

## **The Expansion of the Natural Gas market through the provisions of Law 14.182/21 that deals with the privatization of Eletrobras**

**A Expansão do mercado de Gás Natural por meio do disposto na Lei 14.182/21 que trata da privatização da Eletrobras**

**La Expansión del mercado de Gas Natural a través de la Ley 14.182/21 que trata de la privatización de Eletrobras**

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### **Abstract**

The Brazilian electricity sector is predominantly supplied by clean and intermittent sources of electricity. Intermittency and complementation must be done by other energy sources to further add to the supply of clean energy for Brazil. Natural gas can be one of these sources since it exists in abundance and pollutes less than other fossil fuels such as coal and diesel oil. However, the integration between the electric sector and natural gas must be planned for the development of both and for the benefit of the consumer. Law 14.182/21, authorizes the privatization of Eletrobras (Brazilian Energy Company). The law makes provision for the contracting of 8 GW of thermal energy generation, moved by natural gas, by means of capacity auctions. It further defines in which regions of Brazil that the thermal plants should be installed. In this sense the objective of this article is to make some reflections on the provisions of Law 14.182/21 with respect to the Brazilian electricity sector and the increased participation of natural gas in the national electricity matrix.

**Keywords:** Brazil; Electric sector; Natural gas; Law 14.182/21; Infrastructure; Energy.

### **Resumo**

O setor elétrico brasileiro é suprido predominantemente por fontes limpas e intermitentes, de forma que a intermitência e a complementação devem ser feitas por outras fontes de energia. O gás natural pode ser uma delas, dado que existe em abundância e polui menos que os outros combustíveis fósseis tais como carvão e óleo diesel. No entanto a integração entre o setor elétrico e o de gás natural deve ser planejado para o desenvolvimento de ambos e benefício do consumidor. A Lei nº 14.182/21, que autoriza a privatização da Eletrobras, define a contratação de 8 GW de geração térmica movida a gás natural por meio de leilão de capacidade e define, ainda, em que regiões do Brasil as usinas térmicas devem ser instaladas. Nesse sentido o objetivo deste artigo é fazer algumas reflexões quanto ao disposto na Lei nº14.182/21 no que diz respeito a setor elétrico brasileiro e ao aumento da participação do gás natural na matriz elétrica nacional.

**Palavras-chave:** Brasil; Setor elétrico; Gás natural; Lei 14.182/21; Infraestrutura; Energia.

### **Resumen**

El sector eléctrico brasileño es alimentado de manera predominante por fuentes limpias e intermitentes, por lo que la complementación debe ser hecha por otras fuentes de energía. El gas natural podría ser una de ellas, pues existe en

abundancia y es menos contaminante que otros combustibles fósiles como carbón o diésel. Sin embargo, la integración entre los sectores de energía eléctrica y de gas natural debe ser planeado para el desarrollo de ambos en beneficio del consumidor. La ley 14.182/21, que autoriza la privatización de Eletrobras, determina la contratación de 8 GW de generación térmica alimentada por gas natural por medio de la modalidad subasta de capacidad y define, también, en cuales regiones del Brazil estas usinas térmicas deben ser instaladas. En ese sentido, el objetivo de este artículo es realizar algunas reflexiones sobre las disposiciones de la Ley 14.182/21 con relación al sector eléctrico brasileño e el aumento de la participación del gas natural en la matriz eléctrica nacional.

**Palabras clave:** Brazil; Sector eléctrico; Gas natural; Ley 14.182/21; Infraestructura; Energía.

## 1. Introduction

Brazil is one of the most important countries in the world. It houses the Amazon rain forest, which is known as the largest tropical rain forest in the world. It also contributes a great percentage of oxygen and intakes a wide amount of CO<sub>2</sub> (carbon dioxide) gases. In short, Brazil is the lungs of the world. It is also a country that offers a variety of energy production. Some aspects of electricity production in Brazil comes from predominantly clean sources with almost 76% of its energy produced by renewables like solar and wind sources (EPE, 2021). Such generation sources do not emit CO<sub>2</sub> gases and thus do not contribute to greenhouse gas emission (GHG).

The raw material for these types of renewables is effectively cheap. However, such sources are intermittent, depending on the availability of sun, wind and the amount of water stored in reservoirs for the energy to be generated. Renewable energy is energy from sources that are naturally occurring and are inexhaustible in duration (EIA, 2021). Non-renewable energy is energy from sources that are naturally occurring, but their supply is limited since they are exhaustible in duration (EIA, 2021).

