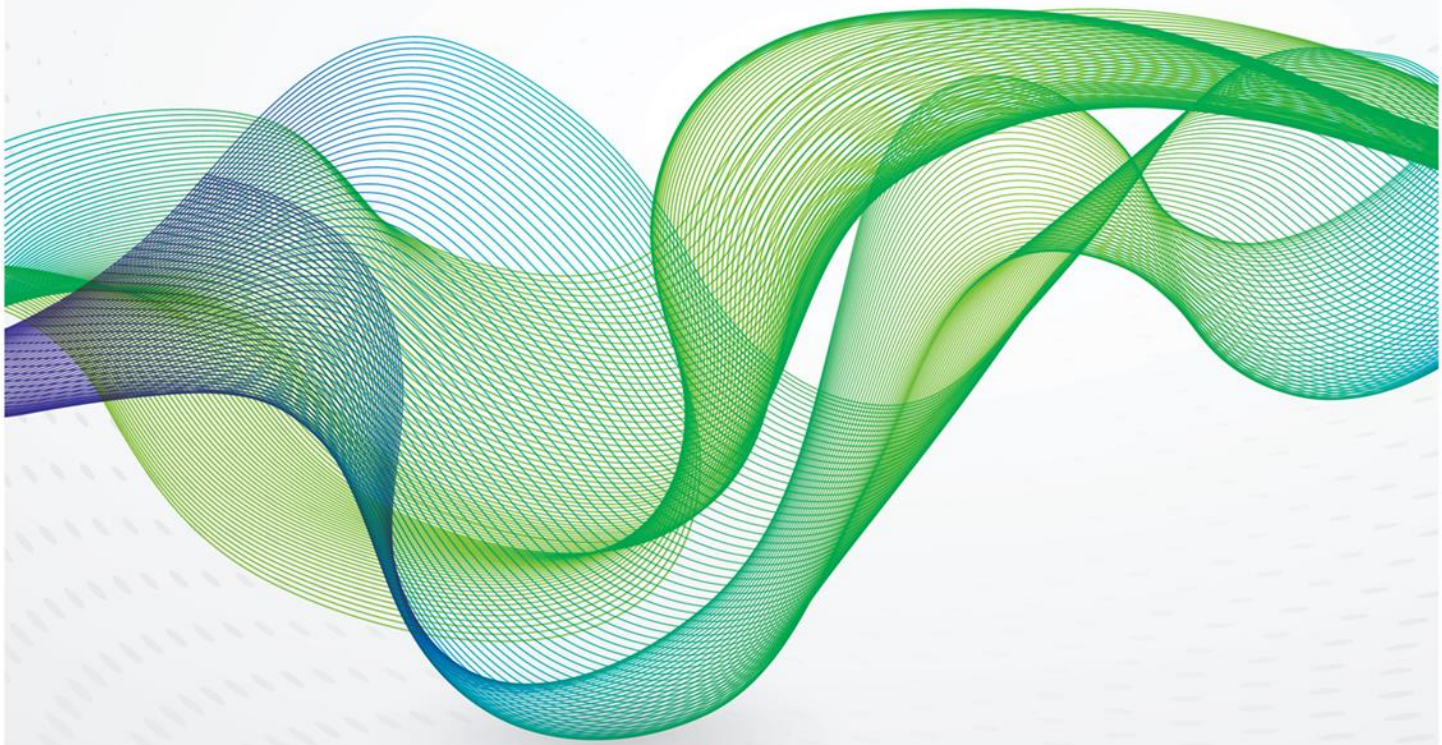
THE OXFORD INSTITUTE FOR ENERGY STUDIES

May 2021

Will Argentina Become a Relevant Gas Exporter?



OIES PAPER: NG 167

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ISBN 978-1-78467-175-4

Acknowledgements

The present paper is the result of the collaboration of the Austral University and the Oxford Institute for Energy Studies (OIES).

The authors would like to thank Bassam Fattouh, Director of the OIES for this initiative and for his very useful guidelines. We also would like to thank James Henderson, Director of the Gas Research Programme of the OIES for reviewing and comments on the paper, Dr. Griselda Lambertini and students from the Energy Institute of Austral University and Instituto Petroquímico Argentino (IPA) for their valuable contribution to the preparation of this report.

Finally, many thanks to John Elkins and Kate Teasdale for her always useful work in editing and publishing the paper.

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Units

Arg $ = peso = Argentine pesos
Bbl = Barrels of oil
Bcf = Billion cubic feet
Bcf/d = Billion cubic feet per day
Bcm = Billion cubic metres
Btu = British Thermal Units
GW = Gigawatt
GWh = Gigawatt hour
m^3 = Cubic metres
m^3/d = Cubic metres per day
MMBtu = Million British Thermal Units
MMm^3/d = Million cubic metres per day
mtpa = Million tonnes per annum
MMton= Million tonnes
MW = Megawatt
MWh = Megawatt hour
tons=metric tonnes
USD = US dollars

Glossary

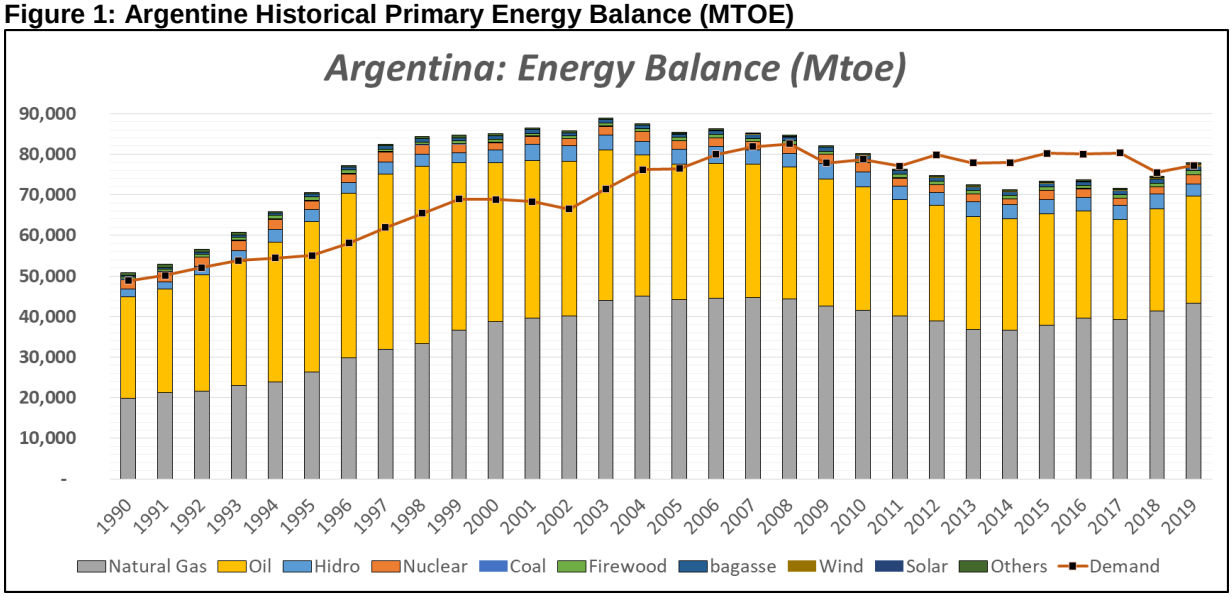
CAMMESA Compañía Administradora del Mercado Mayorista Eléctrico (Argentine Wholesale Electricity Market Dispatch Operator)
CIF Cost, Insurance and Freight
CNG Compressed Natural Gas
DES Delivered Ex-Ship
DOE US Department of Energy
EIA US Energy Information Administration
ENARGAS Ente Nacional Regulador del Gas (National Gas Regulatory Board)
ENARSA Energía Argentina S.A. (Argentine State-owned Energy Company), now IEASA
FOB Free on Board
HH Henry Hub (US Natural Gas Reference Price)
IAPG Instituto Argentino del Petróleo y el Gas (Argentine Institute of Oil and Gas)
IEASA Integración Energética Argentina (formerly ENARSA)
INDEC Instituto Nacional de Estadísticas y Censos (Argentine National Institute of Statistics)
INFOLEG Información Legislativa y Documental (Ministerio de Justicia y Derecho Humanos)
MEGSA Mercado Electrónico del Gas Sociedad Anónima (Argentine Electronic Gas Market).
MEyM Ministerio de Energía y Minería (Argentine Ministry of Energy and Mines)
TGN North Gas Transmission Company
TGS South Gas Transmission Company
YPF (Argentina), formerly Yacimientos Petrolíferos Fiscales

