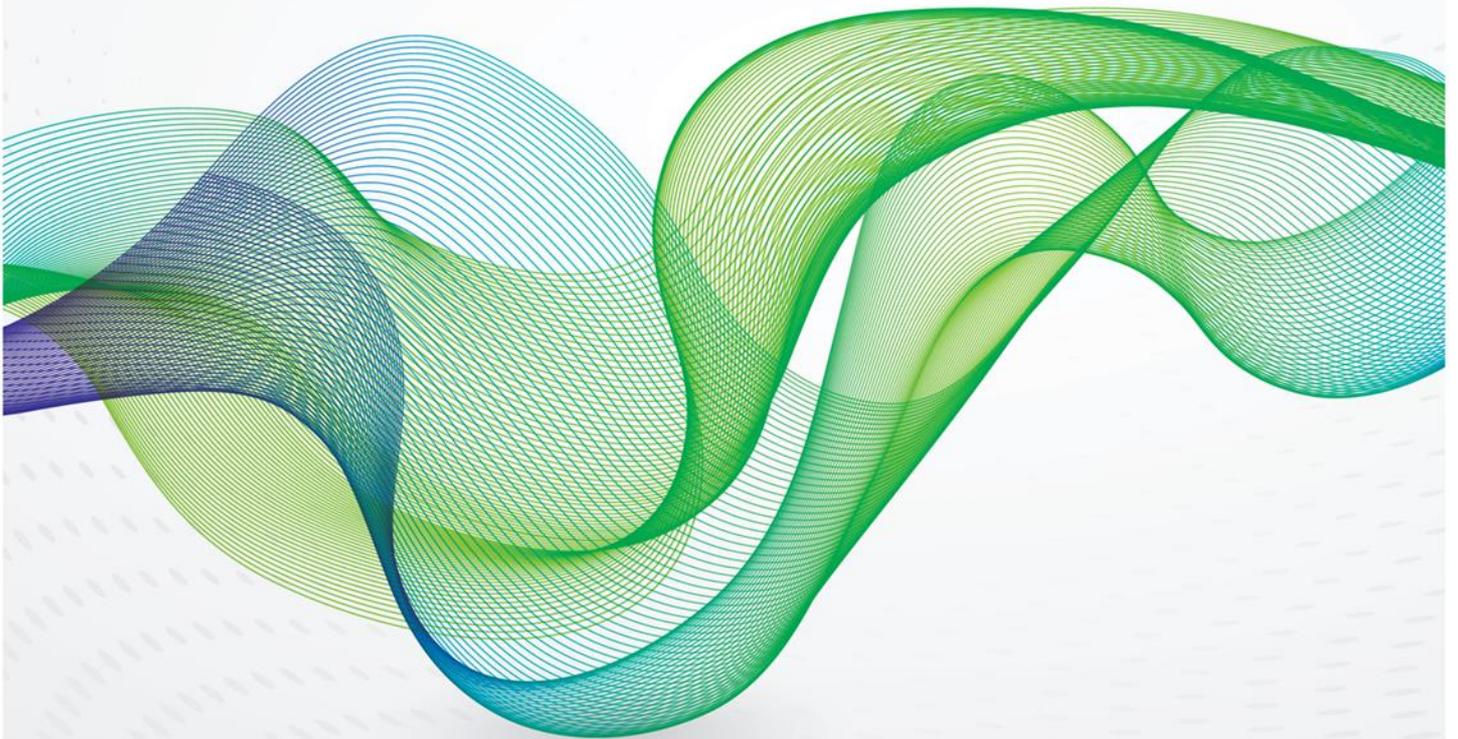
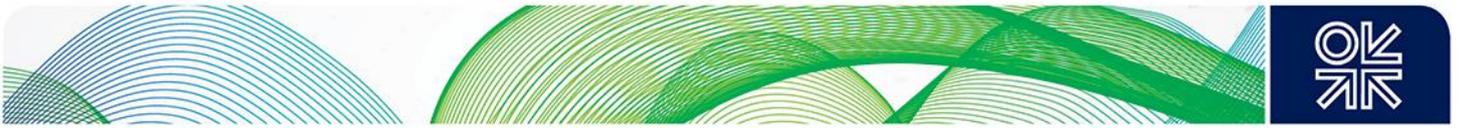


December 2021

Liberalization: the key to unlocking natural gas potential in Brazil?





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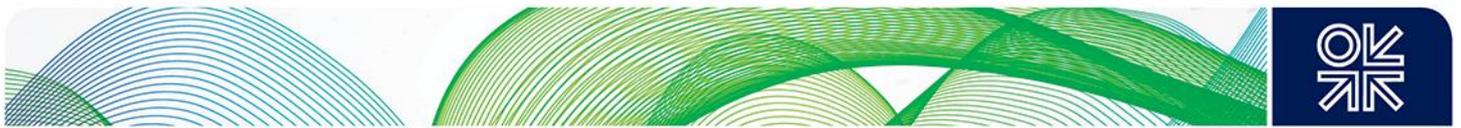


Contents

Figures	ii
Introduction.....	1
Can liberalization be implemented within the constrained window afforded by energy transition?	2
Brazil’s natural gas market in 2021	2
Supply	2
Demand.....	7
Prices	8
The road to reform	10
From Gas to Grow to the new gas market.....	12
The TCC and Petrobras’ retrenchment.....	13
The 2021 Gas Law.....	14
Expected benefits from liberalization	15
Can liberalization singlehandedly effect the required market transformation?	16
Expanding supply	16
Developing infrastructure	21
Igniting demand.....	22
Can liberalization be implemented within the constrained window afforded by the energy transition?	23
Concluding thoughts and recommendations.....	25

Figures

Figure 1: Evolution of Brazilian natural gas supply (2000-2020)	3
Figure 2: Oil and gas pre-salt basins	3
Figure 3: Brazilian natural gas production (2000-2020).....	4
Figure 4: Natural gas transport and import infrastructure	5
Figure 5: Brazilian natural gas consumption by sector	8
Figure 6: Brazilian natural gas price – wholesale and imports and international gas prices	10
Figure 7: Participation of Petrobras in the natural gas chain in 2016	11
Figure 8: EPE gross and marketable production forecast 2021-2030.....	17
Figure 9: Brazilian electricity generation per source (2012-2020)	20
Figure 10: Hub development to path maturity.....	25
Figure 11: 2050 PND Recommendations for the natural gas sector	26



Introduction

Brazil holds great promise for natural gas development: a large population underpinning rising energy demand; sizeable reserves, and a market hungry for diversification of energy sources.

While great progress has been achieved in the last 30 years in the development of natural gas production, infrastructure and demand, the Brazilian gas market remains in its infancy with respect to its potential. A decade ago, the world was preparing to enter the *Golden Age of Gas*, as the International Energy Agency aptly observed.¹ At the time, the North American gas revolution was creating considerable opportunities for greater future use of natural gas globally. While its natural gas industry was not as developed as that of the United States, Brazil had significant natural gas potential given the offshore oil and gas mega discoveries in 2006-2008 that catapulted the country into the big league of hydrocarbon reserves.²

To monetize this potential, the Brazilian domestic natural gas market required further development. With that in mind, the Brazilian government enacted the 2009 Gas Law,³ which was expected to incentivize competition and to encourage more investment in exploration and production leading to market expansion and greater utilization domestically. However, the 2009 Gas Law did not produce the intended results. By 2015, the Brazilian natural gas market continued to suffer from high levels of concentration and price – dominated by a single state-owned company; from being small in relation to its resource base and demand potential; and importantly, from being insufficiently attractive to lure financial resources toward its development.

If the objective was to have a greater diversity of market agents, transparency, competitiveness, access to information, and liquidity to facilitate greater market development, then the rules that gave structure to the market required an overhaul. Regulatory reform and specifically, effective liberalization, were seen as a requirement to unlock Brazil's natural gas potential.

In 2016, under the Temer administration, the Brazilian government launched an effort to revise the regulatory framework. After six years of attempting comprehensive reform, in April of 2021, a new gas law was enacted: the 2021 Gas Law.⁴ The expectation is that this law and its implementing regulation will not only cement the reform providing legal security to investors but will help address obstacles that so far have prevented market expansion. Specifically, the new regulatory framework, and accompanying market design, is expected to herald investment in gas production and transportation infrastructure leading to the expansion of supply, thus allowing more gas to be traded by multiple agents and facilitating the development of market-based price formation mechanisms. In sum, to pave the way to a liquid and competitive market.

In light of this, two important questions come to mind.

Can liberalization single-handedly effect the required market transformation? The recent retrenchment of the incumbent, state controlled *Petróleo Brasileiro S.A. (Petrobras)*, from well-developed and integrated assets along the value chain coupled with the change in rules hold great promise. Indeed, room for other players has been created. The incumbent's divestment has and will continue to attract the interest of large investors; however, a larger spectrum of private sector interest will be necessary to finance transportation and distribution infrastructure beyond the coastal areas and to open up new and, until now, unexplored demand outlets. Resource potential is not an issue, however

This paper benefited from analysis and text previously presented in a range of outlets such as the 27th World Gas Conference proceedings, OGEL Journal, LNGIndustries and 2019 and 2021 Gastech presentations.

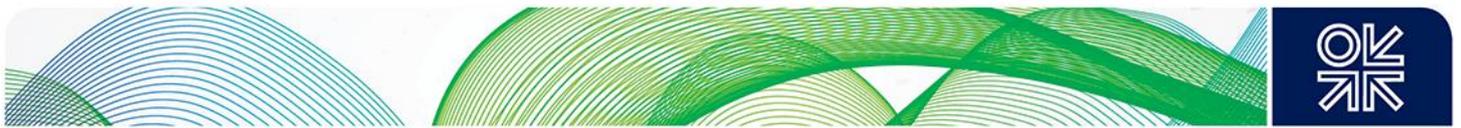
¹ International Energy Agency. (2011). IEA special report explores potential for 'golden age' of natural gas.

<https://www.iea.org/news/iea-special-report-explores-potential-for-golden-age-of-natural-gas>

² Wertheim, P. H. (2008). 'Brazil reserves soar on new find', *Offshore*. <https://www.offshore-mag.com/geosciences/article/16761895/brazil-reserves-soar-on-new-find>

³ Law 11909 of 4 March 2009. http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/L11909imprensa.htm

⁴ Law 14134 of 8 April 2021. <https://www2.camara.leg.br/legin/fed/lei/2021/lei-14134-8-abril-2021-791240-norma-pl.html>



bringing reserves to market in what is still a large undeveloped country is a formidable challenge. Also, as was the case with the 2009 Gas Law, the devil is in the details: implementation and enforcement of the new law will be key to ensure further market development.

Can liberalization be implemented within the constrained window afforded by energy transition?

The successful liberalization of gas markets has been possible, but it has taken time. Much depends on the speed and synchronism with which the requisite network of policies, regulations and institutional capabilities are developed to both build the market architecture and oversight desired, and to influence market agents' interests and behaviours. The energy transition toward carbon neutral energy systems and economies provides a shorter window to develop a liquid and transparent natural gas market.

This paper examines the challenges and opportunities the Brazilian natural gas reform and liberalization process brings. To provide an assessment, the paper first takes stock of the state of the market as of 2021 by providing a view on supply, demand, and prices. Next the paper briefly chronicles the reform efforts, covering their rationale as well as the main features of the recently approved 2021 Gas Law and its expected benefits. The third section focuses on critical aspects in future market development such as offshore reserve gas monetization, transport and import infrastructure development and new demand outlets. The fourth section briefly details the proposed market design and the focus of regulatory developments in the short term. The last section of the paper offers some concluding thoughts and points to relevant topics for a future research agenda.

Brazil's natural gas market in 2021

The following section provides a brief description of the Brazilian natural gas market in 2021.⁵ While examining supply, demand, and price dynamics, it takes stock of the COVID-19 pandemic's impact on the sector and provides an abbreviated discussion on the market's distinctive characteristics and its potential.

Supply

Brazil produces and imports natural gas to satisfy its domestic demand. Originally supply was facilitated by imports, but Brazil has gradually increased its domestic production, which today accounts for roughly 60 per cent of total supply as shown in Figure 1.

Production has been enabled by the discovery of associated gas deposits in the Brazilian continental shelf, and to a lesser extent by small deposits onshore. According to data from the Brazilian National Agency of Petroleum, Natural Gas and Biofuels or ANP by its acronym in Portuguese, proven natural gas reserves (P1) stood at 338 billion cubic meters (Bcm) in 2020,⁶ placing Brazil in third place behind Venezuela and Argentina in natural gas resource potential in South America. 77 per cent of these reserves are located offshore, with a significant portion in the pre-salt area as shown in Figure 2.⁷

⁵ The natural gas industry in Brazil dates to the 19th century with the production of gas from coal, mainly to be used in public lighting. In the early part of the 20th century, about ten Brazilian cities had piped gas networks. Companies such as CEG (the city's gas distributor in Rio de Janeiro) and Comgás (now the main distributor of the State of São Paulo) were created. However, with the advent of electricity in 1882, piped gas development diminished and in fact, was restricted to large urban regions in Rio de Janeiro and São Paulo. Only until the beginning of oil exploration and production activities in the Northeast in the late 1950s, did natural gas regain any importance. Domestic production of natural gas, initially from associated gas in the Northeast, saw increases with the offshore oil and gas discoveries in the Campos Basin, especially in the 1990s. The Brazilian natural gas industry thus was structured as a result of, and mirrored on, developments in oil exploration and production in Brazil. For further detail on Brazil natural gas industry and market history see ANP (2009). *Evolução da Indústria Brasileira de Gás Natural: Aspectos Técnico-Econômicos E Jurídicos*. November 2009. <https://www.gov.br/anp/pt-br/centrais-de-conteudo/notas-e-estudos-tecnicos/estudos-tecnicos/arquivos/2009/evolucao-industrial-gas-natural-2009.pdf>

⁶ Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP). (2021). *Anuário Estatístico 2021*

⁷ The term pre-salt is commonly used to designate geologic layers that formed before a salt layer accumulated above it. It is located in ultra-deep waters, between 1,900 and 2,400 meters. Because the salt layer can exceed 2,000-metre-thick in some