The greenhouse effect is caused by the build-up of water vapour, carbon dioxide, methane with other greenhouse gases like Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons. These gases reach the earth's atmosphere and traps the outgoing solar radiation warming the earth (Birnie et al., 2009). With the increase build-up of these greenhouse gases (GHG) in the earth's atmosphere, more outgoing solar radiation is trapped. This out-going radiation is then reflected into earth, thus, warming the earth and causing adverse effects on the climate. This is known as the greenhouse effect. The long-term effect of the build-up of greenhouse gases and warming of the earth cause climate change. This is called global warming.

Coal and natural gas are still used in Brazil's electric matrix. They emit 95.52, and 53.03 kg of CO<sub>2</sub> per mmBTU- (one million British Thermal Units) (EPA, 2021), respectively. Diesel oil used in electricity generation in Brazil is classified into three types of distillate oils, those of 1<sup>nos</sup>, 2 and 4 (IEA, 2022), which releases 73.25, 73.96 and 75.04 kg of perCO<sub>2</sub> mmBTU (EPA, 2021), respectively. It is however imperative to note that natural gas is a non-renewable source of energy that does not contribute significantly to the increase of GHG emissions, including non-conventional reserves (Lima, et al., 2022; Arend, et al., 2022; Cachola, et al., 2022). Therefore, natural gas is considered as a transition source for supplying intermittencies and/or for increasing the generation offer (Cachola, et al., 2022). It can be used both for substituting coal- or diesel oil-fired plants (Costa, et al., 2022). However, the use of natural gas as a generation source must be studied and considered in indicative planning (Almeida, 2021). One must also consider the fact that the substitution of sources does not make the national matrix more carbonized but the same does not occur if natural gas is used to correct intermittency or to effectively increase generation.

In Brazil, there are no current plans for constructing hydroelectric power plants because of the environmental issues related to the Amazon and economic cost for operation. Nuclear power is still yet to be widely accepted into Brazilian society although it the second largest source of low carbon energy in the world, behind the hydropower (EPE, 2020 – PNE 2050). In order to properly account for the generation and constant supply of clean lower GHG emission energy, Brazil have diversified its energy sector by implementing biomass power plants, thermoelectric plants powered by non-renewable sources such as: coal, diesel oil, natural gas and two nuclear power plants. Brazil is still constructing its third nuclear plant- Angra III. However, there are many challenges that needs to be overcome for the successful construction of new plants.

This paper will seek to show how Law 14,182/21, which deals with the privatization of Eletrobrás, will aid in the provision of lower GHG emissions in Brazil with the utilization of natural gas. It defines in article 1 that the government must contract 8 GW of energy generated from natural gas through a reserve capacity auction. According to Amendment number 574 to Provisional Measure 1.031/21, which preceded the edition of the above-mentioned Law, the inclusion of the referred text is justified by understanding that it is,

*“a priority to allocate the natural gas thermoelectric plant in port areas of the Northeast capital States which do not have a natural gas supply” and to “increase the robustness of the Brazilian Electric System – SEB, increase the energetic security, since the potential load of these port areas are close to the electric energy generation point”.*

In this sense, this article proposes to make some analysis regarding the provisions of Law 14.182/21 with respect to the Brazilian electricity sector and the increased participation of natural gas in the national electricity matrix. Section 2 presents an overview of the situation of the electric and natural gas sectors. In section 3, the analysis of Law 14.182/21, regarding the definition of reserve capacity acquisition and finally in section 4, the final considerations of this paper will be discussed.

## **2. Context**

### **2.1 Overview of the Integration of the Electricity and Natural Gas Sectors**

At the end of the 1990's Brazil started to go through periods of rainfall shortage so that the reservoirs of the hydroelectric plants – HPP were not totally regularized from year to year. To try to maintain energy security, Decree 3.371/00 was issued, which established the Priority Thermoelectric Power Plants Program PPT. This guaranteed the supply of natural gas – NG for the plants integrating the program for a period of 20 years.

In 2001, given the lack of rainfall and an energy demand larger than its offer energy rationing was instituted by the Government of Brazil (Baderlin, 2003). At this moment, some power plants are currently using NG, which comes as a benefited of Decree 3.371/00. However, presently, thermal plants in Brazil are not ready since they take around two years to be built. Decree 3.371/00 have aided in the diversification of energy sources and natural gas, mineral coal and oil thermoelectric, plants in Brazil (Teixeira, 2020). This law reduced the importation of Bolivian gas supplies since it was very volatile and impacted negatively the continuity of the PPT (Teixeira, 2020).

Brazil have already considered NG as a viable source to be inserted into the national energy and electricity matrix since earlier days in its history. In 1995, Constitutional Amendment 9 was approved, which relaxed the Union's monopoly on activities related to the petroleum industry. With the approval of Law 9.478/1997, known as the Petroleum Law, there were market openings for private investors, but not for the natural gas sector (Brazil, 2021). To attract investors to the gas market, Law 11.909/2009 was issued, known as the Gas Law, which also did not bring the expected results.