1. Introduction

Natural gas accounts for 58% of the primary energy supply in Argentina[1]. The country is also the largest gas market in South America, with a widespread consumer base in all segments and a comprehensive infrastructure of gas pipelines and distribution networks. For many years, Argentina enjoyed the position of a reliable gas exporter, with export pipeline connections to Chile, Uruguay and Brazil and import pipeline connections to Bolivia, with most of the gas imports aiming at balancing the supply/demand shortfall in the southern hemisphere winter.

Argentina has a long history as a hydrocarbon producer as shown in Figure 1, with healthy surpluses available for export until 2003, gradually declining to deficits post 2008. Energy and economic policies adopted during the last thirty years strongly affected the country's hydrocarbon production and demand, leading to continued dependency on imports from 2009 onwards.

Figure 1: Argentine Historical Primary Energy Balance (MTOE)



Source: Minem[2]

The discovery of large unconventional gas resources, in particular in the shale gas area of Vaca Muerta was a game-changer, bringing prospects of self-sufficiency coupled to gas export opportunities either by using the existing pipeline export infrastructure or also by exporting LNG to global gas markets.

Since the liberalization and privatization of the natural gas industry in 1992, Argentina's energy policies and regulations can be characterised by the following four phases:

I. From the restructuring and privatization of state-owned energy companies, kickstarted in 1989 through the economic and financial crisis of December 2001. During this period, Argentina was a net gas exporter.

II. From the Public Emergency Law No 25,561 in January 2002 through the institutional normalization of the energy market starting in December 2015. From 2002 to 2009, government intervention in setting prices boosted demand, which outpaced supply, and the country became a net gas importer.

[1] http://datos.minem.gob.ar/dataset/balances-energeticos
[2] Escenarios Energeticos 2030. Documento de Sintesis. Subsecretaria de Planeamiento Estrategico. Ministerio de Planificación. November 2019

III. From January 2016 up to August 2019, new regulations aiming at promoting investment in the development of unconventional oil and gas reserves in Vaca Muerta (Neuquén basin). During this period, domestic production increased, leading to a decrease in imports.

IV. From August 2019 up to the present, marked by another macroeconomic crisis, election cycle, and recent policies implemented by the government inaugurated in December 2019.

This paper will address the impact on supply and demand of the above regulatory phases, with focus on the framework implemented under phases III and IV. In order to facilitate a better understanding of the evolution of the industry fundamentals, the paper provides initially an outline of the regulation of the gas industry from 1989 to 2021, encompassing the upstream, downstream, imports and exports activities, and highlighting the heavy interference of the government in prices and economic activity following a 10-year period of liberalisation (Section 2). This Section also assesses the results and impact of the most recent government plan (*Plan Gas.AR - 2020*) designed to encourage steady gas supplies to priority demand markets.

In Sections 3 and 4, the authors describe the evolution of supply and demand, the growing contribution of unconventional gas in domestic supply, the highly seasonal demand and the need for imports to fill the winter supply gap. In Section 5 the paper outlines export opportunities for monetization of Argentine gas resources. The large size of the resources and the high natural gas liquids content of Vaca Muerta's shale gas might enable the development of LPG, LNG and urea exports. The implementation of LNG export schemes could be constrained by high winter demand seasonality, the lack of evacuation pipelines and the ongoing country macro-economics. In the Conclusion, the paper aims to respond to the question whether Argentina will become a relevant gas exporter, which is conditioned on the direction and pace of regulation post 2024.

2. Natural Gas Legal and Regulatory Framework

In August 1989, upon the enactment of the State Reform Law No. 23,696, Argentina commenced a large public sector transformation process, with the aim of deregulating economic activity and privatizing State assets. The natural gas industry was unbundled and subsequently privatized. This section will provide a summary of the ensuing regulation and its impacts on the gas value chain, namely in the upstream, downstream, imports and exports.

2.1 Regulation of the Upstream

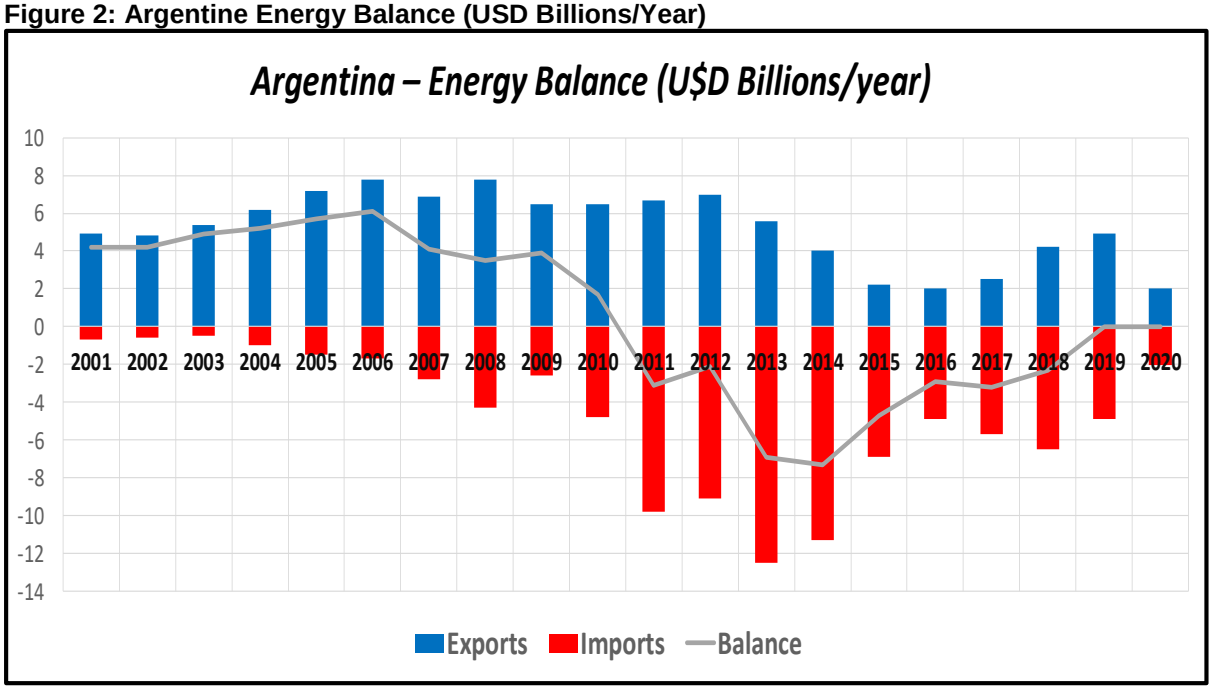
Exploration, production, gathering and treatment activities ("upstream") are activities subject to competition, based on the free disposal of the extracted hydrocarbons as provided for in Hydrocarbons Law No. 17,319 and Executive Decrees No. 1055/89, 1212/89 and 1589/89. The Federal or Provincial Governments keep the ownership of the fields, but the private concessionaire has the right to commercialize or industrialize the extracted hydrocarbons (oil and gas) in the domestic or the foreign market.