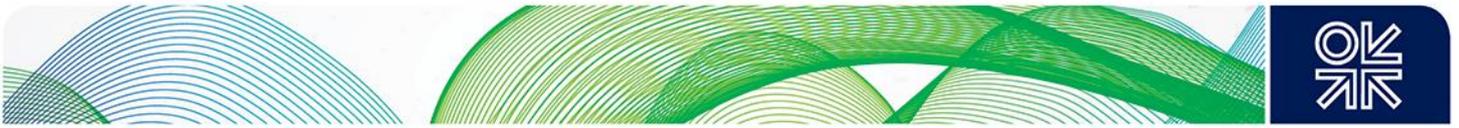
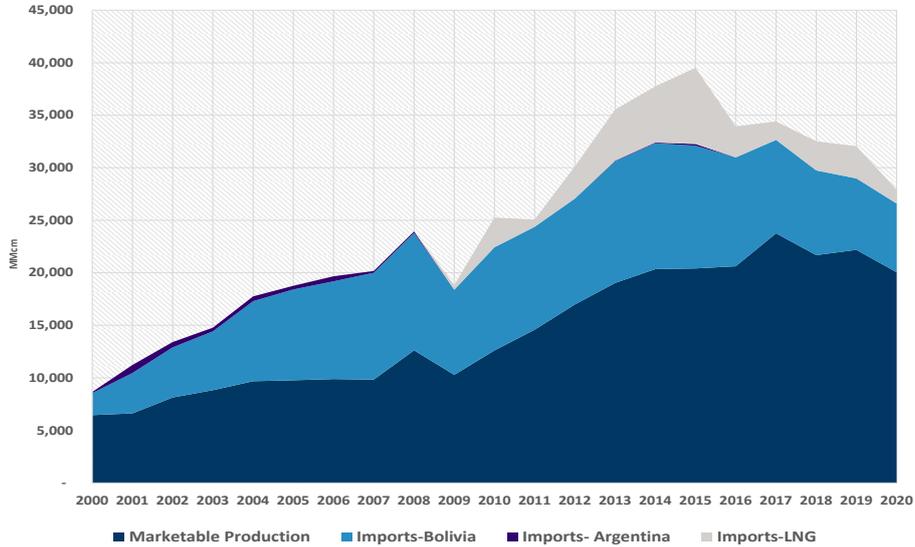
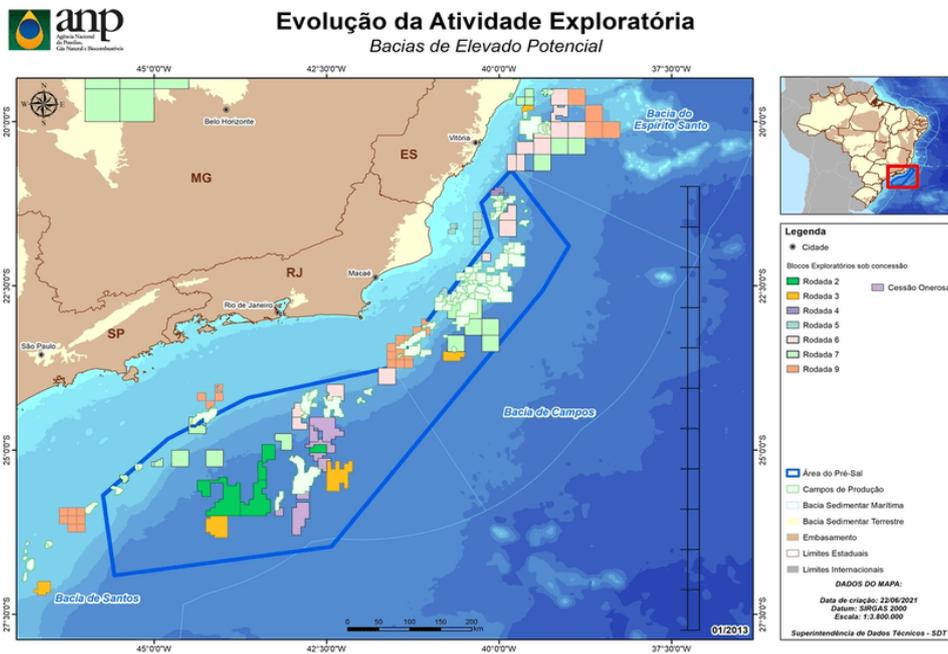


Figure 1: Evolution of Brazilian natural gas supply (2000-2020)



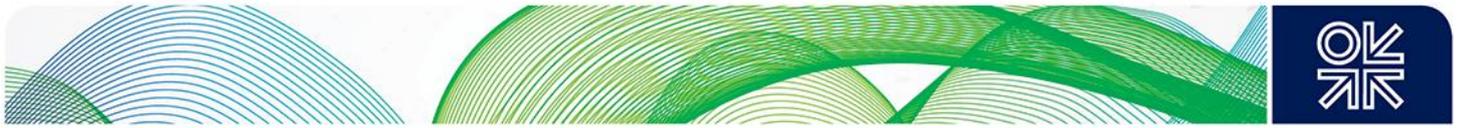
Source: Author with data from ANP. <https://www.gov.br/anp/pt-br/centrais-de-conteudo/dados-estatisticos>

Figure 2: Oil and gas pre-salt basins



Source: ANP. <https://www.gov.br/anp/pt-br/assuntos/exploracao-e-producao-de-oleo-e-gas/dados-tecnicos/mapas-e-p>

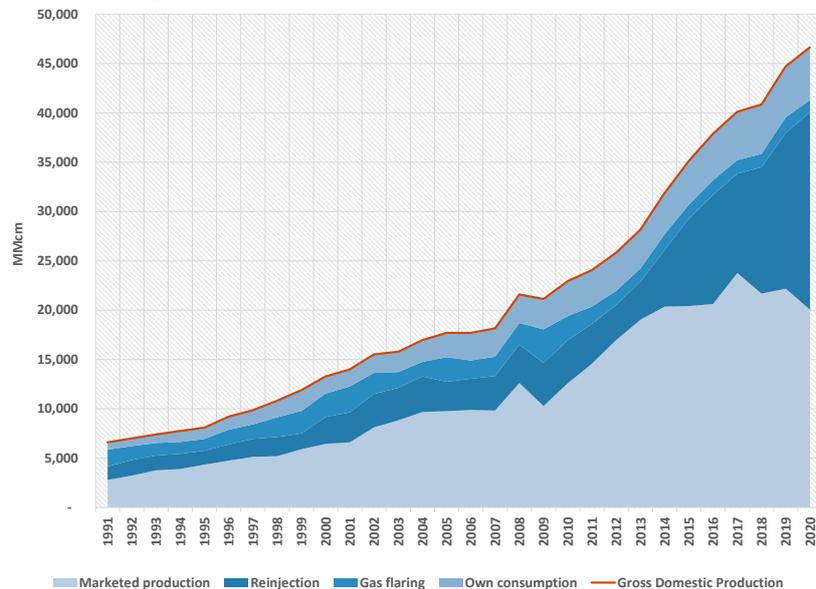
areas, and water depth can reach over 2,000 metres, a pre-salt deposit can be located at a depth of over 7,000 metres. Industry analysts have reported the pre-salt oil and gas potential to be mostly located in the Northeast to South of Brazil, in the Gulf of Mexico and in Africa's West coast. Prospection for oil in the pre-salt layer gained momentum as easy oil deposits located in the above layers started to run out. In 2007, exploration in the pre-salt layer in the Brazilian continental shelf resulted in the discovery of a new oil and gas province with significant hydrocarbons potential.



Brazil's natural gas production has been rising for decades. Gross production doubled in the 1990s and in the last two decades it more than tripled, reaching roughly 46 Bcm in 2020. However, as seen in Figure 3, because of reinjection, gas flaring and own consumption in the production process, marketed domestic production has been only half of gross production. Marketed domestic production reached 20 Bcm in 2020.

Since a large part of Brazil's natural gas resources are associated with oil production and project economics in the Brazilian offshore basins are driven by oil, natural gas extraction has hinged on the rate of oil production. As an associated product, natural gas has been basically available as a free by-product at the wellhead. Yet, the cost of separating, treating, and transporting natural gas to shore has not necessarily been low enough or supported by domestic market prices to result in larger utilization of natural gas in the domestic market. In fact, most of the initial natural gas associated production from the Campos Basin deposits was not actually marketed, but either reinjected or flared.⁸

Figure 3: Brazilian natural gas production (2000-2020)



Source: Author with data from ANP. <https://www.gov.br/anp/pt-br/centrais-de-conteudo/dados-estatisticos>

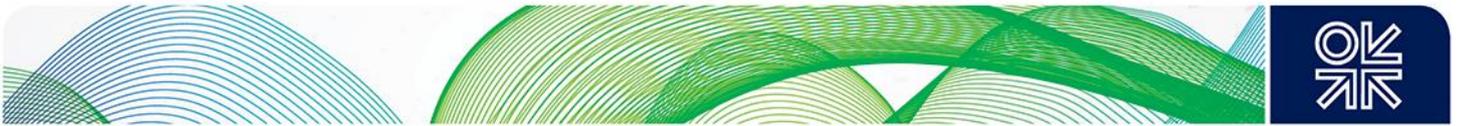
Notably, while Brazil has been one of the most impacted countries by the COVID-19 pandemic, oil and gas production were not severely affected. Production declined drastically during the second quarter of 2020 in the months of April and May, however it quickly rebounded reaching pre-pandemic levels by the fourth quarter of 2020. Natural gas marketable production stood at an average of 56 million cubic metres per day (MMcm/d) in the first semester of 2021, a 12 per cent increase from the 2020 average.⁹

Natural gas production is concentrated on a few key players. As of June 2021, state controlled *Petróleo Brasileiro S.A. (Petrobras)*, Brazil's national oil and gas company, accounts for 91 per cent of domestic production if counted as an operator and 71 per cent if counted as a concessionaire. It is distantly followed by Shell, Eneva, Petrogal, Repsol-Sinopec, Total, Enauta, Equinor and Petrona.¹⁰

⁸ IEA. (2013). 'Brazilian resources and supply potential, in *World Energy Outlook 2013*, 379

⁹ Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP). (2021). *Boletim da Produção de Petróleo e Gás Natural*, June 2021

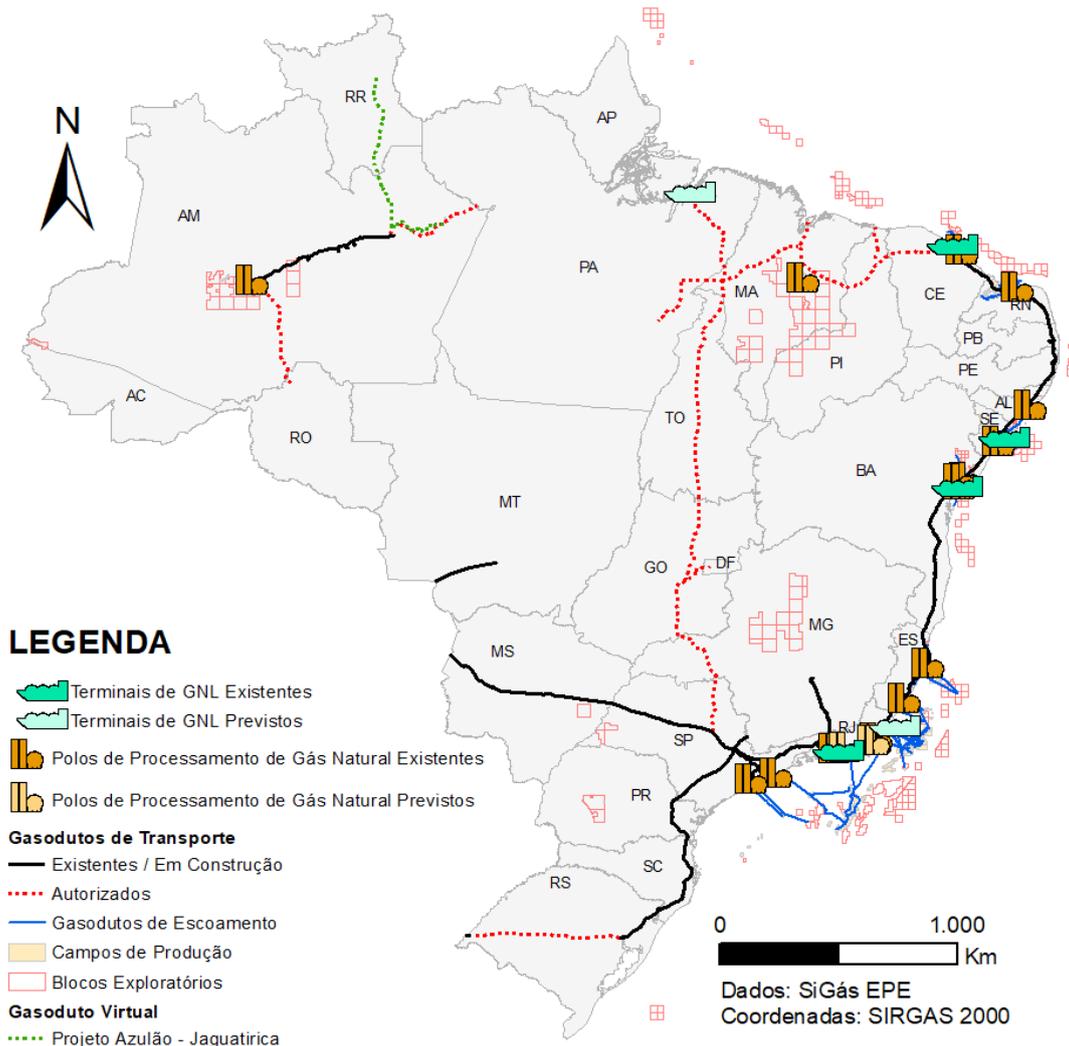
¹⁰ *Boletim da Produção de Petróleo e Gás Natural*, June 2021



Additionally, gathering pipelines and essential processing infrastructure remain under Petrobras control, which up to 2019,¹¹ given the absence of third-party open access rules, positioned it to purchase all production at the wellhead and to become the single gas marketer in the country.

Brazil's natural gas production and transport infrastructure is illustrated below. The domestic transport network is composed of 9,409 km of pipeline. Most of the pipeline network is situated along the southeast and northeast areas of the country. There are 15 natural gas treatment and processing units with a 107,710 MMcm/d processing capacity.¹² Importantly, there are no storage facilities in the country.

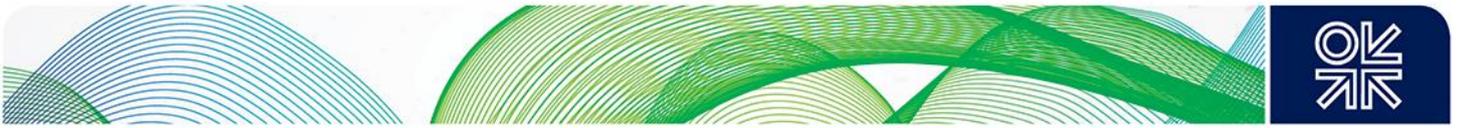
Figure 4: Natural gas transport and import infrastructure



Source: EPE. <https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/plano-indicativo-de-gasodutos-de-transporte-pig>

¹¹ See Section 'From Gas to Grow to the new gas market' for details on the development of third-party access rules. See also Decree nº 9.616/2018: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/D9616.htm

¹² They are known as natural gas treatment units (Unidade de Processamento de Gás Natural or UPGN) and have been classified as essential infrastructure.



Imports have been driven by the development of import infrastructure. Pipeline development commenced with the commissioning, in the late 1990s, of the Bolivia-Brazil pipeline (Gasbol),¹³ followed by the 50-km pipeline that connects Aldea Brasileira, Paraná in Argentina to Uruguaiana in Brazil.¹⁴ Due to concerns regarding the supply reliability of imported gas via pipeline, particularly from Bolivia,¹⁵ in 2006 the Brazilian government, through Petrobras, proposed to develop floating storage and regasification capacity.¹⁶ Three units in the states of Ceará, Rio de Janeiro, and Bahia were developed to import liquefied natural gas (LNG). The Pecém, Guanabara Bay, and Bahia Terminals have a capacity of 7 MMcm/d, 20 MMcm/d, and 14 MMcm/d capacity, respectively.¹⁷ 42 MMcm/d additional capacity has come online in the 2020-2021 period. These terminals have been developed by private players as integrated large-scale LNG to power generation facilities.¹⁸ Another LNG to power project with a planned 15 MMcm/d import capacity is in the development phase¹⁹ and expected to come online in 2022.²⁰ Notably, as of September 2021, a significant number of proposed LNG regasification projects are in the permitting stage.²¹ Given the lack of natural gas storage capacity in Brazil and the flexibility LNG affords, LNG imports provide a complementary solution to the Brazilian power sector and from this beginning, further inroads may be made in the future.