In 2021, Law 14.134 was published, which is called the “*New Gas Law*” that cancelled the previous law and promoted a new regulatory framework for this sector. The formatting of the said law took years to be completed, having started with the Bill of Law – PL 6. 407/13 (Baptista, 2021), passing through the ‘Gas to Grow project,’ of 2016 that had some measures implemented by means of regulation (without the need to be established new Laws), with the edition of Decree 9.616/18 (Rolim, 2021). Moreover, the New Gas Market program was created in 2019, which,

*“aims at the formation of an open, dynamic and competitive natural gas market, promoting conditions to reduce its price and, thus, contribute to the economic development of the country” (Brazil, 2021a).*

However, the new market would only be materialized with the edition of the new regulatory framework. The New Gas Law promised to facilitate the opening of the gas market and investment (Baptista, 2021). This is important for the electricity sector since in addition to NG being a cleaner source of energy, it costs less than diesel oil and coal, and can contribute to the increase in energy production and supply eventual intermittencies. It is worth remembering that the lack of supply or the increase in the supply of energy impact the economic growth of the country and its social development (Tomé, 2019).

## 2.2 Methodology and literature Review

This article intended to analyze integration between the electric sector and natural gas, considering the Law 14.182/21, that authorizes the privatization of Eletrobras. As already said, this law has a provision for the contracting of 8 GW of thermal energy generation, moved by natural gas.

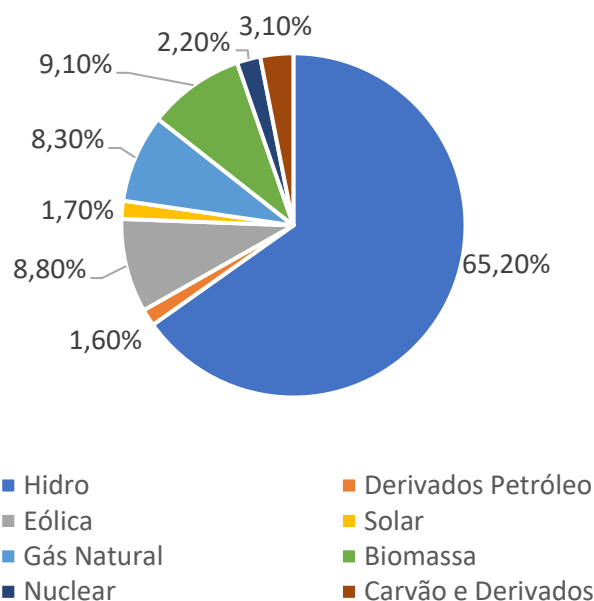
Thus, bibliographic research was made to understand the development of the integration between the electric sector and natural gas in Brazil, considering (i) the legislation and treatment of the theme for Brazilian government; (ii) the main national literature developed in University of Sao Paulo by Research Centre for Greenhouse Gas Innovation<sup>1</sup> (RCGI) group of researchers, by lawyers specialized in energy law, and scholars from Federal University of Rio de Janeiro.

Subsequently, we collected data from main Brazilian Institutions, such as Energy Research Company (EPE) and National Energy Electric Agency (ANEEL) to understand how is structure the energy sector and how gas and power generation are important to Brazilian energy supply.

## 3. Results: Data Collected on Power Generation

The national electric matrix (EPE, 2021 b) counts today with 13% of its offer linked to thermoelectric plants powered by natural gas (8.8%), mineral coal (3.1%) and oil derivatives (1.6%), as can be seen in1 below.

Figura 1 – Brazilian electrical matrix 2020.

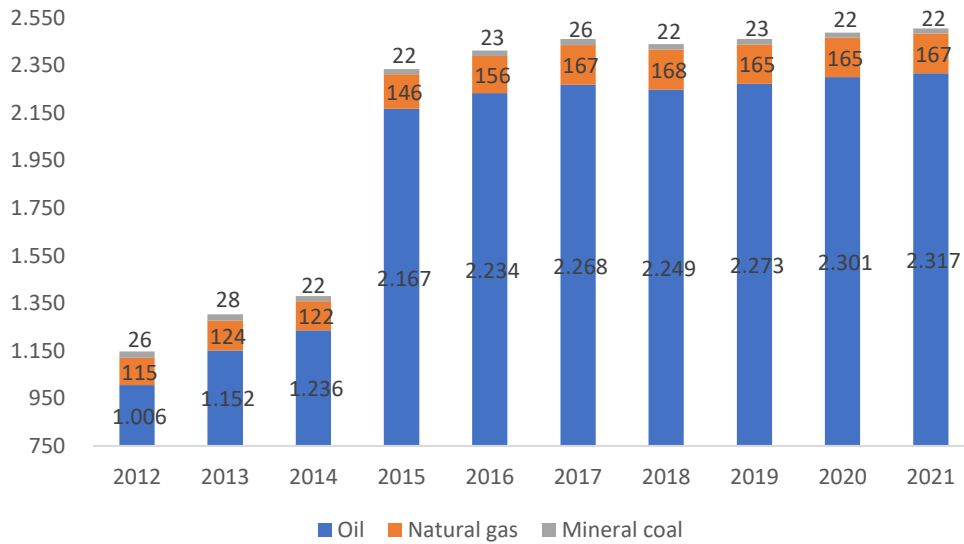


1 (2021).

