroon (2.4 Mt).

In 2016, Australia remained the second largest liquefaction capacity holder behind Qatar, however, according to the IGU (2017), in 2018 Australia will have the largest liquefaction capacity in the world with an installed capacity of 85 Mt.

Figure 3 shows, in a summarized way, data on the liquefaction capacity of the various countries presented above.

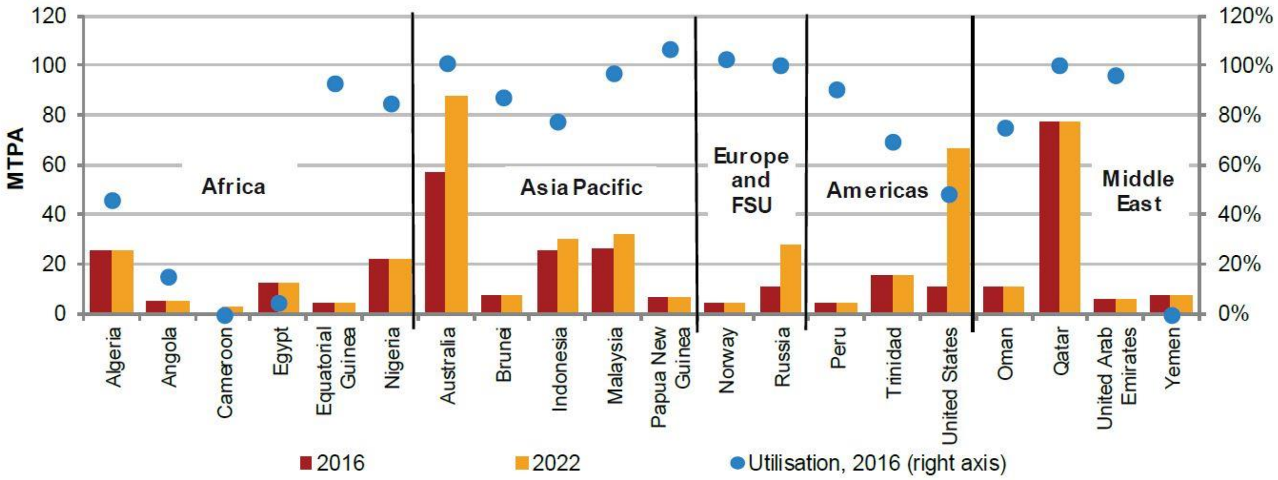

Figure 3. Nominal Liquefaction Capacity by Country in 2016 and 2022
Source: IGU (2017)

According to the IGU report (2017), following the growth in LNG demand, global LNG regasification capacity also increased, reaching at the end of 2016 the capacity of 776.8 Mt in 34 countries. An additional 17.8 Mt was increased in January 2017, raising world capacity to 794.6 Mt. The growth of this new regasification capacity in 2016 came mainly from already established LNG markets such as: Japan, China, India, France, South Korea and Turkey.

The largest concentration of nominal regasification capacity is in Asia and Asia-Pacific regions, with expected growth for both established and developing LNG markets. The North American region was the only locality in the world where regasification capacity did not show recent growth.

The implementation of Floating Storage and Regasification Units (FSRUs) allowed a greater flexibility and access to LNG in new markets, especially in the Middle East, Asia and Latin America regions, reaching a total nominal capacity of FSRU of 83 Mt.

Over the past few years, due to the relatively low LNG price, new markets have been able to complete regasification projects quite rapidly using FSRUs, and it is important that there is sufficient infrastructure for the discharge of fuel. However, most of the new regasification capacity came from existing terminal expansions and the inauguration of new larger ground terminals by offering the stability of a permanent solution when desired.

n 2016, overall usage rates for regasification terminals were 34%, however, if terminals located in the US are excluded, that rate would reach 41%, as a result of the US importing only 1% of its capacity of 129 Mt, as a consequence of the expansion of the large production of the gas and its competitive price. Due to the need to meet demand in the seasonal periods and in order to guarantee security of supply, the capacity of the regasification terminals is greater than the liquefaction terminals. Canada, similar to the US, also had one of the lowest levels of use in 2016 with 3%, also due to the availability of domestic production.