According to the natural gas balance produced by ANP, in the last decade, Brazil imported on average 13 Bcm of natural gas per year.²² Approximately two thirds of imports came from Bolivia under a long-term contract,²³ with the remaining third served by LNG purchased on a spot basis. Given production constraints in Bolivia and other market factors,²⁴ imports from Bolivia have seen substantial reductions since 2017. Both domestic supply and LNG imports have increased to meet demand. Through 2020

¹³ After decades of feasibility and technical studies, Gasbol was finally commissioned in 1999. Designed to achieve a maximum capacity of 30 MMcm/d, the 3,056-kilometre (km)-long pipeline connects Bolivia's natural gas sources in Santa Cruz to Petrobras facilities in the state of Rio Grande Do Sul, traversing five Brazilian states. The pipeline started operations between 1999 (northern stretch) and 2000 (southern stretch). Its capacity equaled more than double of Brazil's total natural gas demand at the time. See Latin America Energy Policy and Regulations Handbook. (2016). Vol. 1, Washington, DC, International Business Publications, 98.

¹⁴ The project was conceived in stages and at its completion is expected to cover 615 km and have a capacity to transport 15 MMcm/day of natural gas to the Porto Alegre area in the state of Rio Grande do Sul in Brazil. Due to natural gas shortages in Argentina, however, imports through this pipeline were quite low and ceased in 2009. However, given the potential of the Vaca Muerta unconventional gas plant in Neuquen, imports from Argentina may become available in the future.

¹⁵ On 1 May 2006, Bolivian president Evo Morales nationalized Bolivia's oil and gas resources and industries. See Prada, Paulo (2006). 'Bolivian Nationalizes the Oil and Gas Sector' in the *New York Times*, 2 May 2006. <https://www.nytimes.com/2006/05/02/world/americas/02bolivia.html>

¹⁶ Conselho Nacional de Política Energética – CNPE (2006). Resolução CNPE nº 4, 21 November 2006. <https://www.legisweb.com.br/legislacao/?id=104918>

¹⁷ They came online in January 2009, April 2009 and January 2014, respectively.

¹⁸ For further detail see the Project Text Box at 'Imports to pick up the slack' Section.

¹⁹ The project is reportedly in the construction stage.

²⁰ The Celba LNG Terminal project is owned by Celba (Centrais Elétricas Barcarena), a consortium formed by New Fortress Energy and the Brazilian company Oak Participações. *Global Energy Monitor Wiki*. 'Celba LNG Terminal', Undated. https://www.gem.wiki/Celba_LNG_Terminal

²¹ Empresa de Pesquisa Energética- EPE. 'Terminais de GNL no Brasil', October 2020.

²² Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP). (2021). Anuário Estatístico 2021.

²³ Yacimientos Petrolíferos Fiscales Bolivianos (YPFB), Bolivia's national oil and gas company, and Petrobras signed a 20-year natural gas sales contract in 1993. The contract was extended beyond its 2019 term- to allow Petrobras to receive volumes paid but not shipped. According to EPE, the contract volume is segmented into two: a base contract quantity and an additional contract quantity. The 16 MMcm/d base contract quantity were destined to fulfill demand by natural gas local distribution companies in the Central-West, South East and South regions of Brazil. The remainder 14 MMcm/day additional contract quantity volumes were destined to serve power generation plants. MME- EPE. (2019). Plano Decenal de Expansão de Energia 2029, Brasília, 187.

²⁴ Including contract renegotiations between Petrobras and YPF, and the ample global supply of LNG at low prices. According to ANP data, from January to November 2020, the average price for LNG delivered into Brazil, calculated on an FOB basis, was \$3.40 per million British thermal units (MMBtu). This is half of what Brazilians paid for Bolivian gas, \$7.36 per MMBtu. ANP (2020). 'Boletim Mensal de Acompanhamento da Indústria de Gás Natural', November 2020.



and in the first half of 2021,²⁵ LNG imports have surged. As was the case in 2015, Brazil is facing a severe drought in 2021 that has restricted water availability for power generation, which accounts for over 60 per cent of generation in 'normal' years.²⁶ In June 2021, Petrobras has been reported to be importing high quantities of LNG -a record high of 42 MMcm/d- to quash rising demand from the power generation sector.²⁷

The prognosis for the rest of 2021 and the next two years is that LNG imports will continue to grow. Particularly as more LNG to power projects come online. As for imports in general, they will see other private agents come into this space as utilization of import infrastructure capacity becomes available through open seasons - facilitated both by Petrobras retrenchment and the regulatory framework provided by new Gas Law.²⁸ In fact, the Brazilian Ministry of Mines and Energy (MME) has reportedly granted a record number of import authorizations in 2020.²⁹ In 2021, large trading groups and commodity trading houses have obtained import authorizations. For example, Shell's domestic arm was authorized to import up to 36.5 MMcm of LNG and 14 MMcm of gas from Bolivia, while Trafigura's was authorized to import up to 25.6 MMcm of LNG into the Bahia LNG terminal, which is connected to the gas grid.³⁰

Demand

According to data from the Energy Research Company (EPE by its acronym in Portuguese),³¹ the main energy planning body in Brazil, natural gas accounted for 12 per cent percent of primary energy supply, but only 6 per cent of final energy consumption in 2020.³² The penetration of natural gas in Brazil is low compared to regional metrics. According to the Latin America Energy Organization (Olaide), gas makes up 34 per cent of the region's primary energy supply.³³

Facilitated by product availability, total natural gas consumption has increased substantially since 1990. In the past 20 years, according to EPE data, consumption has tripled growing roughly at a 7.5 per cent compounded annual rate. As shown in Figure 5 below, most of the gas is consumed by industry (50%) while power generation accounts for 39 per cent of total consumption. The use of gas for transport has been increasing since 2000 as a result of the competitive price of compressed natural gas for vehicular use vis-à-vis that of gasoline, however it remains at just 7 per cent of total consumption. Finally, because

²⁵ The draft of this paper was completed in August 2021.

²⁶ The Brazilian electricity mix is highly dependent of hydropower. See Figure.

²⁷ Luna, D. (2021). 'Petrobras bate recorde na oferta de Gás Natural Liquefeito para atender térmicas' in *CNN Brasil*, 19 June 2021. <https://www.cnnbrasil.com.br/business/2021/07/19/petrobras-bate-recorde-na-oferta-de-gas-natural-liquefeito-para-atender-termicas>

²⁸ 'The 2021 Gas Law' Section and Law No. 14134 of 8 April 2021. <https://www2.camara.leg.br/legin/fed/lei/2021/lei-14134-8-abril-2021-791240-norma-pl.html>

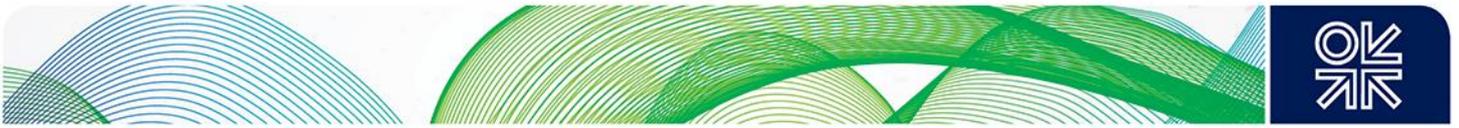
²⁹ Nogueira, M. (2021). 'Brasil tem autorizações recordes de importação de gás em 2020'. *Reuters*. 8 January 2021. <https://economia.uol.com.br/noticias/reuters/2021/01/08/brasil-tem-autorizacoes-recordes-de-importacao-de-gas-em-2020.htm>

³⁰ *Reuters* (2021). 'Shell tem aval para trazer gás da Bolívia ao Brasil; Trafigura importará GNL'. <https://www.reuters.com/article/energia-gas-brasil-idBRKBN2BE1MF-OBRBS>

³¹ Empresa de Pesquisa Energética- EPE.

³² Empresa de Pesquisa Energética- EPE. (2021). 'Balanço Energético Nacional- Séries Históricas', Ministerio de Minas e Energia. Undated. <https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/BEN-Series-Historicas-Completas>

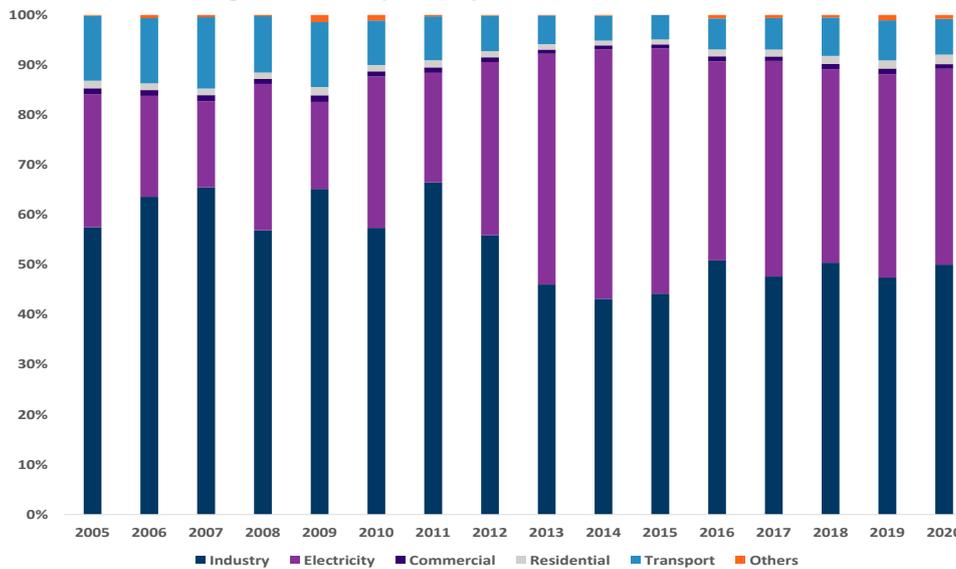
³³ OLAIDE (2020). 'Energy Outlook of Latin America and the Caribbean 2020', November 2020. <http://www.olade.org/noticias/panorama-energetico-de-america-latina-y-el-caribe-2020-la-informacion-mas-relevante-del-sector-energetico-de-los-paises-miembros-de-olade/>



there is virtually no need for space heating in Brazil, gas use for the residential and commercial sectors remains limited to cooking and water heating and therefore marginal.

Despite the pandemic's quarantine measures and the impact of the associated economic slowdown, natural gas consumption was not drastically affected. By November 2020, consumption had reached 90 per cent of 2019 average levels and by early 2021, it had already expanded by 17 per cent above 2020 average levels.³⁴ Overall, given the low penetration, there is ample room to increase the use of natural gas, particularly, in the power generation and transportation sectors.

Figure 5: Brazilian natural gas consumption by sector



Source: Author with data from MME, Boletim Mensal De Acompanhamento De Indústria De Gás Natural (2007-2020)

Prices

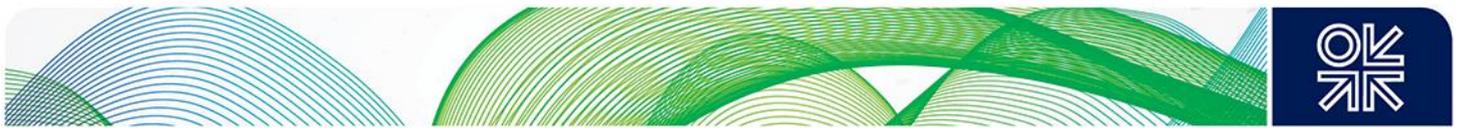
Natural gas in Brazil is priced differently depending on its origin and destination:

- Domestic natural gas: price is established via individual negotiation between the marketer/shipper/wholesaler and the local distribution companies.
- Imported natural gas: for Bolivian supplies, the price is set according to formulas contained in gas supply agreements entered by Petrobras respectively with YPFB, GTB and TBG; for LNG, the price reflects international LNG spot prices.

Pricing of natural gas in Brazil has followed the principle of substitution, meaning the price is set in relation to the price of the closest competing fuel. Prior to 1999, the government established a selling price cap for natural gas, which was based on the price of fuel oil (approximately 75 per cent of the cap).³⁵ Beginning in 1999, the price of fuel oil in Brazil became increasingly linked to international markets, which resulted in fluctuations in the price of natural gas. This price volatility, along with the liberalization of the hydrocarbon sector in 1997, set in motion a restructuring of the natural gas pricing system in Brazil. As such, in 2000 the government devised a new price cap known as TCQ (Transport,

³⁴ Ministério de Minas e Energia Energia- MME (2021). Boletim Mensal De Acompanhamento De Indústria De Gás Natural (2020-2021).

³⁵ The remaining component of the price was not publicly identified.



Capacity, and Quantity), which included a transport and product factor, in which transport would be priced independently of the commodity.³⁶ After a failed attempt at price liberalization in the early 2000s, pricing went on to be negotiated between Petrobras and state local distribution companies (LDCs) and large industrial customers, which reduced transparency in price formation.³⁷

As illustrated in Figure 6, natural gas prices in Brazil (domestic and imported) have been higher than international prices (i.e. TTF and HH markers).³⁸ This is, in part, the result of long-term import supply agreements, which are governed by pricing formulae linked to oil and which do not reflect global gas trends. Additionally, prices for domestic production are reflective of offshore production cost economics, which are higher than onshore conventional and unconventional gas production. A third reason for the price disparity has been the limited size of the market, which has been constrained by lack of infrastructure and, more importantly, competition.

The liberalization guidelines enacted in 2019 impacted pricing. Under the New Gas Market,³⁹ Petrobras offered sales contracts indexed to Brent and the US dollar starting in January 2020. As shown in Figure 6, prices experienced a significant drop throughout 2020 while oil prices were low and the Real depreciated against the US dollar. However, as oil prices recovered in the first quarter of 2021, increases were passed onto end consumers – with a quarterly lag. Increases in natural gas prices were reported to reach 48% in the first semester of 2021.⁴⁰ In May 2021, in addition to the Brent indexation, Petrobras started to provide Henry Hub (HH) indexation as an option in its sales contracts with LDCs. With this move, Petrobras seeks to reduce price volatility during the market transition toward full liberalization.⁴¹

Average prices for LNG imported into Brazil have been going up since February 2021. The surge is partly due to rising spot gas prices, caused by supply bottlenecks and robust demand growth elsewhere. It was also compounded by a spike in February as a result of inclement winter weather across the US and particularly in Texas, as a significant portion of cargoes imported into Brazil have been sourced from the US Gulf Coast since 2017.⁴² Globally, the 2020- 2021 winter season in the northern hemisphere also led to increases in LNG demand, affecting price markers in Europe (TTF) and Asia (JKM).

A fundamental reason to open up the market is to make natural gas more affordable to industry. High natural gas prices are a recurring complaint of industrial consumers in Brazil. In 2018, according to EPE calculations, the price of natural gas for industry was around \$14 per million British thermal units (MMBtu) while in Europe and the US, prices paid by this customer class were significantly lower, \$8.84/MMBtu and \$3.89/MMBtu, respectively.⁴³ Government efforts to enhance competition and transparency in price formation are expected to result in lower prices that can help expand industrial

³⁶ Instituto Acende Brasil (2016). O Mercado de Gás Natural e a Geração Termelétrica, White Paper 16th Ed. February 2016,

³⁷ For more detail on natural gas price formation in Brazil see: ANP. (2011). Análise da Regulamentação, da Estrutura da Indústria e da Dinâmica de Formação dos Preços do Gas Natural no Brasil. December 2011.

³⁸ HH stands for Henry Hub, a hub pricing point in Louisiana, USA, while TTF stands for Title Transfer Facility, a virtual trading point for natural gas in the Netherlands.