The price of gas at wellhead was deregulated and producers had to compete to supply gas to the market. Generally, local gas prices under long term (10 years) contracts between producers and distribution companies for volumes above 1 Million cubic meters per day (MMm^3/d) were adjusted based on crude or alternative fuel prices with a floor/cap price allowing +/- 3% of the base price, adjusted by the PPI (US Producer Price Index – Industrial Commodities). Some large users started to purchase gas directly from producers. Under these circumstances, the market price of gas at wellhead was the netback of the balance between competitive products (fuel oil, and gas oil for thermal power plants) offered in the main demand hub (Buenos Aires).

From 1993 through 2002, Argentina strongly expanded its internal and external natural gas market, through the commissioning of thermal power stations, conversion of vehicles to Compressed Natural Gas (CNG) and export authorizations in excess of 20 MMm^3/d. The new regulatory framework provided for an unbundled and privately owned natural gas system, which was successful in promoting investments, competitiveness, and efficiency.

The 2002 economic and financial crisis and the measures taken by the government to mitigate the effects of the crisis, had a sharp impact on the natural gas sector and generated the conditions for the supply crisis which arose in Argentina as from the beginning of 2004. The price of gas in U.S. Dollars in Argentina experienced a significant drop, while the prices of fuel oil and gasoil remained at their international levels. As from 2005, due to the sharp rise in oil prices, the difference between the price of natural gas and its substitute fuels increased significantly for the industrial and the power sectors resulting in increased subsidies from the Treasury. Those subsidies as a percentage of GDP trebled from 0.4% in 2005 to 1.2% in 2008, then reached a peak of 3.5% in 2014, resulting in annual expenditure of nearly USD 20 billion and depletion of the country's foreign reserves.[3] The impact on the Energy Balance can be seen in Figure 2.

Figure 2: Argentine Energy Balance (USD Billions/Year)



Source: (Argentina Secretaria de Gobierno de Energia (a), 2019), updated to 2020

The Emergency Law Nº 25,561 (which lasted from 2002 to 2017) gave the government the authority to set wellhead gas prices, especially for the residential sector and thermal power plants, much below import parity price. The government suspended the price pass-through mechanism for distributors serving residential and small consumers, as the 'emergency rules' did not allow any increase in consumers' tariff rates.

Uncertainties generated by the regulatory changes and the forced low gas prices reduced investments in exploration to a minimum and caused a significant drop in reserves. Natural gas production capacity was insufficient to meet internal and external requirements. The strong increase in demand, encouraged by low gas prices, led to the gradual suspension of exports to guarantee domestic supply. There was an increase in the use of alternative liquid fuels for electricity generation during the whole year (winter and summer), as well as additional restrictions on industrial consumption in winter periods. This led to the commissioning of two LNG import terminals (Bahia Blanca and Escobar), respectively in 2008 and 2012, and increasing pipeline imports from Bolivia, in addition to the import of liquid fuels (diesel and fuel oil).

As gas and oil products imports increasingly burdened the country's finances, in 2013 the government decided to create the so called "Plan Gas", where producers committed to increase production above

[3] Argentina Secretaria de Gobierno de Energia, 2019.

an adjusted baseline would receive incentives paid by the National Treasury. YPF [4] started a comprehensive campaign to develop the Vaca Muerta shale formation (Neuquina basin), which benefited from the incentives provided by "Plan Gas".

Following the inauguration of President Mauricio Macri in December 2015, the Ministry of Energy focused successively on the new 'normalization' of prices and tariffs, by providing economic incentives for the development of unconventional resources and a gradual return to gas exports. The government encouraged a more aggressive development of Vaca Muerta's potential through the generation of internal and external demand, the mothballing of the LNG import terminal located in Bahía Blanca and by developing a scenario whereby Argentina would become an exporter of LNG in the medium term. Economic incentives for the development of unconventional production in Vaca Muerta were notably successful in terms of volumes added to the market. Regulations regarding the "midstream" encouraged the construction of some of the infrastructure necessary for Vaca Muerta production to reach the market.

However, in 2019, due to macroeconomic difficulties, the government abandoned economic incentives for new investments in unconventional production. The prospect of increasing LNG imports again prompted the government to create a new price incentive plan, announced in late 2020. The impact of these measures and of the COVID-19 pandemic are discussed below.

2.2 Regulation of the Downstream

The activities of transmission and distribution ("downstream") are a natural monopoly. Therefore, those activities were entrusted to the private sector through exclusive licenses, subject to much more stringent regulations (than other sectors), with maximum tariffs ("price cap") regulated by the Ente Nacional Regulador del Gas (ENARGAS) according to Law No. 24,076/1992 (the Gas Act), Executive Decree No. 1738/92 and the relevant Transmission and Distribution License Agreements.

The Gas Act of 1992, followed by Executive Decree No. 1189/92, mandated the privatization and split of the state-owned Gas del Estado S.E. into two domestic transmission companies and nine distribution utilities, which hold license contracts for a term of 35 years, with potential extensions of 10 additional years. Transmission and distribution companies are subject to open access obligations. The legal framework prohibited transmission companies from purchasing or selling gas, except gas required for the operation of their systems.

The price paid by the end user is the sum of:

- the price of gas at wellhead
- the tariff (or margin) received by the transmission company
- the tariff (or margin) received by the gas distribution company
- and applicable taxes.

Initially, transmission and distribution margins were set in US Dollars according to ENARGAS' 'price-cap' regulations, with the wellhead gas price passed-through to users. Transmission and distribution maximum tariffs must be reviewed every five years (Five-Year Tariff Review). Up to July 2000, they were adjusted semi-annually according to the Producer Price (PPI) Index - Industrial Commodities published in the United States.

Between 1992 and 2002, the price-cap tariff system administered by ENARGAS not only satisfied the objective of promoting investments; it also assured reasonable and fair tariffs to end consumers.

[4] In 2012, President Cristina Kirchner renationalised YPF, which was previously acquired by Repsol in 1995, claiming "lack of investment in exploration and production".

Following the 2002 Emergency Law, tariffs for end-users were "*pesified*"[5] and "frozen". Investments in transmission and distribution faced a severe drop. Frozen tariffs scarcely covered operational costs, negatively affecting the quality of service provided by the utilities.

In 2017, President Macri successfully finalised the renegotiation of the transportation and distribution license agreements and the Minister of Energy instructed ENARGAS to provide for the normalization of transmission and distribution tariffs. As of April 1st, 2018 ENARGAS completed and implemented a global review of transmission and distribution maximum tariffs. Semi-annual tariff adjustments reflected the evolution of the inflation index. The focus on the 'normalization' of prices and tariffs contributed to eliminating generalized subsidies to consumers in a phased manner and provided better economic signals to both producers and consumers. However, Argentina's public accounts crisis and currency devaluation led to a new freezing of transportation and distribution tariffs in 2019 that is still in force in early 2021.