Japan remains the largest importer of LNG in the world and, consequently, the largest regasification capacity with 197 Mt, which represents 25% of regasification capacity in the world. South Korea, the world's second largest LNG importer, has the third largest regasification capacity (losing only to Japan and the USA) with 101 Mt. Although Korea had a 35% utilization rate in 2016, demand fell in relation to the 2013 peak, due to nuclear and coal growth.

China over the past five years has been the fastest growing LNG regasification market, increasing world market share from 3.5% in 2011 to 6.3% in 2016. India is another fast growing market for LNG, with 27 Mt of regasification capacity at the end of 2016, with new project proposals forecasting a capacity of 103 Mt by 2020. Despite the strong activity of new regasification terminal ventures, new gas pipeline projects are proposed in order to spread gas supply throughout the country.

Europe as a whole had low utilization rates, reaching an average of 25% in 2016, indicating a variation between 4% and 25%. Despite having around 20% of global LNG regasification capacity, imports in Europe have fallen in recent years due to the expansion in the use of gas pipelines, mainly from Norway and Russia.

Figure 4 shows, in a summarized way, data on the regasification capacity of the various countries presented above.

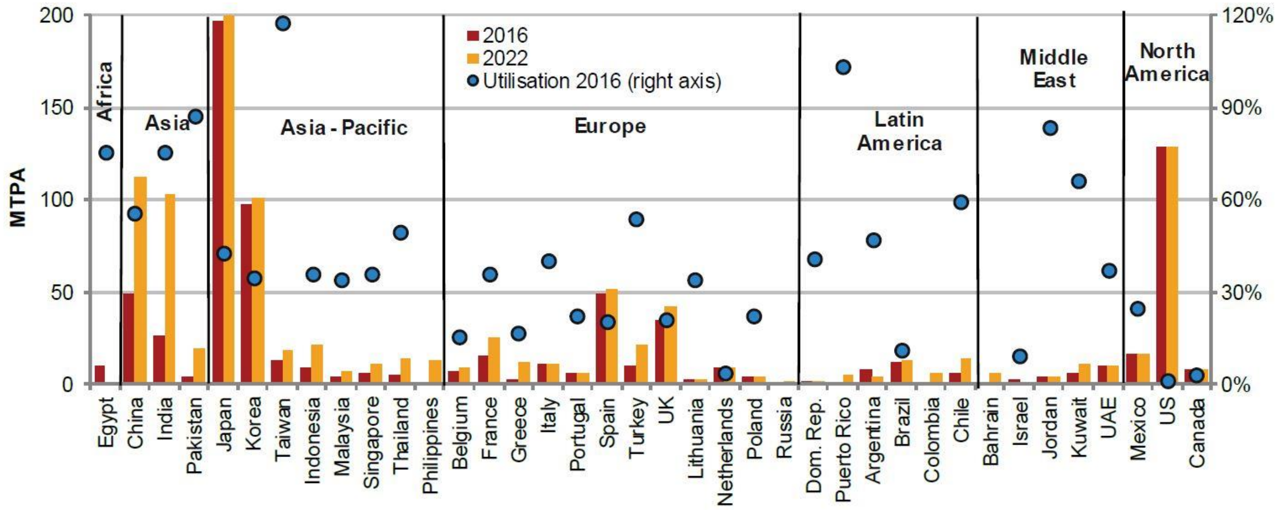

Figure 4. Receiving Terminal Import Capacity and Utilisation Rate by Country in 2016 and 2022
Source: IGU (2017)

Considering the future projections of the use of natural gas, we can see from Fig. 5 the trend of supplying this fuel (in billion cubic feet per day) by region, where it is observed that North America tends to become an exporter of natural gas as unconventional production grows, Russia and the Caspian Sea region establishes itself as the main gas exporter, the Asia-Pacific region becomes the largest importer of gas to meet growing demand.