<sup>1</sup> For more details, please, see: <https://www.rcgi.poli.usp.br/about-rcgi/institutional/>

The referred offer is divided between 2.506 thermoelectric plants (ANEEL, 2021), 2,317 of which run on oil derivatives (96% run on diesel), 167 on natural gas and 22 on mineral coal – as shown in **Erro! Fonte de referência não encontrada.** below.

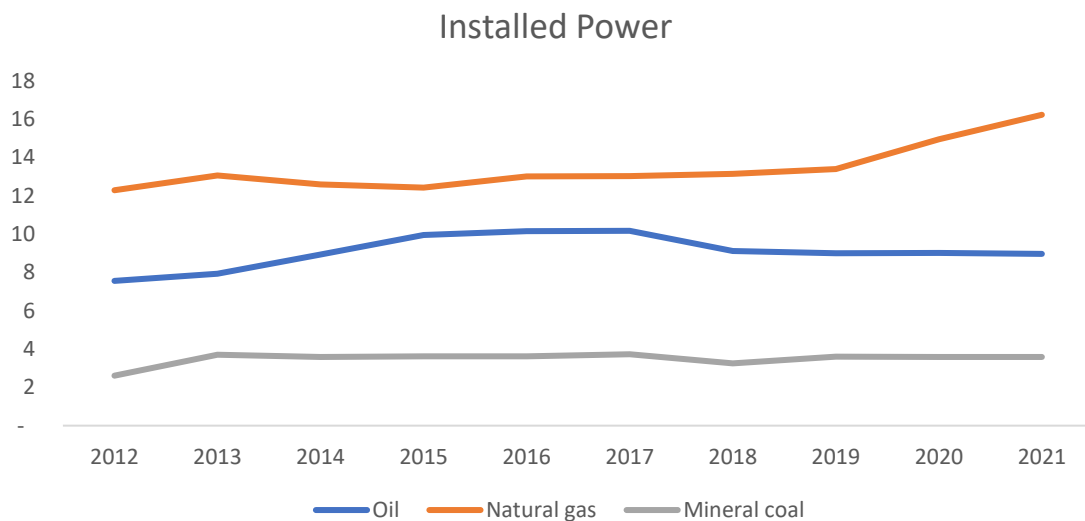
2 Evolution of the quantity of thermal plants in Brazil.



Source: ANEEL (2021).

In spite of the 118% increase in the number of thermal plants inserted in the electric system between 2012 and 2021, there was an increase of 130% and 45% in the installed capacity for diesel and natural gas, respectively, and a reduction of 15% in the installed capacity of coal-fired plants (ANEEL, 2021), as illustrated in **Erro! Fonte de referência não encontrada.** below.

Figure 3 – Installed Power in GW.



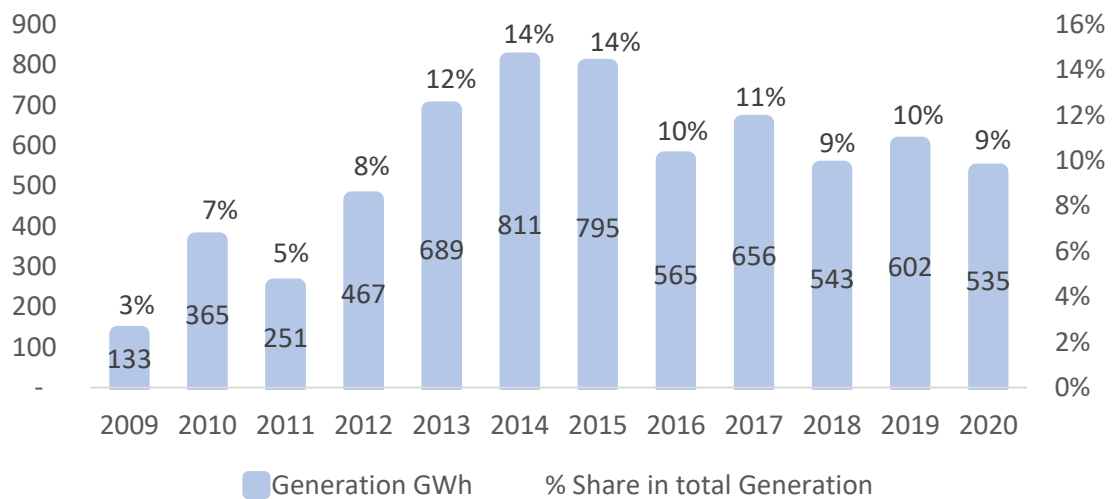
Source: ANEEL (2021).