2.3 Regulation of Exports and Imports

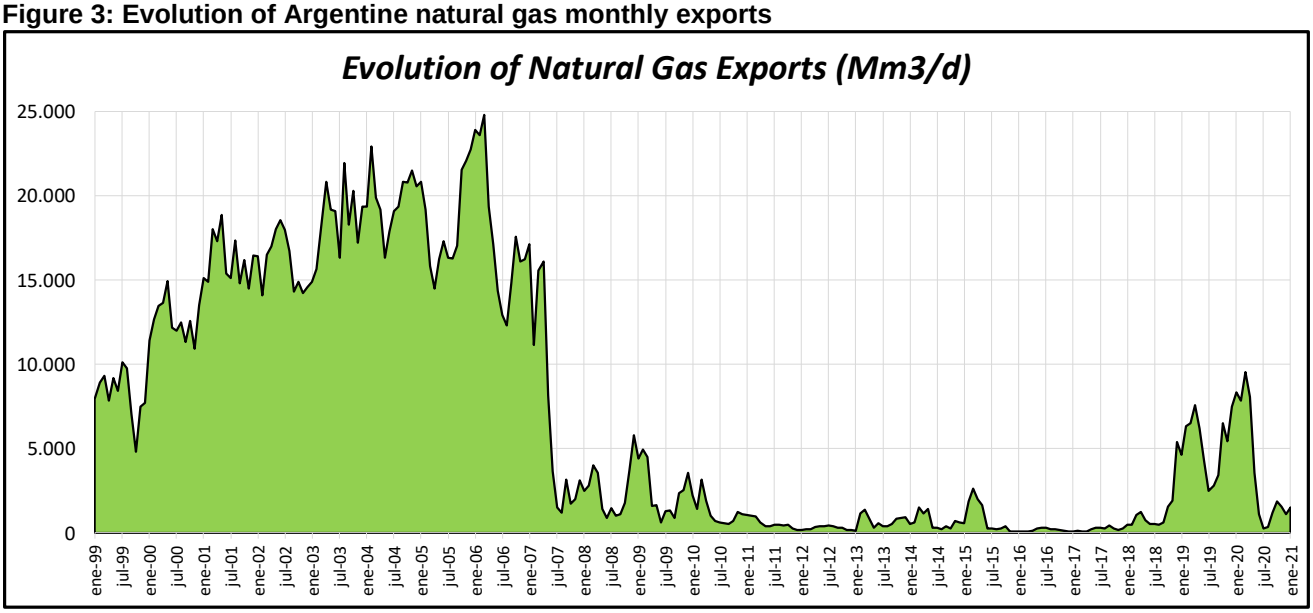
The Gas Act establishes that (i) imports of natural gas are authorized without prior approval; while (ii) exports of natural gas must, in each case, be authorized by the National Executive. Export authorizations are granted to the extent that domestic supply is not affected.

Argentina signed memoranda of understanding ("Protocolos") with Chile, Brazil, and Uruguay for natural gas exports leading to the development of a significant gas export infrastructure. Natural gas was first exported in 1996 following the construction of the Bandurria (Argentina-Chile) pipeline, at volumes of 1.5 MMm3/d (0.5 bcm/year), growing to the 2004 peak of 20 MMm3/d (7.3 bcm/year), 90% of which went to the Chilean market, with the remainder supplied to Brazil and Uruguay. The Gas Act represented a friendly regulatory environment for private investments in the transmission and distribution systems, leading to the construction of 10 international pipelines.

In early 2004, the Argentine economic crisis turned into an energy crisis, because of the extraordinary growth of domestic gas demand, due to low prices, and insufficient investments in exploration. Based on the legal principle that grants priority to domestic consumption, the government imposed direct and indirect restrictions on gas exports, to deal with insufficient supply. Gas exports were restricted as from 2004 and then reduced to a minimum as from the winter of 2007, as shown on Figure 3 below.

[5] Converted to Argentine pesos – until then the tariffs in pesos were fully pegged to the USD

Figure 3: Evolution of Argentine natural gas monthly exports



Source: ENARGAS

In addition, as part of the "emergency-package", the Argentine Government created a withholding tax on gas exports at a 20% rate.[6] This tax effectively discouraged natural gas exports.

The Argentine State faced judicial and arbitral claims regarding the curtailment of exports and the breach of bilateral investment treaties in connection with the changes of rules with respect to the regulatory framework since privatization.

On the other hand, Argentina resumed natural gas imports from Bolivia. In 2006 national oil companies, YPFB (Bolivia) and ENARSA[7] (Argentina) signed a Gas Sales Agreement that will be in force until 2026. Argentina started to import LNG in the winter of 2008 through a regasification vessel (FSRU) moored in Bahía Blanca and in 2012, a second import terminal, also an FSRU, started operations at Escobar, in the northern area of Buenos Aires. In the period, 2004-2017 Argentina lost its role as a regional natural gas exporter and faced energy imports with a strong negative impact on public accounts.

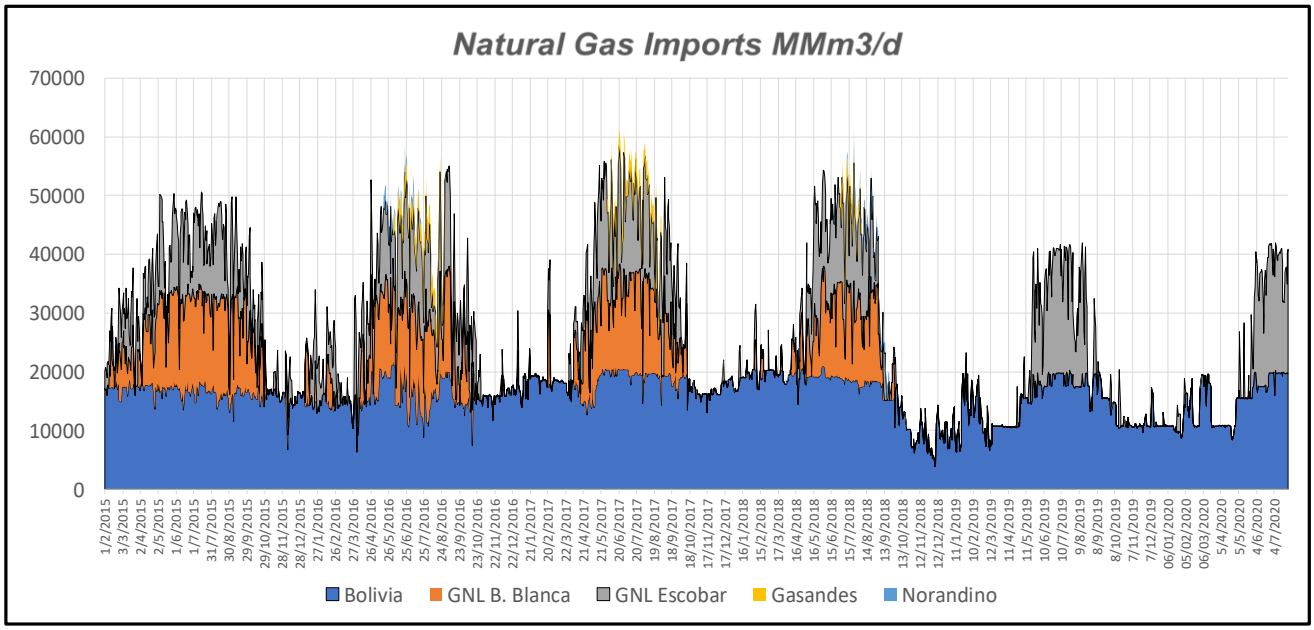
Since 2018, new export regulations helped Argentina in regaining its role as a regional natural gas exporter. In a short period, the incentive program to produce unconventional gas allowed the production of surpluses of natural gas in the months of lower local demand (south hemisphere summer), so it became necessary to open new seasonal markets to cater for the growth of production and thus decrease the import of liquid fuels and LNG during the winter months. The summer surpluses also allowed for the commissioning of a small floating liquefaction plant (Tango LNG), which operated for just one year (2019-2020), due to YPF's suspension of the charter payment.[8]

Figure 4: Argentine Natural Gas Imports and Exports (2015-2020)

[6] https://www.projectfinance.law/publications/2004/august/argentina/

[7] In 2004 Nestor Kirchner's government created a new state-owned Company, Energía Argentina Sociedad Anónima (ENARSA) to explore, exploit, produce, generate, transport, distribute and market petroleum, natural gas, electricity, coal, nuclear energy, and alternative sources.