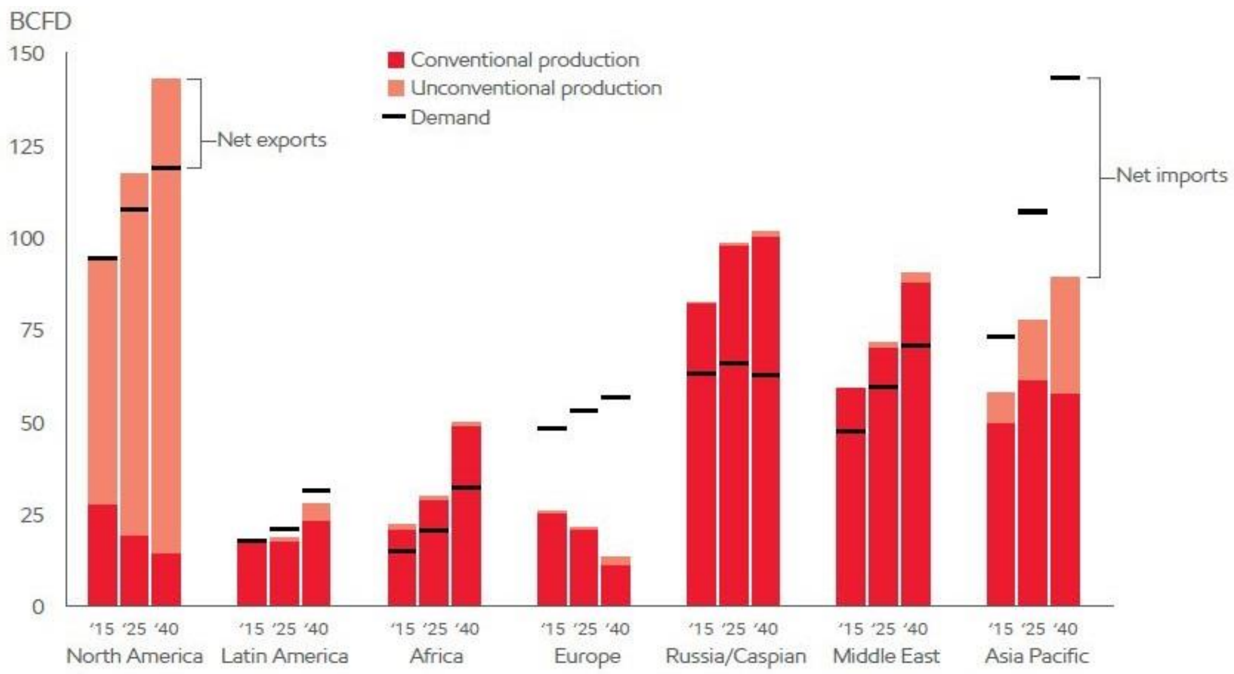

Figure 5. Gas Supply Trends by Regions of the World Until 2040
Source: ExxonMobil (2017a)

3. USE AND FEATURES OF NATURAL GAS IN POWER PLANTS

The latest International Energy Agency (EIA) forecasts in November 2014 confirm the trend in increasing natural gas consumption to 2.2% per year by 2040 (EIA, 2016). Therefore, the aim is to make natural gas the second largest source of energy in the world's electricity matrix, from the current 22% to 28%, behind only oil and its by-products that are expected to have a participation of 29%. In this context, the perspective is that by 2040 natural gas (LNG) will consolidate its position in international markets accompanied by new liquefaction facilities in the USA, Russia, Africa and the Middle East, which will provide greater flexibility and help supply in those markets.

The United States, for example, has been investing heavily in infrastructure for the consumption of natural gas, and this growth is closely linked to the electricity generation capacity by 2020. Currently, natural gas is already the country's main fuel source for electricity generation, and the forecast for 2020 is to continue with this majority scenario, according to Fig. 6 (APPA, 2015).