As far as natural gas-fired plants are concerned, ANEEL's SIGA database, updated to 31/12/21, still shows that there are 7 plants under construction and 22 authorized but not yet started. Which altogether will add another 6 GW of installed capacity to the Brazilian electricity matrix.

The increase in the installed power of natural gas power plants culminates with the increase in the percentage of effective generation as seen in Figure 4 below.

The chart below is showing that the effective generation tripled in 12 years, going from 3% to 9% of the total national generation. It is noteworthy that between 2013 and 2015, Brazil had a longer period of droughts, which led to a greater dispatch of thermal plants. The hydraulicity situation was not resolved from 2016 onwards, however from that date onwards, wind power plants started to gain space, having practically doubled their share in generation from 2015 to 2016 (EPE, 2017).

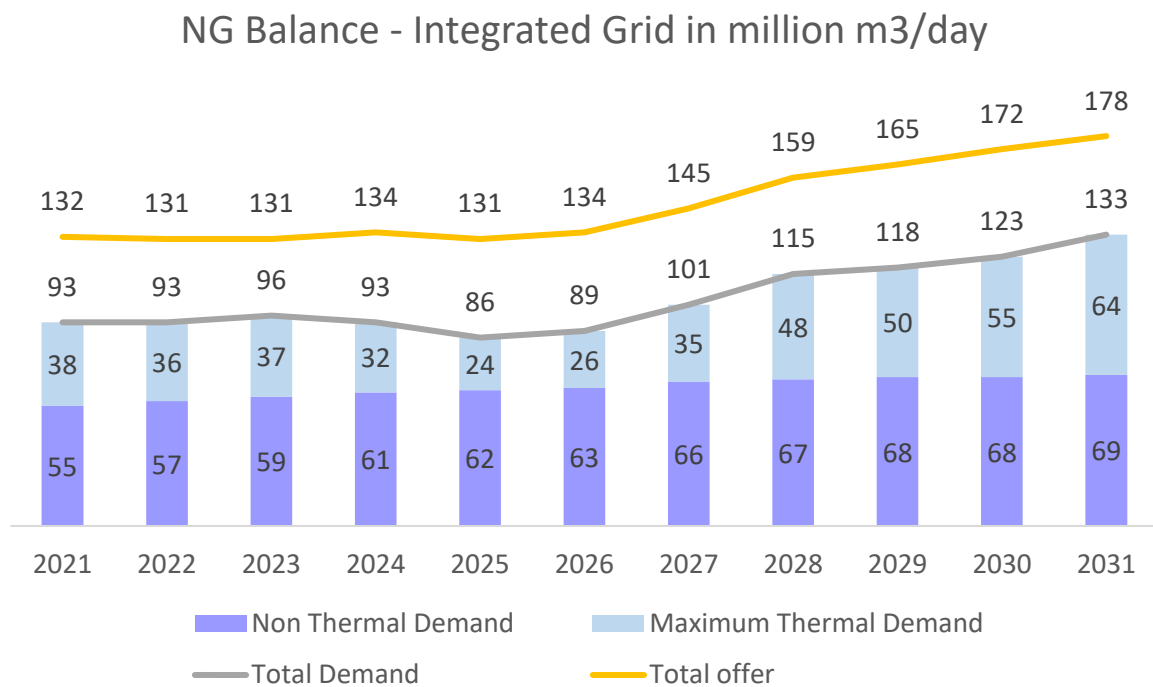
**Figure 3 – NG Generation.**



Source: Own elaboration with EPE data.

4 below shows that EPE's projections (EPE, 2021d) shows a gap between natural gas supply and demand in the integrated system in the entire analyzed period. Furthermore, the data already consider the existing plants, as winners of auctions and other projections. It should be noted that between 2021 and 2022 demand fell due to the end of some contracts and between 2024 and 2026, demand fell because of the COVID-19 crisis.

**Figure 5 – NG Supply and Demand outlook.**



4 (2021d).

#### 4. Analysis of Law 14.182/2021

The privatization of Eletrobras was defined by means of Law 14.182/21. However, its content still defines the contracting of 8 GW of energy generation through natural gas.