[8] In June 2020, YPF sent a force majeure notice to the Tango LNG shipowner, saying it was unable to pay the charter of the vessel, due to the pandemic. Following a settlement between the parties and the early termination of the charter contract, the vessel departed Argentina. https://www.rivieramm.com/news-content-hub/news-content-hub/using-flngs-to-lsquofast-trackrsquo-the-monetisation-of-gas-resourcesnbsp-62790



Source: MINEM

Nevertheless, during the first half of 2019, Argentina exported an average of 5.9 MMm^3/d to Chile, Brazil and Uruguay by pipeline, on an interruptible basis (Figure 4). The new framework provides for firm exports up to 10 MM m^3/d during the summer season (September to May).

2.4 Economic Challenges and COVID-19

As mentioned above, due to the political and macroeconomic scenario, in August 2019, the Secretary of Energy decided on new curtailment measures. These included:

- cut down of economic incentives for unconventional developments;
- postponement of the seasonal transportation and distribution tariffs adjustment;
- suspension of the public bidding process for the third transportation license needed to evacuate Vaca Muerta production;
- the enactment of a special LNG Regulatory Regime has also been delayed.

The financial crisis and the presidential elections of 2019 caused great uncertainty about the maintenance of the economic rules in the sector. As a result, companies put a brake on investments, a situation aggravated by the pandemic. Upon his inauguration, President Alberto Fernandez maintained the freeze on gas prices and faced the additional challenges posed by the renegotiation of Argentina's debt and the strict lockdown measures in the wake of COVID-19.

As a result of all the above factors, from August 2019 to October 2020 there was a continuous fall in the number of fracture stages in unconventional gas production. In June 2020 the production of gas dropped 12% year on year, whereas imports from Bolivia, Chile and LNG reached a record of 73 MMm^3/day. Investment in the upstream dropped from USD 6.9 Billion in 2019 to USD 2.0 Billion in 2020 affecting the domestic supply for the winter of 2021.

Facing the possibility of importing expensive alternative fuels in 2021, the current government (led by Alberto Fernandez) launched a new incentive programme called "Gas.AR Plan" (also known as Plan Gas IV)[9] [10]. The key objectives of Gas.AR Plan[11] are as follows:

[9] Decree 892/2020
[10] http://servicios.infoleg.gob.ar/infolegInternet/anexos/340000-344999/344229/norma.htm
[11] https://www.argentina.gob.ar/noticias/el-gobierno-nacional-puso-en-marcha-el-plan-gasar

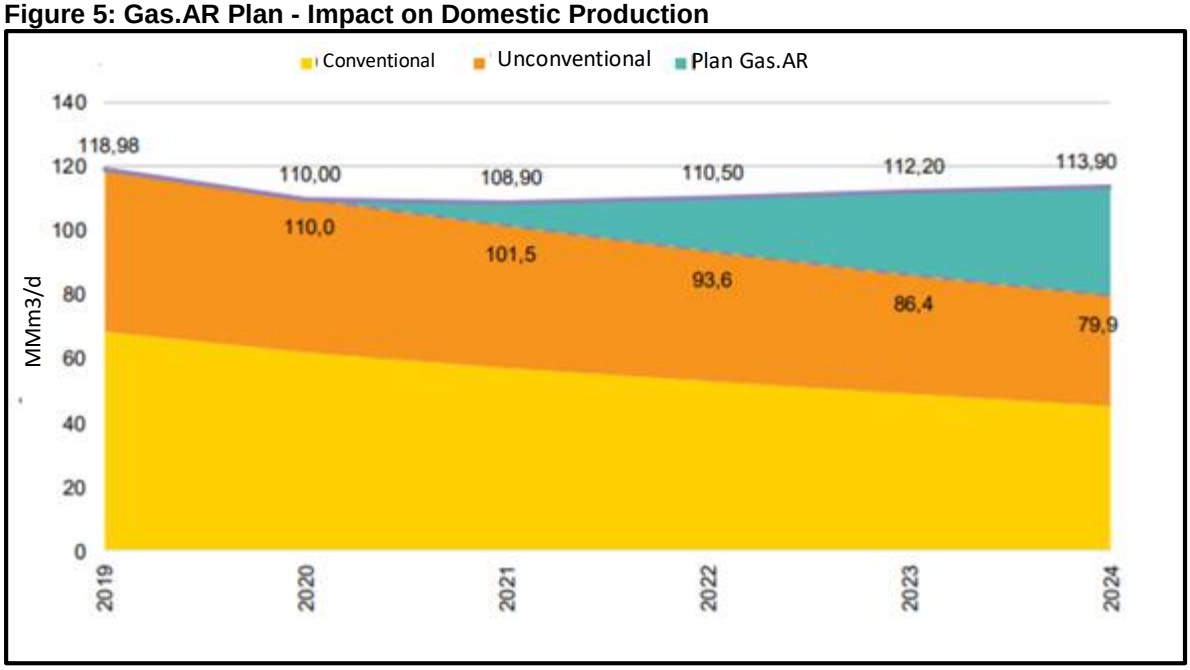
- To enable viable investments in the production of natural gas to meet the country's hydrocarbon needs
- To generate long-term certainty in the sector
- To substitute imports of natural gas (LNG) and the consumption of liquid fuels by the national electricity system
- To achieve a surplus energy balance in line with the Government's fiscal objectives
- To provide predictability of supply to priority demand (small consumers) and to thermal power generation.

The Plan consists of a medium term contract mechanism in US Dollars to boost production for the supply of the priority customers. The key features of the plan are the following:

- Producers must commit to comply with a production curve by basin with an investment plan; and deliver the volumes contemplated in contracts with the distribution companies (Residential demand) and with CAMMESA (Power Plants).
- Contract terms of 4 years, with the possibility to extend to 8 years for offshore projects.
- Contract gas prices set by public auctions.
- There is maximum admissible price for each basin. Prices shall not exceed the maximum Net Present Value price of USD 3.21 /MMBTU.
- The National State will cover the difference between the auction price and the regulated price.
- Producers that adhere to the Plan have priority rights to export part of the total export volume as firm supply, but outside the winter seasonal period.

According to Government estimates, the plan would allow sufficient investment to reverse the decline in domestic production, with production levels slightly above 2020 levels, reducing the need for expensive imported supplies, as shown in Figure 5 below.