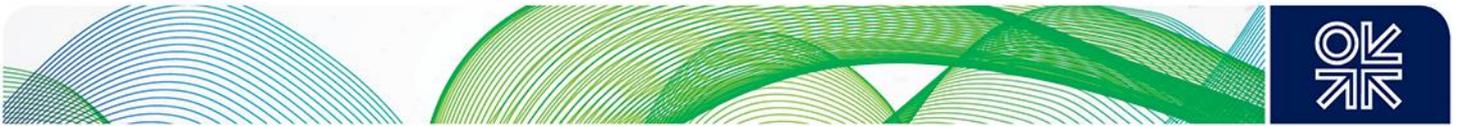
³⁹ See Section 'From Gas to Grow to the new gas market'.

⁴⁰ Epbr. (2021). 'Preço do gás natural vai subir em agosto e aumento chega a 48% em seis meses' 6 July 2021. <https://epbr.com.br/preco-do-gas-natural-vai-subir-em-agosto-e-aumento-chega-a-48-em-seis-meses/>

⁴¹ Valle, S. (2021). 'Brazil's Petrobras to offer natural gas contracts tied to U.S. benchmark'. *Reuters*, 3 May 2021. <https://www.reuters.com/business/energy/brazils-petrobras-offer-natural-gas-contracts-tied-us-benchmark-2021-05-03/>.

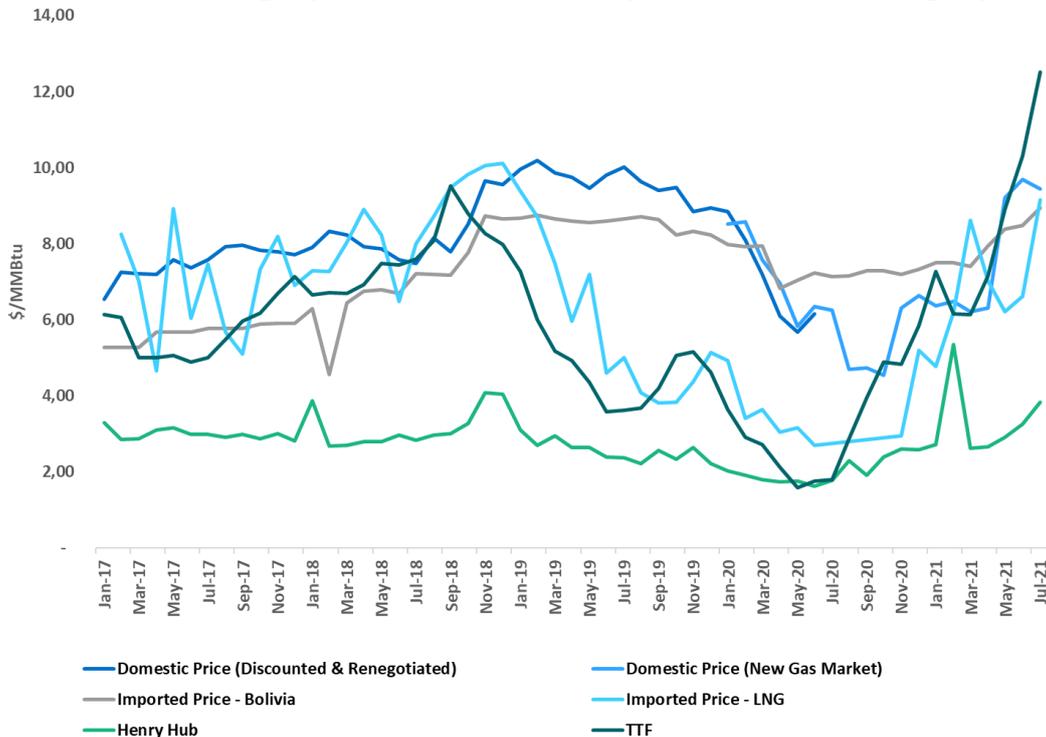
⁴² Douglas, E. (2021). 'Texas largely relies on natural gas for power. It wasn't ready for the extreme cold'. *Texas Tribune*, 16 February 2021. <https://www.texastribune.org/2021/02/16/natural-gas-power-storm/>

⁴³ 'Nota Conjunta - Comitê de Promoção da Concorrência do Mercado de Gás Natural. Rumo a novo mercado de gás', Ministério da Economia - Ministério de Minas e Energia, 8 July 2019. EPE. 'Informe: Comparações de Preços de Gás Natural: Brasil e Países Selecionados', 18 April 2019; <https://www.gov.br/economia/pt-br/centrais-de-conteudo/publicacoes/notas-tecnicas/2019/nota-tecnica-conjunta-rumo-novo-mercado-gas>



demand.⁴⁴ EPE's pricing analysis predicts that natural gas prices for industry could oscillate between \$10.7 to \$12.3/MMBtu⁴⁵ in the next decade if hub trading and gas-on-gas competition can be efficiently developed.⁴⁶

Figure 6: Brazilian natural gas price – wholesale and imports and international gas prices



Source: Author with data from MME, Boletim Mensal De Acompanhamento De Indústria De Gás Natural (2017-2021) - pricing information is not inclusive of taxes and/or duties assessed on natural gas; U.S. Energy Information Administration; and World Bank Commodity Pink Sheet data.

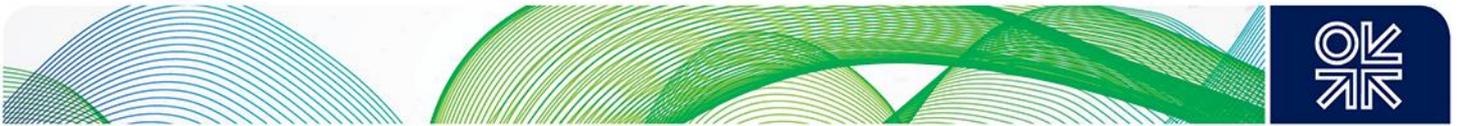
The road to reform

Market reform is a complex task. Besides the intricacies associated with economic intervention, usually the stickiness of institutions and interests work to preserve the status quo making it difficult for policymakers and market agents to successfully implement reforms. Testament to this axiom has been the reform of the Brazilian natural gas market. Finally, after much resistance and more than six years of failed or incomplete attempts at reform, in April 2021, Brazil enacted a new gas law, which sets up rules for a competitive gas market while addressing existing obstacles that have hampered growth. This section briefly chronicles the reform effort, covering its rationale as well as the main features of the new Law and its expected benefits.

⁴⁴ Generally speaking, the enhancement of market competition is expected to result in lower prices for end consumers. Even at a time of high market prices as is the case in the fall/winter season of 2021, this expectation holds for future pricing behaviour. For further detail on the benefits of market liberalization, see IEA (2019), Gas Market Liberalisation Reform, IEA, Paris <https://www.iea.org/reports/gas-market-liberalisation-reform>

⁴⁵ Prices include the price of the molecule, transport and distribution margins and taxes

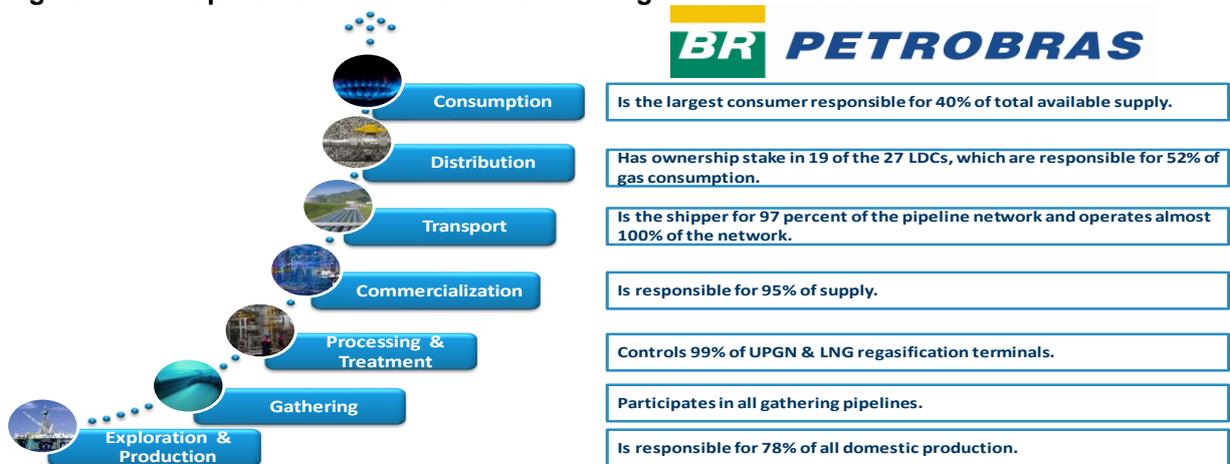
⁴⁶ EPE (2021). Plano Decenal de Energia 2021-2030. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-490/PDE%202030_RevisaoPosCP_rv2.pdf



Historically, Petrobras' guiding imperative has been to supply the country with its energy needs. When it was established in 1953, Brazil was highly dependent on crude oil and refined product imports and was far removed from the resource ownership and control preoccupations of oil-rich countries.⁴⁷ While a 1995 constitutional amendment and the 1997 Petroleum Law⁴⁸ ended the state's monopoly in oil and gas exploration and production, processing, and transportation, Petrobras, in fact, remained the state's primary energy policy agent.

This has been the case with Petrobras' role in the gas market. Rather than focusing its efforts on competitive opportunities, the company continued to operate as the country's national champion balancing its corporate interests with those of the country to have security of supply. That conundrum was evident in the company's initial involvement in the Bolivia-Brazil gas pipeline, Gasbol. In the past, sourcing natural gas as a fuel had been an afterthought. In the early 1990s, the share of natural gas in the market was still a mere two per cent.⁴⁹ Yet the supply of fuel oil proved expensive and forecasts indicated increasing demand, particularly from the industrial sector.⁵⁰ Geopolitical macroeconomic considerations led the Brazilian government to push for the Gasbol pipeline in the early 1990s, but it was Petrobras that was called to oversee construction, finance a portion thereof, and in spite of regulatory uncertainty (leading to the 1997 Petroleum Law) and significant downstream risks, become a take-or-pay off-taker when the pipeline was commissioned in 1999.⁵¹ From this perspective, Petrobras' historical role is better described as that of a market creator/developer and not that of a monopolistic incumbent.⁵²

Figure 7: Participation of Petrobras in the natural gas chain in 2016



Source: Author with data and information from MME, ANP & EPE. (2016). 'Gás Para Crescer - Relatório Técnico'. October 2016

⁴⁷ Schneider, B. R. (2016). *New order and progress: development and democracy in Brazil*. Oxford University Press, Chapter 3

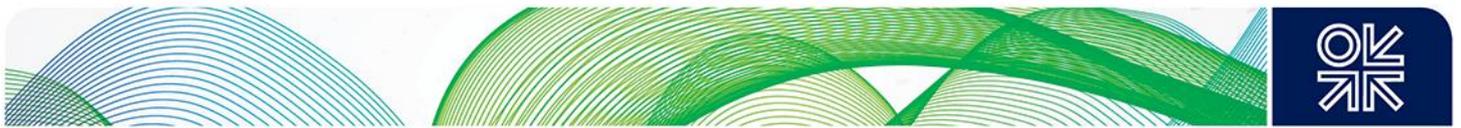
⁴⁸ Law no. 9478 of 6 August 1997. The law established a new regulatory framework, setting rules for private sector participation in oil and gas exploration, production, and transportation via pipeline, as well as establishing the Brazilian National Oil, Natural Gas and Biofuels Agency (ANP) and the National Energy Policy Council (CNPE). https://www.ariae.org/sites/default/files/2017-05/cartilha_lei_9478_ingles.pdf

⁴⁹ Law, P. N. and de Franco, N. (1998). International Gas Trade: The Bolivia-Brazil Gas Pipeline. *Private Sector and Infrastructure Network, Note, 144*.

⁵⁰ Law, P. N. and de Franco, N. (1998). International Gas Trade: The Bolivia-Brazil Gas Pipeline. *Private Sector and Infrastructure Network, Note, 144*

⁵¹ Mares, D. R. (2004). Natural gas pipelines in the Southern Cone

⁵² dos Santos, E. M. (2004). Natural Gas Pipeline Regulation in Brazil: Difficult balance between competition and market development. *Oil, Gas & Energy Law Journal (OGEL)*, 2(3)



As time went by, the company took on the role of market developer and coordinator, gaining a preeminent position as the incumbent and cementing a substantial participation in each segment of the value chain, effectively crowding out competition and overall, exerting a dominant market position. Figure 7 below details Petrobras' participation in each segment of the value chain.

From Gas to Grow to the new gas market

On 4 March 2009, Brazil enacted the 2009 Gas Law regulating the transportation, treatment, processing, storage, liquefaction, regasification, and trading of natural gas.⁵³ In accordance with the Gas Law, the ANP is responsible for implementing natural gas policy with an emphasis on ensuring the supply of natural gas, its by-products, and the protection of consumers interests regarding price, quality and product availability.⁵⁴ The 2009 Gas Law, and its implementing regulations⁵⁵ not only provided a fuller and specific legal regime, but were also expected to *'give rise to competition in natural gas transportation as a result of the establishment of a concessions regime for all gas pipelines considered to be in the general interest, as well as strengthening the guarantee of free access to gas pipelines in order to encourage more investment in exploration and production'*.⁵⁶

According to a 2016 government blueprint on natural gas sector development, eight years after the 2009 Gas Law, *'a meaningful expansion of new agent participation cannot be observed in the natural gas industry'*.⁵⁷ Petrobras' leadership has historically been central to the sector's development. However, its dominant market presence has hindered competition and elevated natural gas prices.⁵⁸ The 2015 ANP superintendent's testimony before the Chamber of Deputies put it succinctly: *'In 17 years, the ANP was unsuccessful in its performance. This means that Petrobras continues to be the only natural gas supplier'*.⁵⁹

Concrete and concerted efforts to overhaul the regulatory framework began in 2016. The Temer administration proposed a 'Gas to Grow' (Gás para Crescer) program⁶⁰ seeking to overhaul the market design and to enhance competition, including measures to harmonize federal and state rules and to overcome barriers for greater utilization of gas in power generation. Temer's reform initiative was eventually derailed in Congress as a result of state resistance over the federal regulation of distribution operations. In Brazil, states are sensitive to federal encroachment that might affect state-owned utilities (and their revenue). In the Brazilian federal political system, the federal government's regulatory powers end at the city gates.⁶¹ The 2009 Gas Law created regimes allowing large consumers to bypass local distribution companies to purchase (i.e., free consumer), import or produce gas, but their

⁵³ Law 11909/09

⁵⁴ Legislação para Exploração e Produção de Petróleo e Gás Natural, - http://www.planalto.gov.br/ccivil_03/leis/l9478.htm and http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/l11909.htm

⁵⁵ Decree 7382/10 and subsequent ANP regulations http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/decreto/D7382imprensa.htm

⁵⁶ Rocha de Sousa, F. (2010). *Desdobramentos da Lei do Gás*. Consultoria Legislativa. Nota Técnica. April 2010. -. Notably however according to this congressional briefing note on the Gas Law, the law did *'not have the power to change the structure of the natural gas transport market in the short and medium term, or to modify the de facto monopoly's domestic natural gas price policy'*.