The Law was preceded by the Provisional Measure – MP 1.031/21 (Brazil, 2021 c), who’s content did not contemplate the contracting of any additional energy. However, Senator Roberto Rocha, affiliated to the Brazilian Social Democracy Party – PSDB of the state of Maranhão, inserted Amendment 574 to Provisional Measure 1.031/21, and justifies its necessity with the sense that the inclusion is,

*“priority to the allocation of thermoelectric plant to natural gas in port zones of the Northeastern States whose capitals are not free of natural gas supply” and to “increase the robustness of the Brazilian Electric System – SEB, increasing the energetic security, since the potential load of these port zones will be close to the electric energy generation point.”*

Provisional measures as amendments may or may not be approved by the House of Representatives in the voting process. If it was approved in the mentioned spheres, it can still be vetoed by the President of the Republic of Brazil (Brazil, 2022). It was seen that Amendment 574 was not treated as a specific article of the MP. However, it was included in item one, paragraph one, which deals precisely with how to give the privatization of Eletrobras so that the non-approval or its veto, would end up making the entire privatization project of Eletrobras unfeasible. The form used to “prevent” the veto, given that parts of articles are not vetoed or approved, created a determinative energy planning for the expansion of the electricity and natural gas sectors (Almeida, 2021).

It is important that article 22 of the Federal Constitution defines that it is the exclusi“e compe”nence of the Union to legislate on energy (Brazil, 1988). In this sense, article 41 of Law 13.844/19 (BrazilL, 2019), defines that it is the competence



of the Ministry of Energy (MME) to establish guidelines for the planning of the mining and energy sectors. The studies and research that subsidize the policies and determinations of the MME are conducted by the Energy Research Company (EPE).

As observed in section 2 above, there is room for the growth of natural gas in the Brazilian electric matrix, even if such insertion carbonizes the matrix. However, the Law have established a format and it will be up to the EPE to fit this format into its studies and establish how it will be implemented; even if it is or is not the best alternative for the expansion of the natural gas sector and for electric power.

Law 10.848/2004 defines that contracting will be carried out by means of capacity reserve auction as established in articles 3 and 3-A, which states that the Granting Authority shall approve the amount of electric energy or reserve capacity to be contracted and that all costs related to such contracts shall be shared among all end users of electric energy of the National Interconnected System (SIN). Including free consumers, captive consumers and self-producers, except for the energy effectively generated by self-producers (Brazil, 2004). In other words, when it comes to the acquisition of reserve capacity, all electricity users will pay the bill.

It was clarified that the capacity reserve is the operating power reserve that is added to the maximum demand of the SIN. It represents a safety factor given that it makes it possible to,

*“cover unexpected increases in demand, instantaneous variations in generation, among other events outside the energy programming, in addition to ensuring the execution of procedures for operating the power grid”* (EPE, 2021).

In other words, it is guaranteed that the supply of energy is not momentarily interrupted. In the past, these momentary variations in generation were supplied by hydroelectric plants with accumulation reservoirs, however, there was a decrease in the predominance of this source in the national matrix and the expansion of intermittent sources such as wind and solar (MME, 2021).

The Law also defines that the contracted plants must have inflexibility of 70%. Regarding the inflexibility, MME Directive 91/2007 (Brazil, 2007), defines that every plant must make an inflexibility statement that is related to the restriction that leads to the need of minimum generation of the plant. In other words, inflexibility will define the maximum time that a plant could operate in each period.

It is a strange fact that the reserve capacity is necessary to supply eventual generation variations and that the plants to be contracted, according to Law 14.182/21 must operate 70% of the time. Moreover, in December 2021, the first reserve capacity auction was held, in which thermoelectric plants without operating inflexibility and thermoelectric plants whose inflexibility was limited to 30% could participate (Brazil, 2021b). The EPE (2021 a) also points out that the auction was designed to contract power generation capacity to be installed and available to be activated only at times when the electric system needs extra reinforcement to meet peak demand, according to dispatch decisions by ONS. Therefore, these plants differ from the thermoelectric plants called, *“in the base”*, which are planned to operate most of the time.

It seems to us that a subterfuge was used to make the plants that have more characteristics of 8enerateon plants that gives security for the system. These kinds of plants have their costs paid by all electricity consumers, given that if contracting were done under the terms of auctions, the consumers who are being paid for said costs, since energy and capacity are sold together to the electricity distributors.

The law also defines which regions should invest in the NG-fired thermoelectric plants subject to the reserve capacity auctions, as shown in 1 below:



1 – Localities and amount to be contracted.