Figure 5: Gas.AR Plan - Impact on Domestic Production

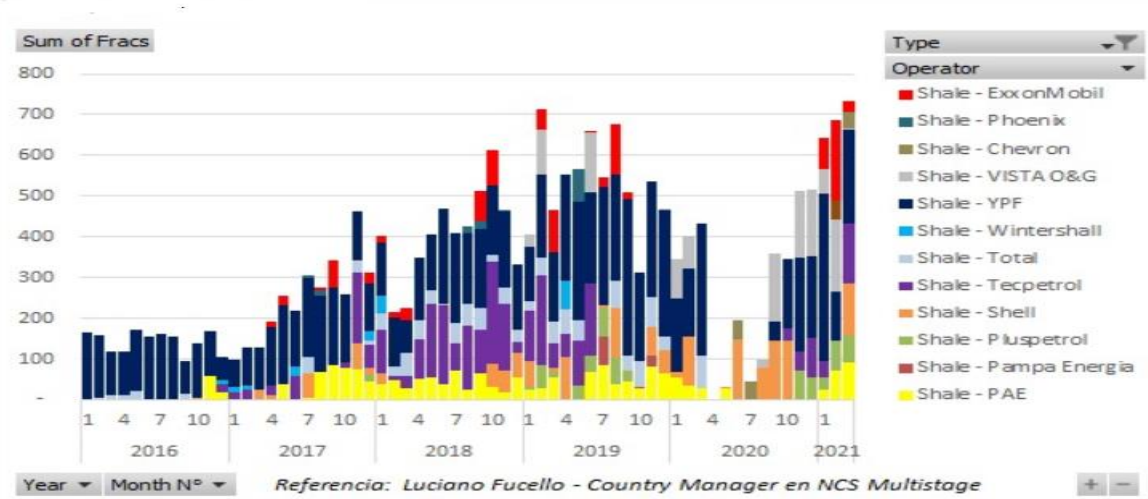


Source: Secretaria de Energia[12]

The Government estimated that the Plan would cost USD 5.1 Billion in the period 2021-2024, of which USD 2.45 Billion would be direct subsidies to the distribution companies and USD 2.6 Billion related to the fiscal cost of imported gas. According to Fitch, the price mechanism is sufficient to cover current production costs (estimated at USD 2.0-3.0/MMBtu), but it might be insufficient to encourage long-term investment in unconventional gas resources, which Fitch estimates requires prices at USD 4.3/MMBtu.[13] However, considering the sheer size and quality of Vaca Muerta and the continuous reduction in extraction costs, Argentine energy experts are optimistic that this mechanism would support the development of unconventional gas beyond 2024. The Gas.AR Plan, unlike the price freezing policies in the earlier periods, provides predictability for the producer, with prices in US Dollars, with a considerable time horizon for a sector that is very sensitive to pricing policies.

Figure 6, depicts the negative impact of governmental measures in 2019-2020 on the well fracturing activities for a number of upstream operators and the recovery of fracturing activities in 2021, following the kick-off of Plan Gas.AR.[14] It is worth noting that most of the fracturing activities arise from wells drilled but uncompleted rather than from new wells drilled. However, drilling activities have been picking up: the number of drilling rigs has increased from 23 in the beginning of 2021 to 27 in March 2021.[15]

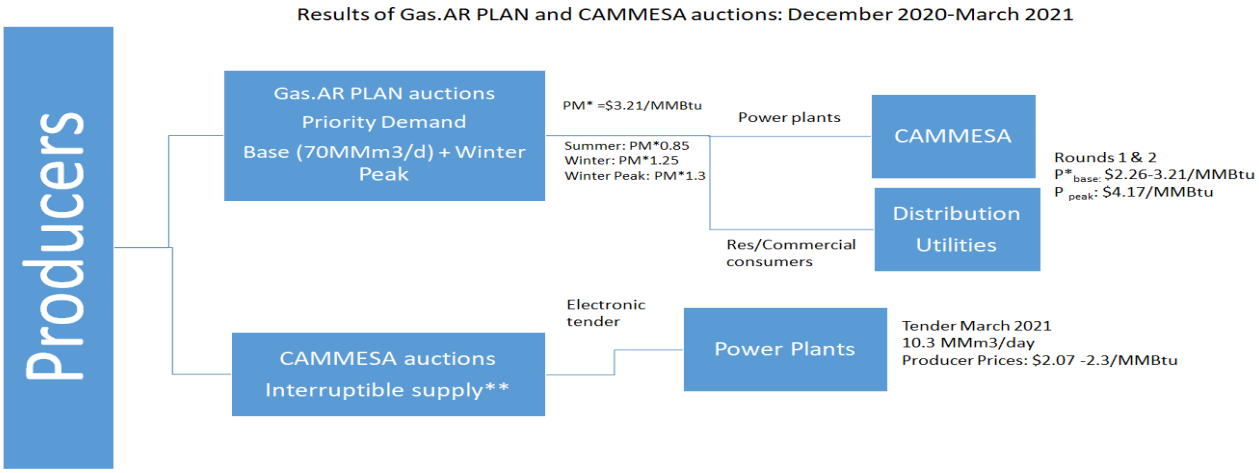
Figure 6: Argentine monthly evolution of shale well fractures (2016-2021)[16]



The Gas.AR PLAN aims to cover base-load demand for power and small consumers served by distribution companies, in addition to peak demand in winter. CAMMESA periodically purchases short-term supplies through auctions organized under the Electronic Market of Gas[17] (MEGSA). For example, in December 2020 CAMMESA succeeded in buying volumes in excess of 14 MMm^3/day at an average price of USD 2.14/MMBtu[18]. Figure 7 below summarizes the results of the auctions organized under Gas.AR PLAN and short term tenders to supply CAMMESA.

[12] https://www.argentina.gob.ar/sites/default/files/if-2020-75636406-apn-dneyrmec.pdf
[13] https://www.fitchratings.com/research/corporate-finance/argentina-plan-gas-4-to-provide-some-cash-flow-stability-to-sector-17-12-2020
[14] Graph axes show months in each year
[15] https://www.ambito.com/energia/vaca-muerta/alejandro-monteirola-ley-hidrocarburos-debe-aislar-las-inversiones-la-situacion-macroeconomica-n5180990
[16] Luciano Fusello. Contactos Petroleros. Jan-2021
[17] MEGSA: Mercado Eletronico de Gas
[18] https://www.energiaynegocios.com.ar/2021/03/energia-activo-ronda-2-del-plan-gas-ar-para-suministro-adicional-en-invierno/

Figure 7: Argentine Producers Prices Gas.AR PLAN and short- term supplies[19]



*PM=Maximum Price, Net Present Value, discount rate 10%. **Short-term interruptible supply

Gas.AR Plan has already started to affect favourably the fracturing activity of shale gas as shown in Figure 6. However due to the delay in announcing the plan, domestic production levels by June 2021 may not be enough in the event of a cold winter, and there are question marks about the volumes available from Bolivia. It is thus very likely that Argentina will increase LNG imports to cover the winter deficit in 2021.

At the time of writing, there has been no progress in clearly defining the regulatory conditions to favour the development of gas production for future potential natural gas exports, both via pipelines and LNG.

3. Natural Gas Resources, and Domstic Supply and Imports

3.1 Conventional Reserves P1 and Unconventional Reserves

Argentina has five gas basins from North to South: Northwest, Cuyana, Neuquina, Golfo San Jorge and Austral. Currently the most prolific and with excellent potential for several reasons are the Neuquina Basin (Vaca Muerta shale and tight gas) and the Austral Basin (mostly offshore) (Figure 8). The historical evolution of reserves from 1992 up to December 2019 is shown in Table 1.

During the 1990s reserves were significantly boosted by major investments in exploration mainly encouraged by the expectation of domestic and regional natural gas demand growth. However, as a result of the government policies implemented after the financial and economic crisis of December 2001, gas reserves were severely impacted by a significant drop in exploration investment, which only started regaining momentum after 2013 with the incorporation of tight gas and later, shale gas reserves.