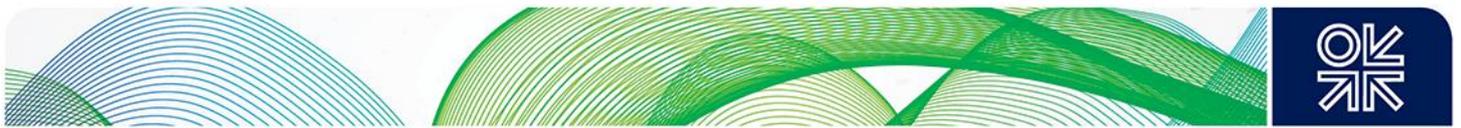
⁵⁷ MME, ANP & EPE. (2016). 'Gás Para Crescer - Relatório Técnico'. October 2016, 14 <http://antigo.mme.gov.br/documents/20182/4dd1aa45-dc01-80c5-6408-e7d405ff2d36>

⁵⁸ Insitituto Acende Brasil. (2016). O Mercado de Gás Natural e a Geração Termelétrica, White Paper No 16, February 2016, 15

⁵⁹ Quote given to Valor Econômico, 18 September 2015, cited in Insitituto Acende Brasil (2016). O Mercado de Gás Natural e a Geração Termelétrica, White Paper No 16, February 2016, 15

⁶⁰ MME, ANP & EPE. (2016). 'Gás Para Crescer - Relatório Técnico'. October 2016. <http://antigo.mme.gov.br/documents/20182/4dd1aa45-dc01-80c5-6408-e7d405ff2d36>

⁶¹ Constitution, Article 25 (as amended in August 1995)



implementation at a state-level floundered for the most part because the regulation of gas distribution and commercialization at a local level is a prerogative of the States regulators.⁶²

To tackle the challenge, in 2019, the Bolsonaro administration sought to work within the available regulatory framework to enact liberalization guidelines under an initiative branded as the New Gas Market or NGM.⁶³ Building on the Gas to Grow recommendations, the NGM called for the unbundling of gas supply from transport and distribution to encourage more upstream investment; non-discriminatory third-party access to essential infrastructure⁶⁴ so that more than one producer gets to market gas at the wholesale level; and the harmonization of tax rules so taxes are applied to the commercial rather than the physical flow of gas.⁶⁵ To avoid resistance, the guidelines also created an incentive for states to self-reform in exchange for federal financial assistance (through the Mansueto Plan⁶⁶ and pre-salt funds⁶⁷). While effective in promoting reform, the NGM guidelines nonetheless lacked the legal security and stability critical to private investors.

The TCC and Petrobras' retrenchment

Efforts to enhance competition in the Brazilian gas market have been facilitated also by Petrobras' strategic realignment since 2016. In the wake of the Car Wash (Lava Jato) corruption scandal⁶⁸ and pressed for cash to lower its debt ratio, Petrobras engaged in a divestment process selling strategic assets along the value chain. This process was catalyzed in July 2019, when the Brazilian competition authority⁶⁹ (CADE by its acronym in Portuguese) and Petrobras signed a Term of Commitment of Cessation (TCC) agreeing to provide third-party access to strategic infrastructure to increase the number of players in gas commercialization and to divest itself of transportation and distribution assets by 2021 as follows:⁷⁰

Third-party access: Subject to certain exceptions, Petrobras agreed not to enter into new engagements to purchase natural gas at the wellhead in Brazil starting in July 2019. The company also agreed to lease its main LNG regasification terminal in Salvador, Bahia. Finally, Petrobras agreed to, in good faith and subject to existing contractual and co-ownership arrangements, negotiate access to gathering and processing infrastructure.

Divestment: Petrobras agreed to map existing gas flows on an entry and exit point basis to determine excess capacity in the NTS (Nova Transportadora do Sudeste S/A) and TAG (Transportadora Associada

⁶² Two states have, in the past months, enacted reforms to bring state-level regulations in line with federal objectives: Rio de Janeiro and Espírito Santo.

⁶³ CNPE Resolution N° 16, 24 June 2019

⁶⁴ Essential infrastructure has been defined as gathering systems, treatment plants and LNG terminals according to the MME, ANP & EPE. (2016). 'Gás Para Crescer - Relatório Técnico'. October 2016, 11

⁶⁵ The assessment of tax both on the movement of the commodity between agents in the value chain and the transportation service (Imposto sobre Operações relativas à Circulação de Mercadorias e Prestação de Serviços de Transporte Interestadual e Intermunicipal e de Comunicação or ICMS) at the place of origin or destination has impeded the adjustment between contractual and actual flows in natural gas swaps

⁶⁶ Through the Fiscal Balance Program (PEF), the government provides for Union guaranteed loans to the states

⁶⁷ Through the Fiscal Financial Strengthening program, the government provides funds raised from the exploitation of pre-salt to states according to a ranking that measures execution of regulatory measures to overhaul the natural gas market

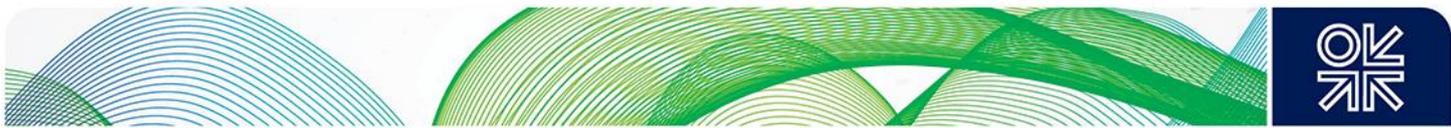
⁶⁸ Since mid-2014, operation Car Wash's investigations uncovered how dozens of companies acknowledged paying bribes to politicians and officials in exchange for contracts with the oil and gas national champion. The scandal together with an impairment of assets, contributed to steep losses for Petrobras of more US\$10bn in 2015. See: Watts, J. (2017). *The Guardian*. 'Operation Car Wash: Is this the biggest corruption scandal in history?' 1 June 2017

<https://www.theguardian.com/world/2017/jun/01/brazil-operation-car-wash-is-this-the-biggest-corruption-scandal-in-history>

⁶⁹ Conselho Administrativo de Defesa Econômica

⁷⁰ CADE-Petrobras agreement, 8 July 2019:

https://petrobras.com.br/data/files/0D/92/F0/C7/B81DB710E2EF93B7B8E99EA8/TCC%20assinado%20entre%20o%20Cade%20e%20Petrobras%20_1_.pdf. The agreement has been amended since, particularly with respect to the schedule/dates in light of the pandemic and difficulties faced by Petrobras



de Gás S.A) pipelines that can then be put out to tender.⁷¹ The company also committed to sell its remaining 10 per cent share both in the TAG and NTS pipelines by December 2021. It will also sell its 51 per cent share in Bolivia-Brazil (TBG)⁷² import pipeline by December 2021 once the tender to contract available capacity is awarded. Finally, Petrobras agreed to sell either its 51 per cent share of the marketing company Gaspetro or its individual shares in each of the 19 state-level distribution companies.

Despite the difficult market environment in 2020 and the lingering uncertainty and volatility associated with the ongoing COVID-19 pandemic, Petrobras has made great strides in the execution of the TCC. Under GAS + Program, a program recently launched by Petrobras to increase its competitiveness amidst the opening up of the market, the company is set to introduce new commercial products and tools, such as digital contracts, and sales through automated platforms as well as new business models contemplating negotiated access to pipelines and gas processing infrastructure.⁷³ Petrobras has also committed to specify the maximum injection and withdrawal volumes at each receiving point and delivery area of the TBG,⁷⁴ TAG⁷⁵ and NTS⁷⁶ transportation system, so that transportation companies can offer the remaining capacity to the market, thus enabling other shippers and marketers to trade gas. As of the time of writing [August 2021], Petrobras had successfully divested its remaining 10 per cent stake in NTS⁷⁷ and TAG,⁷⁸ entered into binding phase for the sale of its stake in TBG⁷⁹ and the Bahia terminal,⁸⁰ and signed contracts for the sale of its stake in Gaspetro.⁸¹

The 2021 Gas Law

As Petrobras retrenched from the market, questions arose as to who would pick up the baton, who would invest? As covered in the previous section, Petrobras' divestment has been successful and has

⁷¹Nova Transportadora do Sudeste S.A. (NTS) is a 2,000+ km gas pipeline that runs along the southeastern Atlantic coast of Brazil including Rio de Janeiro, São Paulo and Minas Gerais. Transportadora Associada de Gás S.A. (TAG) is a 4,500 km gas pipeline mainly running along the central and northern Atlantic coast of Brazil

⁷² Transportadora Brasileira Gasoduto Bolívia-Brasil S.A. (TBG) can transport up to 30 MMcm/d of natural gas along the 2593 km of gas pipeline, which passes through the states of Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul

⁷³ Petrobras (2021). Annual Report and Form 20-F 2020, 126. <https://www.investidorpetrobras.com.br/en/>

⁷⁴ Transportadora Brasileira Gasoduto Bolívia-Brasil

⁷⁵ Transportadora Associada de Gás

⁷⁶ Nova Transportadora do Sudeste

⁷⁷ In April 2021, Petrobras approved the sale of the remaining stake to Brookfield Asset Management and Brazil's Itaúsa for \$337 million. With the acquisition of the remaining 10%, Brookfield fund owns 100% of NTS. *Reuters* (2021). 'Brazil's Petrobras sells stake in NTS gas pipeline network'. <https://www.reuters.com/business/energy/brazils-petrobras-sells-stake-nts-gas-pipeline-network-2021-04-29/>

⁷⁸ In July 2020, Petrobras announced the divestment of its 10% stake in TAG. Engie, the French multinational utility company and CDPQ (Caisse de depot et placement du Quebec), a global institutional investor, acquired it for €160 million. The TAG network represents 47% of the country's entire natural gas infrastructure. Engie (2021). 'ENGIE and CDPQ to acquire remaining 10% of TAG in Brazil', press release, 21 July 2021. <https://www.engie.com/en/journalists/press-releases/acquire-remaining-tag-brazil>

⁷⁹ On 2 May 2021, Petrobras announced it entered the binding phase to sell its stake in TBG. See: Nasdaq (2021). 'Brazil's Petrobras begins binding phase for TBG, TSB pipeline sales'. <https://www.nasdaq.com/articles/brazils-petrobras-begins-binding-phase-for-tbg-tsb-pipeline-sales-2021-05-02>

⁸⁰ In August 2020, Petrobras release the tender documents and in February 2021 reissued them. In July 2021, Excelerate's proposal, the single bidder, was disqualified on technical grounds, but later corrected. Excelerate has advanced to the qualification stage. Petrobras (2021). 'Petrobras on LNG Regasification Terminal leasing', press release, 26 August 2021. <https://api.mziq.com/mzfilemanager/v2/d/25fdf098-34f5-4608-b7fa-17d60b2de47d/7345dc3d-fa45-fb1d-9566-f6b40daff98e?origin=1>

⁸¹ In February 2021, Petrobras entered the binding phase for the sale of Gaspetro. Brazilian-based Cosan's Compass Gas & Energia (CGE) submitted an offer and in July 2021, Petrobras and CG&E signed a contract. Petrobras Press Release (2021). 'Petrobras signs contract for the sale of Gaspetro', 28 July 2021. <https://api.mziq.com/mzfilemanager/v2/d/25fdf098-34f5-4608-b7fa-17d60b2de47d/8674f463-748e-43be-7050-fbf8901a1db1?origin=1>



attracted the interest of large investors such as Brookfield, Engie, EIG Global Energy Partners; however, a larger spectrum of private sector interest will be necessary to finance transportation and distribution infrastructure beyond the coastal areas and to open up new and, until now, unexplored demand outlets. To lure investors, assuring legal security and stability became a priority and in October 2019, Congress rehashed the previously rejected reform bill. Finally in early April 2021, after a fast-track approval process, Congress approved, and the president signed law No. 14,134 (the 2021 Gas Law), which regulates the transportation, treatment, processing, storage, liquefaction, regasification, and commercialization of natural gas in Brazil.⁸² The Law enshrines many of the features of a competitive market design including unbundling, third party access rules, an entry–exit transport system, and introduces an authorization regime for the development of transport infrastructure abandoning the previous burdensome concession framework.⁸³

The new market design, led by the ANP, contemplates the coexistence of a physical market and an organized virtual market. The plan is to implement a virtual trading hub called *ponto virtual de negociação* or PVN, where transactions take place through standardized contracts. The PVN would also allow transactions in organized, over the counter markets (OTC). The aim is to develop a hub infrastructure that would facilitate price discovery and the emergence of gas-on-gas pricing (i.e. market-based pricing) while promoting greater depth of trading, transparency and liquidity.

Following the spirit of the Law, the final goal is to create an independent yet integrated natural gas transportation system in Brazil. The market design contemplated by the Law provided for the creation of an independent market operator known as the Gestor da Area de Mercado to manage and oversee the transportation system. However, infrastructure and taxation restrictions may require an interim solution using market areas (potentially outlined following the current pipeline systems) until an integrated system can be achieved.⁸⁴

Expected benefits from liberalization

Liberalization is expected to result in increased competition, enhancement of available supply, significant price reductions, greater investment in the development of production and transport infrastructure, the opening of new demand outlets, and many more benefits. For example, the National Confederation of Industry, the largest industry association, believes liberalization can triple investment in the sector to reach \$31 billion per year by 2030.⁸⁵ For Economy Minister Guedes, the reform will bring a ‘stock of cheap energy’ to Brazilian industry.⁸⁶ Government calculations in the past suggested that a mere 10 per cent reduction in the price of natural gas could increase industrial GDP by 2.1 per cent.⁸⁷

Yet, the path to successful liberalization is long and winding and efforts are in their early stages. While the 2021 Gas Law has cemented the reform and has set up the basis for the development of a competitive market, much remains to be done to create the market architecture necessary to evolve

⁸² Law No. 14,134 of 8 April 2021. <https://www2.camara.leg.br/legin/fed/lei/2021/lei-14134-8-abril-2021-791240-norma-pl.html>

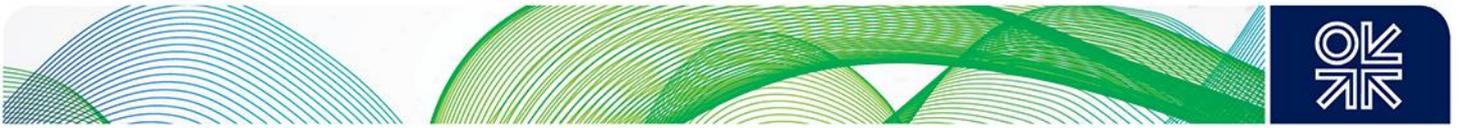
⁸³ Ministry of Mines and Energy (2021). Fact Sheet of New Gas Law. A comprehensive synthesis of the main changes can be found at Mayer Brown (2021). New Gas Law: Summary Table of Major Changes. <https://www.mayerbrown.com/-/media/files/perspectives-events/publications/2021/03/legal-update--nova-lei-do-gs--17-de-maro-2021.pdf>

⁸⁴ ANP (2021). Mercados Organizados e Ponto Virtual de Negociação, 3^o Workshop sobre o Modelo Conceitual do Mercado de Gás Natural, 7 May 2021. <https://www.gov.br/anp/pt-br/acao-a-informacao/agenda-eventos/arquivos-3o-workshop-sobre-o-modelo-conceitual-do-mercado-de-gas/sim-anp.pdf>

⁸⁵ CNI (2020). ‘Nova Lei do Gás abrirá mercado e atrairá investidores para o país, avalia CNI’. CNI portal, 1 September 2020. <https://noticias.portaldaindustria.com.br/posicionamentos/nova-lei-do-gas-abrira-mercado-e-atraira-investidores-para-o-pais-avalia-cni/>

⁸⁶ ‘Brazil lower house approves reform of natural gas sector’. *Reuters*, 1 September 2020 <https://www.reuters.com/article/brazil-gas-law/brazil-lower-house-approves-reform-of-natural-gas-sector-idUKL1N2FZ03C>

⁸⁷ ‘Brazil approves pro-market gas regulations’, *Argus media*, 25 June 2019. <https://www.argusmedia.com/en/news/1928024-brazil-approves-promarket-gas-regulations>



from a small and highly concentrated market to a competitive, dynamic, transparent, liquid and expanding market. As the old adage states, the devil is in the detail: implementation and enforcement of the new law will be key to assure further market development.