Region	GW	Observation	Input Operation
NE	1.000	in capital cities or metropolitan regions of the Federation units that do not have NG supply in their capital city at the time of publication of the law	
CO	2.500		
N	2.500	in the capital cities of the States or metropolitan regions where it is feasible to use the proven reserves of national natural gas existing in the Amazon Region, guaranteeing, at least, the supply to two capital cities that do not have a NG supply point as of the date of publication of the LAW;	1 GW in 2026, 2 GW in 2027 and 3 GW in 2028
IF	2.000	- 1,250 MW in States with a natural gas supply point, and - 750 MW for States in the area of influence of the Superintendence for the Development of the Northeast (Sudene) that do not have a NG supply point at the time of publication of the LEI	1 GW in 2029 (states with NG supply point) 1 GW in 2030 (remaining)

Source: Own preparation with law data.

#### 4. Discussions

Considering that Brazil is a country that depends on natural resources for energy production, contracting 8 GW of energy from NG generations, may initially seem to be the solution for solving the problem of intermittence and guaranteeing supply. After all, resulting to NG will aid in eroding the problems related to energy supply and also aid in generating jobs and developing the regions where the natural gas would reach and also developing the natural gas and electricity sectors. The Brazilian Natural Gas Association (in Portuguese Associação Brasileira das Empresas Distribuidoras de Gás – ABEGAS, 2021) estimates that nine capitals could benefit from the LEI, namely: Belém, Rio Branco, Porto Velho, Macapá, Boa Vista and Palmas in the North, São Luís and Teresina in the Northeast and Brasília, Goiânia and Cuiabá in the Centre-West.

4 above showed that the projection of offer is larger than that of demand for the integrated system, for the next decade. However, 1.25 GW of the 8 GW that should be contracted can be acquired in places where there are interconnection with the integrated system. Therefore, at present, there are no gas pipelines that could carry this NG offer to the regions determined in the LAW. Contracting 8 GW, with 70% inflexibility, will cause an increase in demand of at least 25 MMm<sup>3</sup>/day and could reach 36 MMm<sup>3</sup>/day of natural gas at its peak (Almeida, 2021). The expectation shown in 4 is that in 2030 and 2031 there will be an excess supply of about 30 and 45 MMm<sup>3</sup>/day respectively, which is much above the peak demand in the year of NG 2030 used.

Moreover, concerning supply, the Law defines exclusively that for the North Region, the use of gas from the proven reserves existing in the Amazon Region, would be utilized. However, these reserves will be committed to supply the exist thermal plants that generate electric power in Manaus and Boa Vista(Almeida, 2021). For other regions, there are no limitations, so, for example, imported liquefied natural gas – LNG (Almeida, 2021) can be used. LNG is transported in methane ships and allows storage in places close to consumption (Botão, 2019), and must be re-gasified for such. This strategy can be a good solution for capital cities and metropolitan regions located on or near the coast, such as the coastal cities of the state of Espírito Santo: Linhares, São Mateus and Conceição da Barra, which are all located in the area of SUDENE (SUDENE, 2022). On the other hand, its viability should be assessed for the city of Brasília, given that between the Federal Capital and the port of Vitória (the closest) there are over 1,200 km of distance.

Another aspect that should be highlighted is that the LAW defines that the supply of energy must be contracted for a period of 15 years at the updated price of the average of the 2019 A-6 auction. In this sense, two situations may occur:

- (i) given that there is no infrastructure for the NG to reach the largest portions of the amount that should be contracted, the value cannot be sufficient to remunerate the investment for the 15-year supply period, which will drive investors away from the contest; or
- (ii) the value may be high, there will be no competition with other sources, thus affecting the modicity of electricity.

The supply of electricity must occur through auctions (Brazil, 2004) in which modifications are sought, so as to make electricity prices accessible to consumers. The lowest cost is usually obtained by plants that have greater flexibility in generation (Tomé, 2020). Perhaps this is the reason for the inflexibility set forth in the 70% Law, to cover the costs of gas purchase contracts, which have price clauses linking the value of gas to oil (Almeida, 2021) and minimum consumption, known as *take or pay* (Tomé 2020, Almeida, 2021), In this system, the monthly buyer pays a minimum amount that does not effectively use the contracted amount. From the buyer's point of view these clauses aim to ensure the stability of the gas supply and from the seller's point of view, ensuring the necessary cash flow to pay for the project's infrastructure (Silva, 2005).

Given that the LAW defines regions in which gas pipelines must be installed as plants, one must think about how natural gas would reach them, given the requirement to establish the largest portion of them in regions without access to NG. The construction of new gas pipelines, which has not been carried out since 2010, is complex issue from a regulatory, environmental and economic point of view (Almeida, 2021 a) and demands time and money. The New Gas Law defines that the ANP must authorize those interested in exercising the activity of transport and for construction and expansion, to be made public, by calls of the ANP. The natural gas transportation activity has the characteristics of a natural monopoly, since large investments are required for its implementation, and the implementation of parallel gas pipelines is not justified (Almeida, 2021a).