[19] Source: authors used information from MEGSA and the Energy Secretariat

Figure 8: Argentine Main Basin Location

Source: MINEM

Table 1: Argentine Historical Proven Reserves[20]

ARGENTINA: HISTORICAL PROVEN RESERVES BY BASIN (BCM)														
	1992	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AUSTRAL	85,7	136,3	185,2	123,7	106,6	103,9	100,8	110,7	109,5	120,9	113,7	117,0	107,7	101,0
CUYANA	0,8	0,9	0,7	0,3	1,1	1,1	0,8	0,7	0,8	0,7	0,6	0,4	0,4	0,2
GOLFO SAN JOF	10,0	16,1	39,0	52,2	45,9	48,6	48,4	47,8	48,0	48,6	46,0	43,4	43,8	42,5
NEUQUINA	321,1	343,8	399,1	204,7	161,5	145,3	133,7	139,0	147,9	156,5	156,0	177,1	204,7	242,9
NOROESTE	122,8	122,1	153,5	74,7	43,6	33,6	31,8	30,1	26,6	23,7	20,3	17,4	14,9	13,6
TOTAL	**540,4**	**619,3**	**777,6**	**455,6**	**358,7**	**332,5**	**315,5**	**328,3**	**332,7**	**350,4**	**336,5**	**355,3**	**371,6**	**400,2**

Reserves correspond to December 31 of each year

Source: Instituto Argentino del Petróleo y del Gas (IAPG)-MINEM

3.2 The Decline of Conventional Production and Rise of Unconventional Gas

In the period 1992-2001, natural gas production volumes doubled due to increasing demand driven by the electricity and residential sectors, the increase of natural gas exports to neighboring countries, the development of natural gas as a vehicle fuel and the requirements of the industrial sector (Steel, Urea, Aluminum, Ceramics, etc.). Growing demand in regional markets enabled investment in gas export

[20] http://datos.minem.gob.ar/dataset/reservas-de-petroleo-y-gas

pipelines to Chile, Uruguay and Brazil. In addition, Argentina, Bolivia and Brazil carried out exploration and development projects to boost their reserves.

Due to the populist energy policies after 2001, production had serious difficulty covering domestic demand, leading to cuts in exports, and in supplies to industry in winter, and LNG and pipeline imports.

The impact of policies of substantial incentives in wellhead gas price, such as the Gas Plan I implemented in 2013, started to show results in 2015. Subsequently, by 2016, the price normalization policies of President Macri's government and the price incentive program for non-conventional production started to show a positive impact on gas production. From 2015 onwards, non-conventional production started to offset the drop in conventional gas production during the period 2004-2014.

Table 2: Historical Gas Production by Basin

ARGENTINA: HISTORICAL GAS PRODUCTION BY BASIN (BCM)

	2004	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AUSTRAL	9,29	10,44	10,82	11,14	10,51	10,02	9,65	10,59	10,68	11,04	12,04	11,53
CUYANA	0,06	0,06	0,06	0,06	0,06	0,06	0,05	0,05	0,05	0,05	0,06	0,05
GOLFO SAN JORGE	3,84	5,23	4,88	5,22	5,23	5,30	5,72	5,70	5,35	4,95	4,68	4,16
NEUQUINA	31,73	25,98	25,16	23,86	22,64	23,22	24,63	25,97	26,18	28,39	30,74	27,63
NOROESTE	7,46	5,40	4,61	3,85	3,26	2,89	2,85	2,67	2,40	2,11	1,84	1,70
TOTAL	**52,4**	**47,1**	**45,5**	**44,1**	**41,7**	**41,5**	**42,9**	**45,0**	**44,7**	**46,5**	**49,36**	**45,10**

ARGENTINA: HISTORICAL GAS PRODUCTION BY EXTRACTION TYPE (BCM)

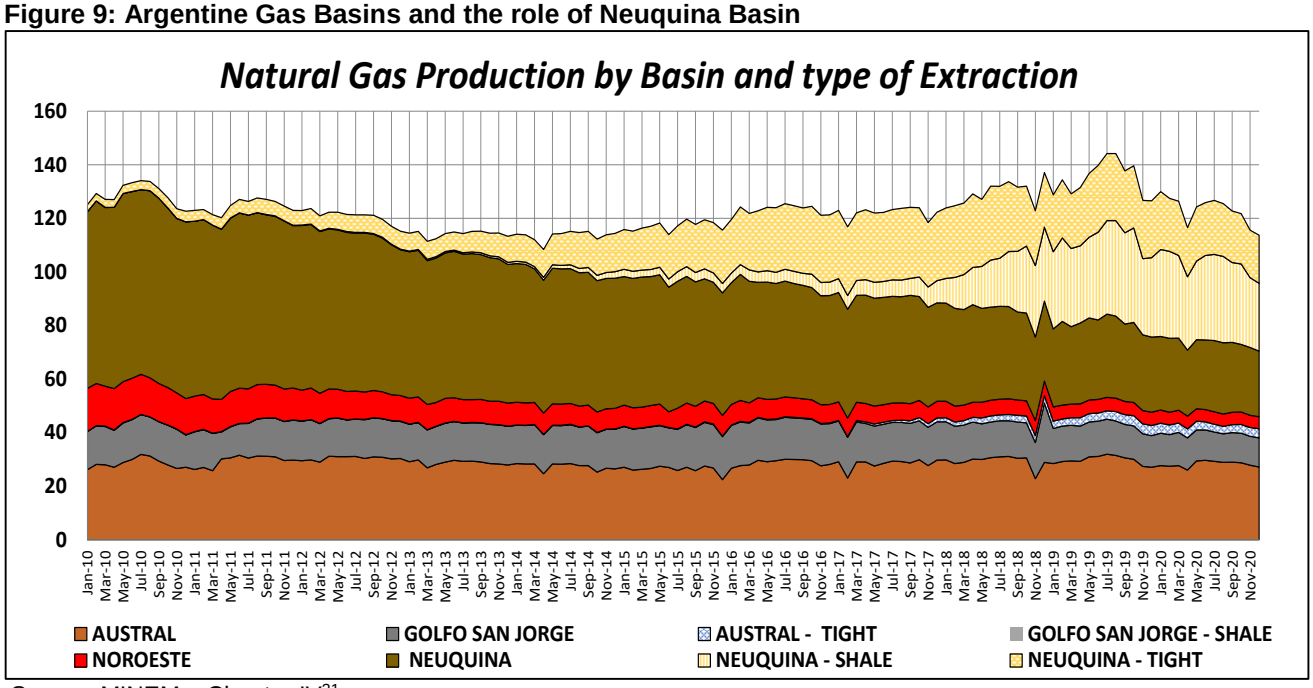
	2004	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Shale		0,01	0,03	0,08	0,20	0,54	1,16	1,59	2,29	6,75	11,53	10,98
Tight		1,23	1,82	2,34	2,78	4,45	6,27	8,67	9,70	9,85	10,29	8,32
Convencional	52,38	45,87	43,68	41,71	38,73	36,49	35,47	34,73	32,67	29,94	27,54	25,80

Source: Instituto Argentino del Petróleo y del Gas (IAPG)-MINEM (Chapter IV)

Source: MINEM – Chapter IV

The peak in gas production occurred in July 2019 when the total gross production reached 144 MMm^3/d, with 44% of non-conventional (shale 24% and tight 20%). The Neuquina Basin was a major contributor with peak production of 91 MMm^3/d (35 MMm^3/d Tight and 25 MMm^3/d Shale).The Neuquina Basin has always been the main gas basin in Argentina, where fields such as Loma de La Lata were the key supplies for the entire national production. Now it is a declining mature conventional field. Table 2 and Figure 9 depict the importance of unconventional resources in the Neuquina Basin compensating the decline in conventional gas production. The effect of the new Plan GAS.AR is not yet shown in the production figures, because of the government delay in signing it until the end of November 2020, but there is an increase in the number of shale fractures in 2021, reaching levels similar to the first half of 2019.

Figure 9: Argentine Gas Basins and the role of Neuquina Basin



Source: MINEM – Chapter IV[21]

In addition to the Neuquina Basin, the conventional Austral Basin includes a set of important fields that were discovered in the 1980s and 1990s and have been gradually put into production. Production from Austral Basin Concession I continued growing, reaching current levels above 20MMm^3/d, achieved by the progressive start-up of new fields, Aries (2006), Carina - Fenix - Orion (2010), and Vega Pleyade (2016).