Can liberalization singlehandedly effect the required market transformation?

The expectation is that the 2021 Gas Law and its implementing regulation will not only cement the reform in stone providing legal security to investors but will help address all the obstacles that so far have prevented market expansion. Specifically, the new regulatory framework, and accompanying market design, is expected to herald investment in gas production and import and transportation infrastructure leading to expansion of supply.

So far it is clear that the crown jewels in the natural gas sector mid and downstream segments have been attractive to large investors, as they have rushed to acquire them from Petrobras.⁸⁸ However, a larger spectrum of private sector interest will be necessary to finance the development of production, infrastructure and demand required to expand the market. This section focuses on critical aspects in future market development such as offshore reserve gas monetization, transport and import infrastructure development, and new demand outlets, and how the new rules may impact them.

Expanding supply

Resource potential is not an issue in Brazil. However, bringing reserves to market in what is still a large, undeveloped country is a formidable task. The difficulty is compounded when a considerable share of the potential is associated gas located in deep waters far from shore or in the Amazonas region, far from infrastructure and consumption centres (see Figure 2 and Figure 4). To add to the complexity, the market is undergoing regulatory reform while navigating the global push for decarbonization. This presents both opportunities and challenges to those wishing to lure investments and those eager to enter the market.

The Brazilian government expects gross natural gas production to more than double by 2030, reaching 276 MMcm/d (a 117% increase from 2020 levels).⁸⁹ About 85 per cent of this production is expected to come from fields in the Campos and Santos basin as oil production begins in earnest in the pre-salt area.

The prognosis is less upbeat for natural gas marketable production. As illustrated in Figure 8, in the next five years, production available to the market is expected to slightly decline from 2021 levels as offshore fields currently in production hit natural declines. Marketable production is expected to recover to 2021 levels (73 MMcm/d) by 2026 and to reach 140 MMcm/d by 2030.⁹⁰ Thus, although a doubling of marketable production is expected in the next decade, approximately 50 per cent of gross production is not expected to make it market.⁹¹

⁸⁸ See footnotes 77, 78 and 79 for examples of investors' asset acquisitions from Petrobras

⁸⁹ EPE (2021). Plano Decenal de Energia 2021-2030, 191-194. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-490/PDE%202030_RevisaoPosCP_rv2.pdf

⁹⁰ EPE (2021). Plano Decenal de Energia, 191-194

⁹¹ EPE's production forecast for 2021 appears high compared to actual production figures in 2019 and 2020. The reasons for the discrepancy are unknown and could be the result of EPE's expectation regarding lower levels of reinjection in 2021

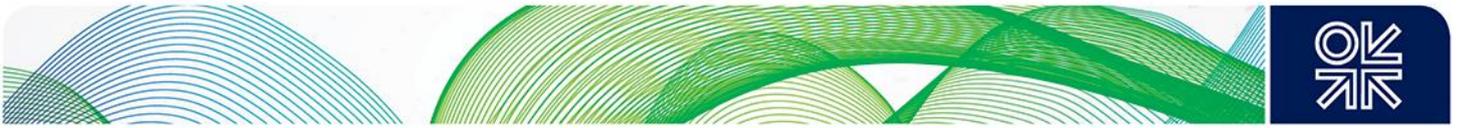
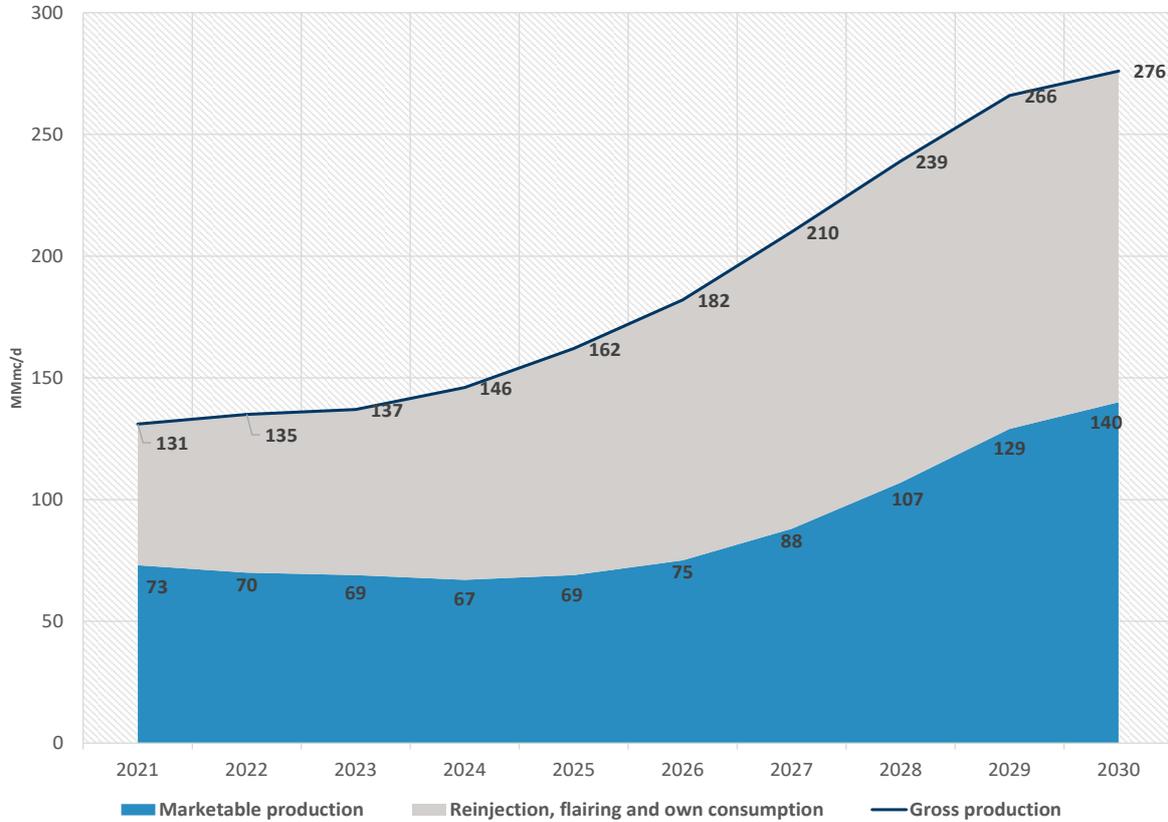


Figure 8: EPE gross and marketable production forecast 2021-2030



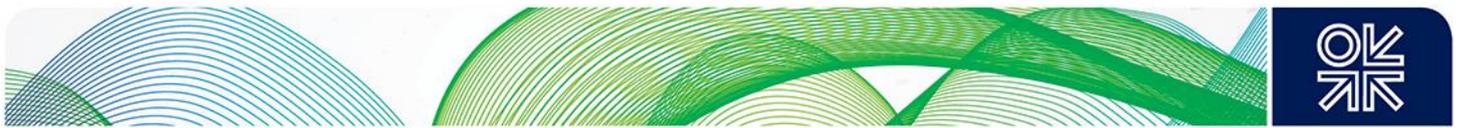
Source: EPE 2030 PED. Available online at: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-490/PDE%202030_RevisaoPosCP_rv2.pdf
Offshore reserve gas monetization

Offshore reserve gas monetization presents challenges to supply expansion.

As Petrobras and other producers focus their efforts on offshore oil development, how to channel associated gas production will increasingly be an issue. So far, a solution has come in the form of gas reinjection.

In April 2021, the amount of gas reinjected hit a new record of 61 MMcm/d (nearly twice the imported volume of 34 MMcm/d).⁹² There are different reasons why gas gets reinjected. Apart from the high costs associated with separating, treating and transporting natural gas to shore, in the case of the post-salt, associated natural gas has been used as a secondary recovery method at the Campos Basin. In the case of the pre-salt, gas has been reinjected due to the lack of space at the Floating Production, Storage, and Offloading (FPSO) unit to purify the associated gas. Moreover, separating carbon dioxide (CO₂) from natural gas can be expensive and can also increase space and weight requirements on a

⁹² Ministério de Minas e Energia Energia- MME (2021). Boletim Mensal De Acompanhamento De Indústria De Gás Natural, April 2021



FPSO.⁹³ Finally, the lack of an adequate gas pipeline infrastructure, particularly in the offshore areas, has also contributed to higher reinjection levels.

Pre-salt gas economics also depend on the way it is transported. Traditionally, this has been done through subsea gathering networks connecting to onshore treatment plants (UPGNs). By 2025, the capacity of the three gathering systems ('Rota 1, 2 and 3')⁹⁴ that are expected to be online will be insufficient (approx. 44 MMcm/d). A fourth project ('Rota 4') which is planned, by private investors, may lessen the constraint if it materializes.⁹⁵ A critical factor in gas monetization is whether investing in gathering and processing infrastructure is a sound decision as the market is currently in flux and investors face heightened supply, demand, and price risks. Prior to liberalization, Petrobras undertook the risk of infrastructure development, but now the risk burden seems to be allocated to all market participants.

Alternative solutions to bring this gas to market have been studied, including the economics of floating compressed natural gas (FCNG), floating liquified natural gas (FLNG) and floating gas-to-liquids (FGTL). According to EPE's analysis, the best option continues to be the subsea gathering network/UPGN as it provides the greatest gas value at the offshore platform. Scale matters and if larger volumes of gas are considered, the FCNG and FGTL options may become viable. The FLNG alternative seems to be the least attractive in low LNG price scenarios (less than \$6 per MMBtu).⁹⁶ Should LNG prices become substantially higher than they were in 2019-2020, in the 2025 to 2030 period, its attractiveness as a solution to the pre-salt gas monetization problem may increase.⁹⁷ Pre-salt LNG could be shipped to regasification terminals in Brazil to serve seasonal demand from the power sector or new industrial and transportation demand centres. Alternatively, pre-salt LNG could be offered to the international market. However, this option will depend as much on pre-salt gas production, processing and liquification economics, as on the available opportunity in the international market.

In any case, scale and third-party access to essential infrastructure are expected to make a difference for pre-salt gas to reach the shore in higher quantities. The amount of pre-salt natural gas that actually makes it to shore greatly depends on not only the availability of offshore pipelines but also on the CO₂ content in the gas. Pre-salt gas has a high content of CO₂.⁹⁸ Break-even values could vary considerably, from about \$2 to about \$10 per MMBtu for CO₂ levels up to 20 per cent.⁹⁹ Processing and bringing this gas to shore becomes uneconomical when prices for alternative supply options hover below \$7 per MMBtu. And this is where a greater number of players and infrastructure availability becomes relevant. Producers developing fields with different CO₂ content ranges, and therefore facing differentiated breakeven values, could blend these volumes for sale as a basket of processed natural gas and offer

⁹³ According to the IEA, costs associated with separating out and treating the gas and transporting it to shore are around \$1-2 per million British thermal units in the case of gas from the Santos basin. IEA. (2013). 'Brazilian resources and supply potential', in *World Energy Outlook 2013*, IEA, 376

⁹⁴ As of August 2021, Rota 3 is in construction. Petrobras' control over Rota 1 and Rota 2, both in service, has constrained competitive supply and resulted in high prices for consumers. In October 2020 however, the company announced it would agree to provide access to transportation and processing capacity to its partners in the Santos basin and eventually to third parties to contribute to the creation of a competitive market. Petrobras' partners in the Santos basin are Petrogal Brasil, Repsol Sinopec Brasil, and Shell Brasil. Petrobras (2020). 'Petrobras on natural gas pipeline and processing plants', press release, 30 September 2020. <https://api.mziq.com/mzfilemanager/v2/d/25fdf098-34f5-4608-b7fa-17d60b2de47d/0d57e914-3589-d513-5518-97977b3a126f?origin=1>

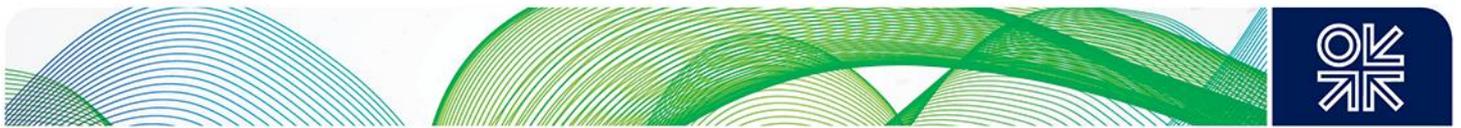
⁹⁵ EPE (2020). 'Monetização de gás natural offshore no Brasil'. 20 September 2020

⁹⁶ EPE (2020). 'Monetização de gás natural offshore no Brasil'. 20 September 2020

⁹⁷ Reportedly, Petrobras and New Fortress Energy are looking into the FNLG alternative. Pamplona, N. (2019). 'Petrobras retoma estudos sobre terminal flutuante para gás do pré-sal', in *Folha*, 31 October, and New Fortress Energy (2021). Q1 2021 Investor Presentation, May 2021. <https://ir.newfortressenergy.com/static-files/70935079-3013-4f65-9a09-02228a06915f4>

⁹⁸ High content of CO₂ is seen by some analysts as a positive aspect, as it can further enhance oil recovery when natural gas is reinjected to increase the pressure of the reservoir

⁹⁹ Empresa de Pesquisa Energética- EPE. 'Estudo sobre aproveitamento do Gás Natural do Pré-Sal'. 20 March 2020.



it to the market at a weighted average price, so that supply remains competitive. In addition, several nearby blocks could jointly develop the gathering and processing infrastructure necessary to attain economies of scale that could potentially enable gas with a higher CO₂ content to be produced. This works if third-party access rules are in place and enforced.¹⁰⁰

Imports to pick up the slack

With domestic marketable production expected to decline up to 2026,¹⁰¹ imports have a window of opportunity to make further inroads. To assess this opportunity, a view of demand to 2030 is required.