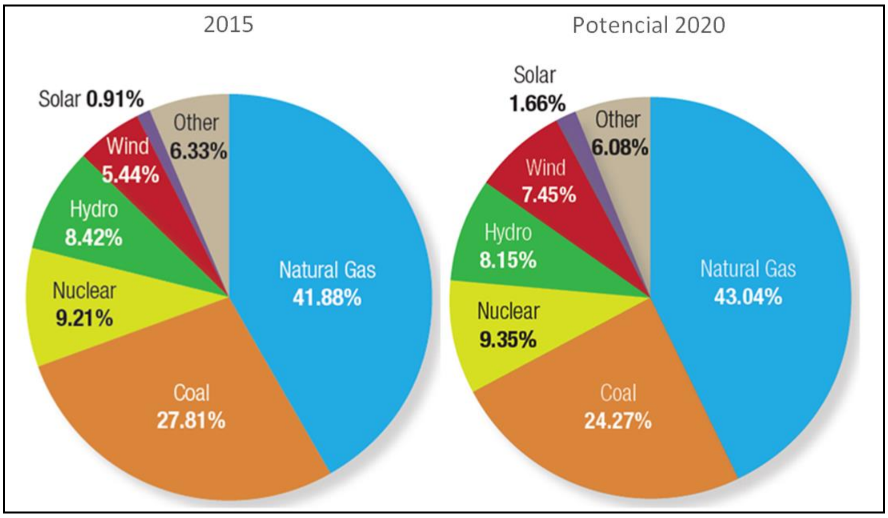

Figure 6. Capacity of Generation between 2015 and 2020 (USA)
Source: APPA (2015)

A very important aspect to be analyzed in power generation plants is in relation to emissions of pollutants. Among the main greenhouse gases emitted, it is estimated that about 90% corresponds to carbon dioxide, 9% to methane and 1% to nitrous oxide (IEA, 2016b). Although the Global Warming Potential (GWP) of CO_2 is 23 and 296 times lower than CH_4 and N_2O, respectively, its emission contribution, as seen, is much more significant than that of other pollutants (IPCC, 2007).

The energy sector accounts for 68% of all anthropogenic emissions of greenhouse gases, followed by agriculture with 11%, industrial processes with 7%, and other types of activity with 14%. In addition to this greater participation, we have also increased the demand for energy in the last decades. Between 1971 and 2014, primary energy supplies increased by about 150%, with more than 80% coming from fossil sources (IEA, 2016b).

In terms of CO_2 emissions, in 2014 the electricity and heat generation sector accounted for 42% of the total emitted, followed by the transportation sector with 23%, the industrial sector with 19%, the residential sector with 6% and by the service sector and others with 10% (IEA, 2016b).

The share of oil in world primary energy in 2014 was 31.3%, followed by coal (28.6%), natural gas (21.2%) and other types of sources (18.9%) Regarding the generation of electricity, it is observed that once again there is a predominance of fossil fuels, according to the IEA (2016a), in 2014 66.7% of the electricity generated in the world came from fossil fuels and in relation to CO_2 emissions the share of oil, coal, natural gas and other sources contributed 34%, 46%, 19% and 1% respectively (IEA, 2016b).

The difference between the values of the participation of the fuels in the energy matrix and how much it actually emitted from CO_2 is due to its different emission factors, and this, on the other hand, is linked to the composition of the fuel (IEA, 2016b). Figure 7 shows the average amount of CO_2 emitted per kWh of electricity produced given the type of fuel of OECD member countries between 2000 and 2014.

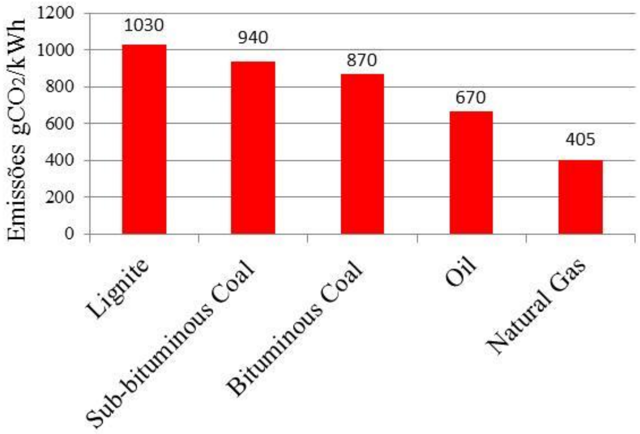

Figure 7. Carbon Emission Factor in Fuel Generation (CO_2 / kWh)
Source: IEA (2016b)

Since the world has been perceiving and caring for the importance of a more balanced and sustainable environment for decades, it is observed that natural gas among fossil fuels is the one with the lowest emission factor, contributing, therefore, to this process of lower emissions of pollutants.