4 below presents the current transport infrastructure:



**Table 2 - Natural Gas Value Chain.**

Chain Link	Description
Exploration and Production	Natural gas production stage
Flow	Stage of moving the gas from the platform to the shore
Processing	Stage of Natural Gas Processing Units (NGPU). Natural gas of onshore or offshore origin needs to be treated, i.e. gas fractionation (ethane, methane, propane and butane)
Transport	Stage of entry of the gas into the transportation network after leaving the NGPU's
Distribution	Stage where the gas leaves the transport network and enters the distribution network so that the gas reaches the end consumer
Import	Stage in which foreign gas is acquired via pipeline or through regasification terminals
Marketing	Stage of the purchase and sale of natural gas through supplier and consumer agents

2.

Based on the described dynamics, it will be possible to identify the obstacles associated with the use of NG produced in the Pre-Salt.

The extracted gas can be used in two ways: (i) total reinjection of the gas produced for oil extraction; this helps maintain reservoir pressure and increase oil production; or (ii) making the gas available on the market. Ideally, when defining the costs of setting up an oil platform, one should consider whether the gas will be re-injected or made available, since the form of use alters the expected return on venture. In the case where NG is made available, one must also consider the investments with outflow and processing and consider the probable reduction of the platform's gas and oil processing capacity. Likewise, in the case of the re-injection decision, it should be considered how much will no longer be available to the market.

In short, consider all the monetization scenarios with the commercialization of gas (ANP, 2020). The National Petroleum, Natural Gas and Biofuels Agency – ANP (2020) points out that *“the ideal is that the beginning of the flow and sale of gas should occur together with the first oil. Otherwise, there is the risk of delaying the start of production, which must be considered in the economic evaluation of the project.”* This means that the decision to re-inject or make available must occur before the start of the project.

Furthermore, it is worth elaborating that in cases where it was decided to make NG available for consumption, it is necessary to invest in infrastructure after processing, since treated NG must be transported by pipelines or there must be consideration of another form of transport, in cases where it is liquefied (ANP, 2020). Although the national production of NG is growing because of the Pre-salt area, there is still a lack of structure, to bring it to the continent and demand to compensate for the investment in infrastructure (Ramos, 2019).

Therefore, once more the need of integrated planning is demonstrated, making it possible to combine the decision of making NG available and the contracting and transmission of energy generated by means of this same NG, under penalty of compromising energy security (Almeida, 2021).

## 5. Concluding Remarks

The energy integration between the natural gas and electric sectors is of utmost importance given the need to maintain the security of supply and increase the offer of energy, to maintain the economic and social and environmental development of Brazil. However, the NG value chain is complex and costly, and it is necessary to plan these resources to be integrated with the electric sector, with the consideration that like all sectors, this one depends on the implementation of infrastructure so that the energy generated is properly delivered to the consumer.

While natural gas is a non-renewable source of energy, it produces lower amounts of GHG emissions than the traditional coal and oil and gas used for electricity production in Brazil. Therefore, with the implementation of natural gas within the Brazilian matrix, Brazil will be moving away from the traditional non-renewable, heavy polluting sources of energy to a cleaner and widely available source. Brazil will have also further curb the effects of their GHG emissions within the territory and would have aided in reducing the effects of climate change. Hence, it is very important for the Government of Brazil to provide the necessary mechanics in the form of funds and skilled labour for the wide use of natural gas in their matrix. Not to only mention, but Brazil will also be effectively complying with several international laws and regulations that promote the transition into cleaner energy sources.

The creation of the 8 GW power contracting through natural gas defined in Law nº14.182/21 creates a public policy, determining the contracting of 8 GW of energy by means of natural gas as well as defining the regions that must offer the abovementioned energy supply that could impel the growth of the gas industry. Even though the abovementioned Law defines the energy purchase price, if this price is not sufficient to cover the costs, the investor will not make investments and the NG transport and processing infrastructure should also be amplified. On the other hand, in case the pre-defined price, if it is larger than the cost necessary to cover the NG extraction process until energy production, the hour adjustability may be compromised.

In any case, until the implementation and effective operation of all the thermal plants that will make available the power to be contracted under the terms and conditions of Law 14.182/21, Brazil is yet to overcome several challenges. When all thermal plants are operational, though the provisions of the Law for an additional 8GW of power as mentioned above, Brazil will also provide stable power to many homes stopping irregularities within its electric matrix. By the end of 2030, when and if all the projects are operating, the country is expected to have not only fostered the natural gas industry, but also managed to maintain energy supply, generating wealth and improving the population's condition.

Considering that this article did not include budget data for the implementation of the 8 GW of energy defined by Law 14.182/21, it is suggested that the official budget data for implementation be compared with values for the implementation of other energy sources with the objective of identifying if the Brazilian consumer is being financially benefited or not.

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