According to EPE, from a baseline of 93 MMcm/d in 2021, natural gas demand is expected to grow at a five per cent compounded annual growth rate (CAGR) reaching 148 MMcm/d by 2030. Incremental demand is projected to be driven by the power generation sector, which by 2030 is expected to account for 53 per cent of total demand. Industrial, residential, and commercial demand is expected to increase modestly, growing at a two per cent CAGR and reaching 45 MMcm/d in 2030 (equivalent to 30% of total demand).¹⁰²

The power sector has great potential if project developers are able to economically and reliably source natural gas. Brazil's electricity auctions of long-term energy contracts in the regulated market for new supply have increasingly embraced gas-fired generation in order to push for further integration of natural gas into the power generation matrix and increase the reliability of supply. Given the frequency and severity of droughts,¹⁰³ water availability for power generation has been compromised in hydro dominated Brazil (over 60% of generation in the last 8 years as illustrated in Figure 9) raising concerns regarding future reliability of the power system. So, it is no surprise that several large LNG-power projects have been successful in the auctions, including the *Gás Natural Açú*, *Porto de Sergipe I* and *Novo Tempo Barcarena* (see text box). Ample availability of LNG at competitive prices made LNG an attractive option to anchor gas fired generation. At 30 to 40 per cent capacity factors, this demand source is unable to provide the constant, sustained flow of gas demand required by associated domestic gas, thus flexible LNG has become a solution. Several other LNG projects are being considered to anchor thermal power bid rounds.¹⁰⁴ The law that approved the capitalization of Eletrobras, the Brazilian state-own electricity holding company, mandates the development of eight gigawatts of natural gas power generation capacity through locational reserve auctions.¹⁰⁵

¹⁰⁰ EPE (2019). 'Informe: Custos de Gás Natural no Pré-Sal Brasileiro'. 18 April

¹⁰¹ The COVID-19 pandemic may have impacted the expected development program for some of the fields, pushing it beyond 2025 with the resulting impact on production, which is only expected to increase, according to EPE by 2026

¹⁰² EPE (2021). Plano Decenal de Energia 2021-2030. https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-490/PDE%202030_RevisaoPosCP_rv2.pdf

¹⁰³ Droughts are associated with El Niño, a natural phenomenon in which a band of warm ocean water develops in the equatorial Pacific. Occurring every two to seven years, it substantially alters weather patterns across the globe. Scientists have argued that deviations from normal ocean surface temperatures are associated with climate change. The intensity and length of El Niño episodes have increased in recent years. Several of the worst droughts have occurred in the past decade and are expected to continue

¹⁰⁴ EPE (2020). 'Terminais de Regaseificação de GNL no Brasil Panorama dos Principais Projetos', 20 October

¹⁰⁵ Law N° 14.182, 12 July 2021. <https://in.gov.br/en/web/dou/-/lei-n-14.182-de-12-de-julho-de-2021-331549377>

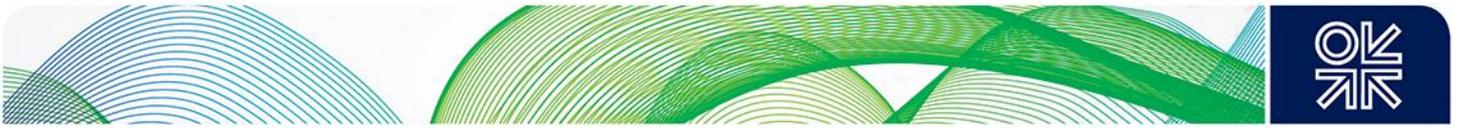
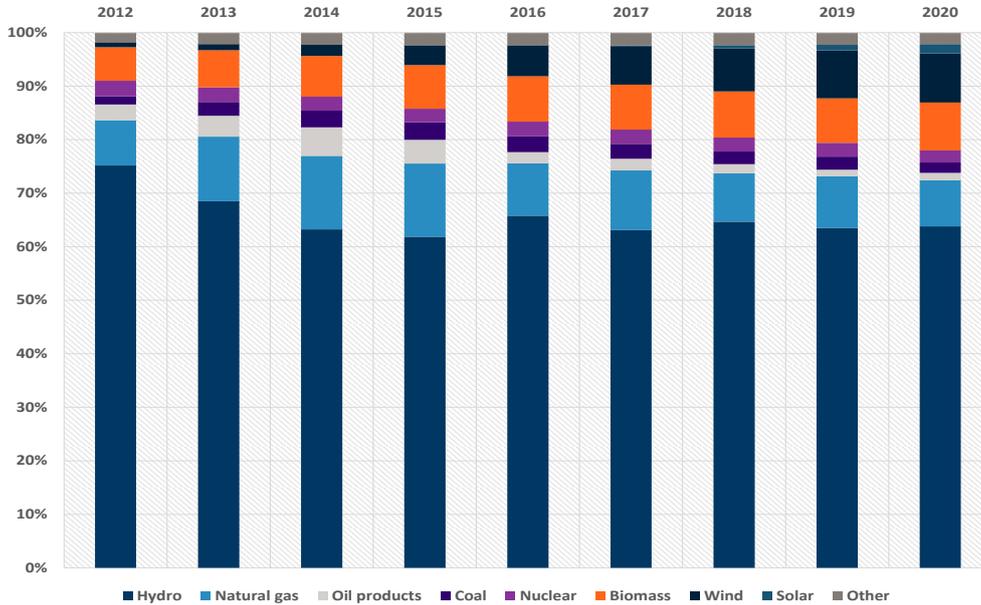


Figure 9: Brazilian electricity generation per source (2012-2020)



Source: EPE- ANUÁRIO ESTATÍSTICO DE ENERGIA ELÉTRICA 2021 <https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/anoario-estatistico-de-energia-eletrica>

For some of the LNG-to-power project developers, development of infrastructure required to service power generation customers is a springboard for further expansion into the industrial, vehicular, and small-scale LNG demand segments. A case in point is New Fortress Energy (NEF), with its acquisition of Hygo Energy Transition (formerly Golar Power), has not only developed a sizable footprint in the LNG-to-power segment, but through partnerships is seeking to supply LNG for vehicular, industrial and small-scale LNG uses across Brazil. NEF has reported 26,119 MMcm/d in sales volumes, which will be served by NEF’s LNG projects in development (i.e., Barcarena, Suape and Santa Catarina)¹⁰⁶ and the Sergipe I terminal, online since March 2020.¹⁰⁷ These volumes include sales to large industrial customers. Another five LNG regasification terminals, adding 97 MMcm/d of capacity, are currently - as of September 2021 - in the planning and permitting stage.¹⁰⁸

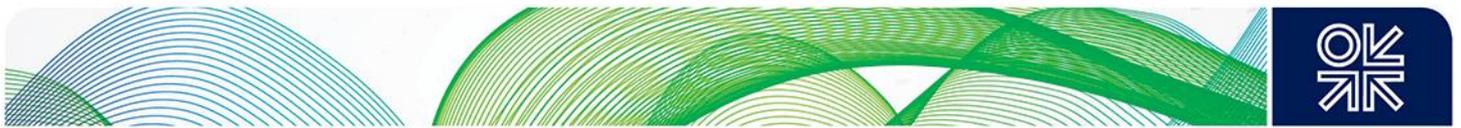
- Porto de Sergipe I: Operating since March 2020, a 1.5 GW LNG-to-power combined-cycle plant with a 21 MMcm/d FSRU on the coast of the state of Sergipe. The project is supplied under a long-term supply and purchase agreement (SPA) with an Exxon Mobil and Qatar Petroleum

¹⁰⁶ The three terminals add to 55 mmcmd of regasification capacity. They have reached the final investment decision. As of August 2021, key permits secured, EPC contract executed and construction started at the Santa Catarina terminal; construction permits secured, EPC contract executed, and construction started at the Barcarena terminal; and an anchor customer signed up at 1.4mm GDP. See New Fortress Energy (2021). Q2 2021 Investor Presentation, August 2021, pp. 30, 31, 32 and 41. Available online at: <https://ir.newfortressenergy.com/static-files/61822434-f4b8-4ebd-bc9d-e8808a0d6fb9>

¹⁰⁷ Ibid, New Fortress Energy (2021). Q2 2021 Investor Presentation, p. 41. Available online at: <https://ir.newfortressenergy.com/static-files/61822434-f4b8-4ebd-bc9d-e8808a0d6fb9>

Sales volumes are quoted in gallons per day and include committed and in discussion volumes amounting to 6.9 million GPD. Converted into mmcmd using 1 million gallons/day = 3785.4118 cubic meters/day.

¹⁰⁸ EPE (2021). Plano Indicativo de Terminais de GNL, July 2021, p. 33



joint venture for 1.3 million tons per annum (mtpa). The project was developed by a partnership between EBrasil and New Fortress Energy.¹⁰⁹

- Gás Natural Açú: a 3 GW LNG-to-power project encompassing two combined-cycle plants (GNA I and GNA II) with a 21 MMcm/d FSRU on the coast of the state of Rio de Janeiro. GNA 1 is scheduled to begin operations during the second semester of 2021 and be supplied LNG by BP. The project is being developed by EIG Global Energy Partners, BP, Siemens, and State Power Investment Corporation's local subsidiary.¹¹⁰
- Novo Tempo Barcarena: a 605 MW LNG-to-power combined cycle plant in the northeast state of Pará to be supplied through a FSRU. The project is being developed by New Fortress Energy together with Brazilian Energy Participações S.A. and OAK Participações Ltda.¹¹¹

The ability of LNG importers to capture a bigger slice of the expected incremental demand will be facilitated by the development of pipeline infrastructure connecting their facilities to the gas grid. In any case, the outlook for increased LNG imports in the next five years is rosy. Albeit from a lower base compared to other importers, that type of growth heralds increasing opportunity.

Developing infrastructure

In 2021, only nine per cent of the total municipalities in Brazil are connected to a natural gas pipeline.¹¹² With the ongoing redefinition of Petrobras' role in the market, it will be necessary for the country to encourage investments in new supply beyond the pre-salt that will reach the entire country beyond the most industrialized and populated coastal regions.¹¹³ To do so, it will need to buttress the construction of transportation infrastructure. In 2014, the MME issued the Decennial Plan for Expansion of Transport through Pipelines (PEMAT 2013-2022), finding that lack of supply did not allow it to bid the construction or expansion of pipelines. It described this situation in which demand and supply were necessary to justify new infrastructure that in turn might spur increased demand and supply, as a 'chicken and egg dilemma'.¹¹⁴

In late 2019, the government launched the *Plano Indicativo de Gasodutos de Transporte* (PIG), replacing the PEMAT.¹¹⁵ The PIG outlines the infrastructure required to unleash market expansion in line with liberalization objectives. The 2020 PIG studied 4380 km of gas pipeline projects (approximately 47% addition to the current network of 9409 km) and outlined potential investment of about \$13 billion (74.2 billion reais) in new pipelines, gathering systems, processing units and regasification terminals (totalling 40 projects).¹¹⁶ The PIG is provided only as an indicative tool and the government expects the private sector to take the lead in developing the necessary transport infrastructure. Consonantly, the

¹⁰⁹ NS Energy. "Porto de Sergipe Power Plant, Barra dos Coqueiros", Undated. Available online at: <https://www.nsenergybusiness.com/projects/porto-de-sergipe-power-plant-barra-dos-coqueiros/>

¹¹⁰ NS Energy. "Gas Natural Açú (GNA) Power Project, Rio De Janeiro", Undated. Available online at: <https://www.nsenergybusiness.com/projects/gas-natural-acu/>

¹¹¹ NS Energy. "Golar Power secures PPA for 605MW power project in Brazil", October 22, 2019. Available online at: <https://www.nsenergybusiness.com/news/golar-ppa-power-project-brazil/>

¹¹² According to EPE, only 10 out of the 27 federative units in Brazil are connected to the gas grid. See Empresa de Pesquisa Energética (EPE). "Plano Indicativo de Gasodutos de Transporte – PIG 2020". Apresentação do PowerPoint (epe.gov.br).

¹¹³ Oddone, "Oil & Gas in Brazil: A New Silver Lining?" Available online at: <http://publications.atlanticcouncil.org/brazil-oil-gas-oil-gas-in-brazil.pdf>

¹¹⁴ MME, EPE. (2014). Plano Decenal de Expansão da Malha de Transporte Dutoviário – PEMAT 2022. Brasília, March 2014. Available online at: http://www.mme.gov.br/documents/10584/1433753/Relatorio_PEMAT_2022_Final.pdf/a1ddd798-95c6-4b36-a0d3-b9adeba0ac6f

¹¹⁵ MME, EPE. (2019). Plano Indicativo de Gasodutos de Transporte. Rio de Janeiro, October 11, 2019. Available online at: http://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-415/PIG%20-%20Plano%20Indicativo%20de%20Gasodutos%20de%20Transporte_EPE2019.pdf

¹¹⁶ EPE. (2020). "Plano Indicativo de Gasodutos de Transporte – PIG 2020. Apresentação do PowerPoint (epe.gov.br)



2021 Gas Law provides for an authorization regime for the development of infrastructure in order to facilitate private sector initiative and cut the red tape that made infrastructure development so cumbersome in the past.

Expanding supply does not seem to be a problem, at least for the foreseeable future import capacity seems to be growing. The question that comes to mind then is will there be enough demand to justify the investment in those 40 projects?

Igniting demand

According to the Brazilian Development Bank (BNDES), natural gas will be the main transition fuel as it is the fossil fuel that emits the least pollutants. With Petrobras' retrenchment as market developer and coordinator, BNDES plans to step in to assist not only with project origination, structuring and promotion, but also with de-risking financing and securitization. In its 2020 assessment of the gas market, BNDES recognized that to attract the foreign investment necessary to fund sustainable infrastructure it would need to firm up demand from foundational sectors such as power generation and industrial consumption and help develop additional demand in the commercial and residential sectors (particularly in less populated areas) and in the transportation sector generally.¹¹⁷ The Bank plans to become the cornerstone that facilitates market development and somehow contributes to lessen the chicken and egg problem.

One of the new demand outlets considered by BNDES is the transportation sector. The opportunity for fuel substitution in the heavy-duty transport segment is quite attractive. Vehicles powered by natural gas can emit up to 85 per cent less toxic pollutants and can generate a reduction of 10 per cent in greenhouse gas emissions compared to diesel vehicles.¹¹⁸ The price differential between imported diesel and natural gas for the transport sector is substantial¹¹⁹ and can help justify the investment in LNG or compressed natural gas (CNG) powered heavy duty trucks. Given a tradition for natural gas usage in transport in Brazil and the available refuelling infrastructure, targeting this sector seems logical. BNDES estimates incremental demand from diesel substitution in heavy duty truck fleet at 0.8 MMcm/d (0.3 Bcm)¹²⁰ (8000 trucks) in 2025 and 4.5 MMcm/d (1.3 Bcm)(27,000 trucks) in 2035. The development of Blue Corridors¹²¹ may see much support in the foreseeable future in Brazil. BNDES expects at least two phases of development, covering routes close to the gas grid or with greater heavy traffic density; and routes for medium density highways (1500 to 5000 trucks/day).¹²²

Another sector that holds great promise is the industrial sector, where BNDES estimates 42 MMcm/d (15 Bcm) of additional potential demand by 2030, with 29 MMcm/d (10 Bcm) materializing from investments in new industrial facilities.¹²³ The iron and steel, and chemical sectors concentrate the largest incremental demand (87%). According to the Brazilian chemical industry association, Brazil

¹¹⁷ Banco Nacional de Desenvolvimento Econômico e Social (2020). 'Gás para o desenvolvimento'

¹¹⁸ Mouette, D., Machado, P. G., Fraga, D., Peyerl, D., Borges, R. R., Brito, T. L. F., Shimomaebara, L. A. and Dos Santos, E. M. (2019). 'Costs and emissions assessment of a Blue Corridor in a Brazilian reality: The use of liquefied natural gas in the transport sector'. *Science of the total environment*, 668, 1104-1116

¹¹⁹ The average price of imported diesel in 2018 was reported at \$0.540/litre or \$14.90/MMBtu. Silva, C. (2019). 'Gás Natural: combustível do futuro ou do presente?' O novo mercado de gás natural: opiniões de especialistas, perspectivas e desafios para o Brasil", FGV Energia, August, 25-26.

As shown in

Figure, in 2017 and 2018, the prices of natural gas available domestically ranged between \$8.00 and \$10.00/MMBtu.

¹²⁰ Converted using 365 days a year

¹²¹ Blue Corridors are routes for vehicles that use natural gas that can be compressed or liquefied, and that present an alternative to the traditional consumption of diesel or gasoline, mainly in the transport of road cargo

¹²² Banco Nacional de Desenvolvimento Econômico e Social (2021). 'Gás para o desenvolvimento', 2021 https://web.bndes.gov.br/bib/jspui/bitstream/1408/20581/1/Relatorio_Gas_Developmento%20Final.pdf

¹²³ 18 MMcm/d in new industrial plants and 11 MMcm/d in new thermoelectric plants for self-production. 'Gás para o desenvolvimento', 2021, 27



could triple or quadruple the demand for natural gas in the production of fertilizers, as long as producers in this subsector have a competitive and secure supply that can meet steady demand for a long period of time.¹²⁴ The fertilizer sector is significant given that Brazil is one of the largest agricultural producers and importers of fertilizers in the world. According to BNDES, fertilizer imports totalled \$9.10 billion in 2019, representing more than 80 per cent of the fertilizers consumed in the country. The survey of industrial players underpinning BNDES' forecast found that prices in the range of \$4 to \$6 per MMBtu (exclusive of taxes) were considered the most viable and could generate the largest potential demand.¹²⁵ Thus, the key to unleashing demand rests on the ability to increase the price competitiveness of gas, which greatly depends on the ability to develop the appropriate market structure.