In addition to aspects such as reserves, production, consumption and emission of pollutants, there is also the question of costs. Just as the GHG emission intensity in electricity production is a parameter measured in g-CO_2eq / kWh, an analogous parameter is used in order to compare the production costs of several electric power generation technologies called Levelized Cost of Energy (LCOE). The Levelized Cost of Energy is the total cost of producing one MWh of energy, considering the cost of investment, generation, the useful life of the enterprise, as well as a discount rate for the remuneration of investors' capital.

Figure 8 shows that, among the conventional sources, the combined cycle thermoelectric plants have the lowest LCOE, that is, the cost associated with the generation of one MWh is lower when compared to the other sources.

Figure 8. Levelized Cost of Energy Comparison
Source: Lazard (2015)

Another very important aspect to be analyzed in relation to the natural gas plants is the security in the supply of electric energy. Table 5 shows the installed capacity of the power generation plants by source and the average capacity factor of the ten largest Brazilian power plants in each follow-up, with the exception of nuclear power plants, which are only two (MME, 2015, MME, 2016a). Table 5 also shows the efficiencies that each kind of plant can achieve, in which case the efficiency values are not from plants restricted to Brazil.

Table 5. Capacity Factor of Power Plants by Source

Power Plant	Dez/14		Dez/15		Eficiência [%]
	Capacity [GW]	Capacity Factor	Capacity [GW]	Capacity Factor	
Coal	3.39	0.67	3.39	0.64	35-40(1)/45-48(2)
Nuclear	1.99	0.88	1.99	0.85	33-36
Natural Gas	12.60	0.73	12.43	0.72	36-39(3)/55-60(4)

(1) Subcritical Plants; (2) Super and Ultra-Supercritical Plants; (3) Single Cycle; (4) Combined Cycle.
Source: MME (2015); MME (2016); Tolmasquim (2016)

It can be observed for Tab. 5 that the natural gas plants have a high capacity factor, behind only the nuclear ones, ratifying their safe supply of electric energy. In addition, there is also a regularity in the presented values of the combined cycles, both with respect to capacity and efficiency factor, as well as to costs and emission factors, indicating that such developments tend to grow more and more once which point out to be a great alternative in the electric matrix.

4. CONCLUSIONS

The increasing insertion of natural gas in the world's electric matrix requires a need to expand the transport infrastructure of the fuel that is linked to the supply and demand of the same, so that this factor is not an obstacle to the use of the fuel.

The present study showed that the regions of Europe, Eurasia, North America and the Middle East are the main producers of natural gas in the world, with the Asia Pacific region being the largest consumers. With the increasing supply and demand for natural gas, mainly LNG, there is a growing investment in liquefaction plants (in the exporting countries) and regasification (in the importing countries), with emphasis on Japan, the United States and China and, for those, highlight Australia, Qatar and the United States..

The work also pointed out that the competitiveness of natural gas in relation to other fuels, such as coal, with relevance comparing greenhouse gas emissions, since their contribution in launching them amounts to less than half of the values emitted by coal. In addition, cost-related aspects should always be taken into account, where combined-cycle gas-fired plant developments prove to be highly competitive.

The energy policy that governs the world today is based on three main characteristics: safe supply, efficiency in supply and social and environmental sustainability. Since it is not feasible to expand a country's electricity matrix only by renewable sources, since these are intermittent power generation technologies, this study reveals the importance of the growth of natural gas in the world energy matrix and, consequently, the essential investment in infrastructure in order to absorb demand that fuel and meet the energy supply needs.

5. ACKNOWLEDGEMENTS

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7. RESPONSIBILITY NOTICE

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