Can liberalization be implemented within the constrained window afforded by the energy transition?

Natural gas market reform processes seek to foster competition and market liquidity for the benefit of end users. The primary goal is to transform markets defined by monopolistic features and behaviours into mature, liquid, functioning markets with full retail competition. The processes involved are complex and lengthy.¹²⁶ According to the International Energy Agency, common features of these processes include regulatory measures to promote market competition such as unbundling and third-party access rules, and price deregulation frameworks to accompany wholesale and retail competition development. Regions such as the European Union and large countries such as the United States have successfully reformed their gas markets. These reform processes have taken decades. In some cases, despite great efforts, they remain in a sense incomplete compared to the progress elsewhere.¹²⁷

A benefit of a long-winded and bumpy reform process is that along with each attempt at reform some incremental change is achieved. Since 2018 in Brazil, progress has been made in setting up rules that favour a competitive gas market.¹²⁸ However, these efforts were restricted to what the legal framework permitted. With the passage of the 2021 Gas Law, the legal framework for a new competitive market design has been set up and now the real work begins to develop the requisite network of policies, regulations and institutional capabilities to both build the market architecture and oversight desired, and to influence market agents' interest and behaviour.¹²⁹

¹²⁴ BNDES (2021). 'Gás Natural: O Potencial de Consumo da Indústria Brasileira'. Podcast- Diálogos BNDES <https://agenciadenoticias.bndes.gov.br/blogdodesenvolvimento/detalhe/Gas-natural-o-potencial-de-consumo-da-industria-brasileira/>

and 'Gás para o desenvolvimento', 2021

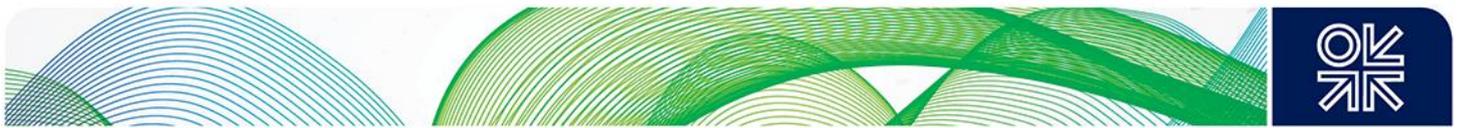
¹²⁵ 'Gás para o desenvolvimento', 2021

¹²⁶ Heather, P. (2015). 'The evolution of European traded gas hubs'. Oxford Institute for Energy Studies OIES paper NG 104

¹²⁷ This is the case of the Italian market. Favasuli, S. (2020). 'Italy's gas market – an ecosystem where price takers thrive', in *S&P Global*, 29 July 29 <https://www.spglobal.com/platts/en/market-insights/blogs/natural-gas/072920-italys-gas-market-an-ecosystem-where-price-takers-thrive>

¹²⁸ For example, when the Temer reform bill was derailed in Congress, the government settled for an administrative decree in which the ANP was empowered to continue within the confines of existing 2009 Gas Law to regulate, amongst other things, non-discriminatory access to strategic infrastructure and the pipeline network in a manner that encouraged a transition into a transportation system based on a capacity entry-exit model with competitive trading and pricing. Coupled with the NGM guidelines, these interim rules helped pave the way for the development of transport capacity open seasons. Decree nº 9.616/2018: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/D9616.htm

¹²⁹ Some of this entails developing network codes and guidelines; oversight capabilities; information sharing protocols; conflict resolution mechanisms, etc.



According to the ANP, with the passage of the 2021 Gas Law and its implementing regulations,¹³⁰ coupled with ANP regulatory efforts under the NGM,¹³¹ Brazil is close to entering the transition stage (number 2 in Figure 10) in the path to market maturity. ANP has set an ambitious regulatory schedule which has already been faced with challenges. In mid-October 2021, the industry press reported that at least ten regulations covering natural gas and LNG transport, distribution, sales and fares that were originally scheduled to be completed by August 2022 would be completed at later dates, extending to 2023 in some cases.¹³²

Both the regulators and interested stakeholders understand that time is of the essence. The energy transition toward carbon neutral energy systems and economies provides a shorter window for Brazil to accomplish the great feat of successfully developing a liquid and transparent natural gas market. While enjoying the benefits of learning from successful reform experiences - the dos and don'ts, Brazil can't afford to spend 20 or 30 years implementing the reform. In the next decade, given the urgency to limit greenhouse gas emissions to arrest climate change, regulations to price carbon could be implemented in other markets and in Brazil. A domestic carbon price will impact the cost competitiveness of pre-salt fields, which until now have been attractive enough to lure substantial and consistent investment in production. Associated offshore gas production would undoubtedly be affected by this cost increase, in turn reducing the price competitiveness of domestic gas and therefore, its future demand.

Without the right institutional and regulatory framework, it will be difficult to lure the investment required to develop the infrastructure that can help unleash both supply and demand. Building that framework will be a testament to the ability of the Brazilian state, its energy planning, and regulatory bodies to act swiftly and in a coordinated manner while including meaningfully market agents in the regulatory development process. So far, the MME, ANP and EPE have done a tremendous job informing public opinion on the conceptual design for the market.¹³³

¹³⁰ On 2 June 2021, the Bolsonaro administration approved Decree No. 10.712, the first set of rules that implement the 2021 Gas Law. It includes provisions regarding transportation, underground storage, gathering pipelines, UPGNs and LNG Terminals, gas fungibility, distribution and trading, regulatory harmonization, and transition rules. Some of the most relevant aspects in this decree relate to regulatory harmonization with respect to the regulation of the free consumer to avoid resistance from states. While the regulatory purview will remain with the states, they will need to define minimum gas consumption volumes to allow consumers to eventually be able to choose their own natural gas supplier

¹³¹ ANP Resolution No. 794/2019 (price transparency) and preparation of the proposal for the certification of independence of carriers (the first resolution of the ANP Regulatory Agenda 2020-2021).

¹³² Gompertz, R. (2021). 'Brazil delays gas regulation updates further', *Argus Media*, 13 October <https://www.argusmedia.com/en/news/2263322-brazil-delays-gas-regulation-updates-further>

¹³³ For example, ANP has held public information sessions to educate the public on the reform process, spell out the market design and discuss concrete regulatory proposals

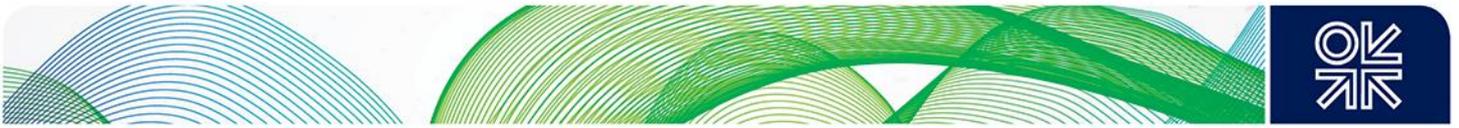
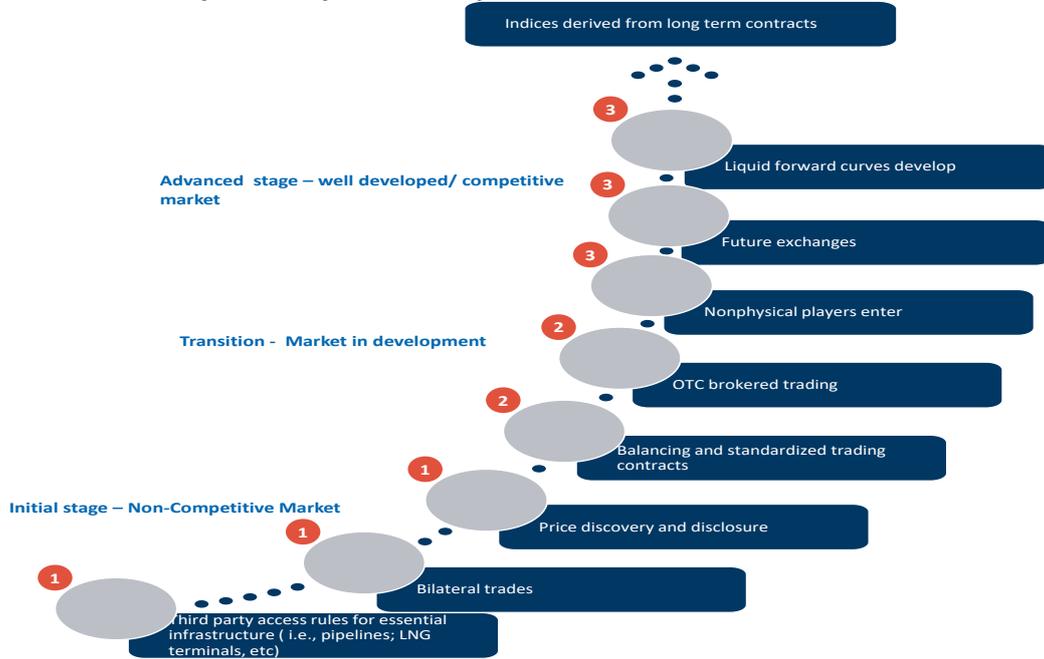


Figure 10: Hub development to path maturity



Source: Graph developed with information from ANP and Heather, P. (2015). 'The evolution of European traded gas hubs'. OIES NG 104.

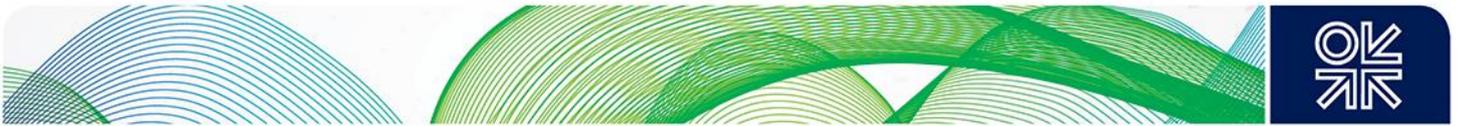
Concluding thoughts and recommendations

In the last six years, significant strides have been made in the development of a natural gas market in Brazil, particularly regarding the definition of a regulatory framework and market design that favour competition, transparency, and liquidity. Both the Petrobras TTC and the enactment of the 2021 Gas Law have provided support to an aspiration that Brazil has the institutional and regulatory wherewithal to bring its natural gas resource wealth to bear. As this paper has examined, there are still substantial hurdles to developing a well-functioning gas market that fosters competition and market liquidity to the benefit of end users, including how to effectively expand supply, develop infrastructure, ignite demand, and develop efficient market pricing.

A significant hurdle is that natural gas development has long been tied to oil production.¹³⁴ Over the years, that association has hampered its progress as a separate commodity. While natural gas has achieved a strategic position driving industrial activity in the country's heartland and affording power supply reliability, policy signals are still needed to improve its availability and affordability. The recent regulatory overhaul is a step in the right direction. However, as Brazil's amazing transformation from oil dependency during the 1973 oil crisis to energy powerhouse indicates, the pace at which the natural gas market evolves hinges on the definition of a long-term vision for natural gas that clearly specifies the role it should play in the foreseeable future, particularly given the transition to carbon neutral energy systems and economies.

In 2020, the MME published the National Energy Plan 2050 (PNE 2050) outlining the government's long-term expansion strategy for the energy sector. The document discusses the key themes for energy

¹³⁴ In fact, the Brazilian natural gas industry was structured mirroring developments and, as a result of, domestic oil exploration and production. See footnote 5



systems such as energy transition, climate change and decarbonization. Regarding natural gas, it analyses its prospects with respect to the expected impact of reform efforts undertaken in 2019, future demand and supply, and gas penetration in the electricity sector. The PND estimates potential natural gas supply (domestic production + imports) to range between 340 MMcm/d and 450 MMcm/d by 2050.¹³⁵

A set of recommendations are provided for further development and integration of this fuel in the energy matrix. As illustrated in Figure 11, none of the recommendations point to a definition of its role as the liberalization process unfolds or with regards to the energy transition.¹³⁶ It could be that the studies undertaken to outline the contribution of natural gas in 2050 were prepared prior to the enactment of the 2021 Gas Law. Therefore, its impact has not been properly analyzed and there may soon be a refined version of the PNE 2050 as it pertains to the contribution of natural gas.

Figure 11: 2050 PND Recommendations for the natural gas sector

Challenges	Recommendations		
	2020-2030	2030-2040	2040-2050
To create a competitive gas market and make viable the expansion of the gas transportation grid	Develop a liquid natural gas market with diversity of players		
	Make viable new technological solutions for the natural gas sector as well as articulate with the competent authorities the regulatory and tax treatment of these solutions.		
Harmonization of state regulations	Work along state authorities to harmonize and continuous improvement of state regulatory frameworks for gas distribution		
Integration of new market models for the gas and power sectors	Make compatible the constant, sustained flow gas production and the electricity generation flexibility for different current and future business models		

Source: MME/EPE. (2020). Plano Nacional de Energia 2050. <https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-227/topico-563/Relatorio%20Final%20do%20PNE%202050.pdf>

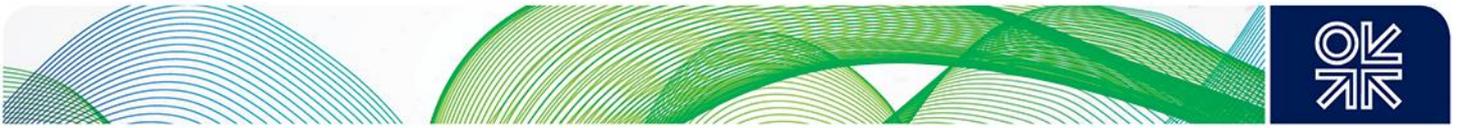
A clearly defined role for natural gas during the energy transition could help keep the government's resolve to invest in the implementation of the reform project. Reform processes are complex and lengthy and require unwavering commitment to establish functioning competition. Maintaining that resolve won't be easy without clearly outlining an objective. Is it to develop a natural gas market that can serve as a springboard for biomethane and hydrogen? Or is it to develop the market so that offshore reserves can be properly and fully monetized to supply an expanding demand responding to competitive prices?

While leapfrogging from a half-developed gas market to a biomethane or hydrogen market may be a possibility, the transition cost could be too high. Recently, the MME unveiled its hydrogen strategy. One of the policy fronts outlined concerned a feasibility study on the use of existing gas pipes to transport hydrogen and its corresponding regulatory framework.¹³⁷ If the development of a hydrogen driven economy is in the cards, a limited gas transportation network may become an impediment. As this paper

¹³⁵ MME/EPE. (2020). Plano Nacional de Energia 2050, 180. <https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-227/topico-563/Relatorio%20Final%20do%20PNE%202050.pdf>

¹³⁶ MME/EPE. (2020). Plano Nacional de Energia 2050, 179, 185-186. <https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-227/topico-563/Relatorio%20Final%20do%20PNE%202050.pdf>

¹³⁷ Ministério de Minas e Energia (2021) 'MME apresenta ao CNPE proposta de diretrizes para o Programa Nacional do Hidrogênio', 4 August. <https://www.gov.br/mme/pt-br/assuntos/noticias/mme-apresenta-ao-cnpe-proposta-de-diretrizes-para-o-programa-nacional-do-hidrogenio-pnh2>



examined, expanding Brazil's current coastal and limited pipeline network largely depends on the ability to expand supply and demand to overcome the chicken and egg problem. This will be greatly facilitated when the transition to a competitive market takes place.