The decline in production, and the fall in investment in fracturing, starting in August 2019, is a result of non-technical factors:

- the political uncertainty due to the results of the primary round in the presidential elections slowed down investments in the upstream
- the spread of COVID-19 starting in March 2020, slowing down demand and operators' activities
- the lack of a clear energy pricing definition by the new government.

Demand started to recover in the last part of 2020. The favourable impact of the Plan Gas.Ar (November 2020), can be measured by the growth in investment in shale fracturing, and by investment announcements by producers. State-controlled YPF announced that it has planned investments for 2021 of USD 2.6 Billion in Vaca Muerta of which USD 1.5 Billion represents YPF direct investment and USD 1.1 Billion investment by their partners in different areas[22]. According to YPF, such investments would allow unconventional gas output to be boosted by 70% in 2021 when compared with 2020. The independent company, Vista Oil&Gas announced plans to put into production 16 new shale oil wells in Vaca Muerta during 2021 and increase its hydrocarbon production by 40%.[23]

3.3 Natural Gas Imports

In early 2004, just at the beginning of the domestic production crisis, Argentina was not able to produce enough gas to cover both the domestic and export commitments. A dry weather season affected the output of the hydro power plants, therefore requiring increased dispatch from thermal natural gas power

[21] http://datos.minem.gob.ar/dataset/produccion-de-petroleo-y-gas-por-pozo
[22] https://www.hellenicshippingnews.com/argentinas-ypf-to-invest-1-5-Billion-to-ramp-up-vaca-muerta-output/
[23] https://econojournal.com.ar/2021/02/vista-planea-invertir-este-ano-mas-de-us-275-millones-de-dolares-en-vaca-muerta/

plants. In order to meet the increase in demand, Argentina agreed with Bolivia the daily purchase of 5.0 MMm^3/d at an average price of USD 1.60 /MMBTU. At the beginning of 2005 the volume increased to 7.7 MMm^3/d and the price went up to USD 2.0/MMBTU. After the inauguration of Evo Morales as president of Bolivia in 2006, the price of gas increased again to USD 3.20/MMBTU.

On June 29th 2006, Bolivia and Argentina signed a new Framework Agreement for the supply of natural gas for a period of 20 years. From July 15 (effective date of the new agreement) until December 2006, the price was set at USD 5.0/MMBTU. Finally, a price formula based on the international price of fuel oil was established. This agreement was initially set for a volume of 7.7 MMm^3/d, with the possibility of quadrupling gas purchases during the next 20 years.

In March 2010, the governments of Argentina and Bolivia agreed to modify the schedule of the 2006 Framework Agreement, with quantities up to 13 MMm^3/d in 2013 and 27 MMm^3/d in 2017, but Bolivia's supply limitations did not allow for achieving those volumes. This agreement has been recently modified, with lower volumes in summer and higher volumes in winter, and a higher price for volumes exceeding the baseline volumes in the winter season.

Another significant issue was the impact of the harsh winter in 2007. Because of the low temperatures residential demand grew enormously (more than 30% of historical peak demand), affecting industrial consumers with an almost total supply cut. An LNG import project was fast-tracked by commissioning a regasifier vessel (FSRU) in the port of Bahía Blanca. This solution, which was initially planned to cover only the gas deficit during winter 2008, stayed in place until November 2018, when Bahia Blanca was mothballed, due to higher domestic production and the need to reduce the imports of expensive LNG. Likewise, as of 2011, a second LNG terminal was commissioned in the town of Escobar, 70 km north of the province of Buenos Aires. The terminal location has the advantage of being closer to the high demand density area around Buenos Aires, but due to navigation limitations in the La Plata River, the terminal cannot take full cargoes of LNG.

Tables 3 and 4 depict the annual and peak imports by pipeline and LNG terminals and show the large swing from average to peak consumption. More recently, prices and volumes in the supply contracts from Bolivia have been renegotiated (2020).

Table 3: Argentine Natural Gas Imports Year Average (MMm^3/d)

ARGENTINE NATURAL GAS IMPORTS

(MMm3/d)	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
From Bolivia	0,00	4,41	5,15	7,79	12,76	16,14	16,22	16,31	16,05	18,17	15,91	13,93	16,82
Bahia Blanca Regas Vesse	0,00	0,00	4,69	6,64	6,40	9,04	8,93	8,45	6,13	6,06	4,63	0,00	0,00
Escobar Regas Vessel	0,00	0,00	0,00	4,37	6,06	7,44	7,27	6,74	7,13	6,19	5,14	4,76	6,64
	0,00	**4,41**	**9,84**	**18,80**	**25,22**	**32,62**	**32,43**	**31,51**	**29,31**	**30,42**	**25,68**	**18,70**	**23,46**

Source: Enargas

Source: ENARGAS[24]

Table 4: Argentine Natural Gas Imports Year Peak (MMm^3/d)

ARGENTINE NATURAL GAS IMPORTS PEAK

(MMm3/d)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
From Bolivia	6,76	16,31	18,69	19,29	18,44	21,70	20,83	20,93	20,00	20,16
Bahia Blanca Regas Vesse	18,05	16,06	17,13	17,48	17,39	18,04	17,99	17,87		
Escobar Regas Vessel	12,91	15,26	16,94	17,19	17,09	17,23	20,14	20,21	21,90	22,09
	37,72	**47,63**	**52,76**	**53,96**	**52,92**	**56,97**	**58,96**	**59,01**	**41,90**	**42,25**

Source: Enargas

[24] https://www.enargas.gov.ar/

Source ENARGAS

In 2020, IEASA (previously known as ENARSA) bought 31 cargoes of 2.1 TBTU each, totaling 1.82 Bcm for delivery at the Escobar LNG terminal. The cargoes were acquired to cover the winter season at DES prices ranging from USD 2.09 to 3.47/MMBtu, with an average price of USD 2.91/MMBtu, totaling USD 189.36 million.[25] In its first tender for the winter demand of 2021, IEASA bought 24 LNG cargoes (1.41 Bcm) at a total cost of USD 330 million. The average price of USD 6.50/MMBtu is 123% higher than the price paid in 2020.

The uncertainties related to winter residential and power plant demand in 2021, the pace of recovery of domestic production and higher liquid fuel prices forced the government to reopen the Bahia Blanca LNG terminal. In addition to using the existing Escobar terminal, the Government mandated the state-owned company IEASA to launch a tender to procure an FSRU for Bahia Blanca, which will operate during the period June-August 2021 with commissioning expected in May 2021.

4. Gas Demand

4.1 Domestic Gas Demand

Argentina's demand is mainly composed of Power (38%), Residential (27%), Industrial (29%), and Compressed Natural Gas (CNG-Vehicular) (6%) on average annual basis[26] as shown on Table 5.

Table 5: Evolution of Argentine Natural Gas Demand by Sector

ARGENTINE NATURAL GAS DOMESTIC DEMAND													
(MMm3/d)	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Residential/Commercial/SDB	23,8	26,0	31,7	33,2	34,9	36,4	35,3	35,7	37,7	33,9	33,7	33,2	32,9
Industry	27,3	31,5	33,0	34,3	31,9	33,9	34,2	34,6	33,1	34,3	36,1	36,8	35,1
Power Plants	29,9	29,3	31,6	35,5	39,3	39,6	39,8	40,9	43,8	47,3	47,1	41,6	39,4
VNG	4,6	8,7	7,3	7,6	7,6	7,6	7,8	8,2	7,7	7,0	6,6	6,8	5,2
	85,6	**95,4**	**103,6**	**110,5**	**113,8**	**117,6**	**117,1**	**119,4**	**122,4**	**122,5**	**123,5**	**118,3**	**112,6**
Source: Enargas													

Source: ENARGAS[27]

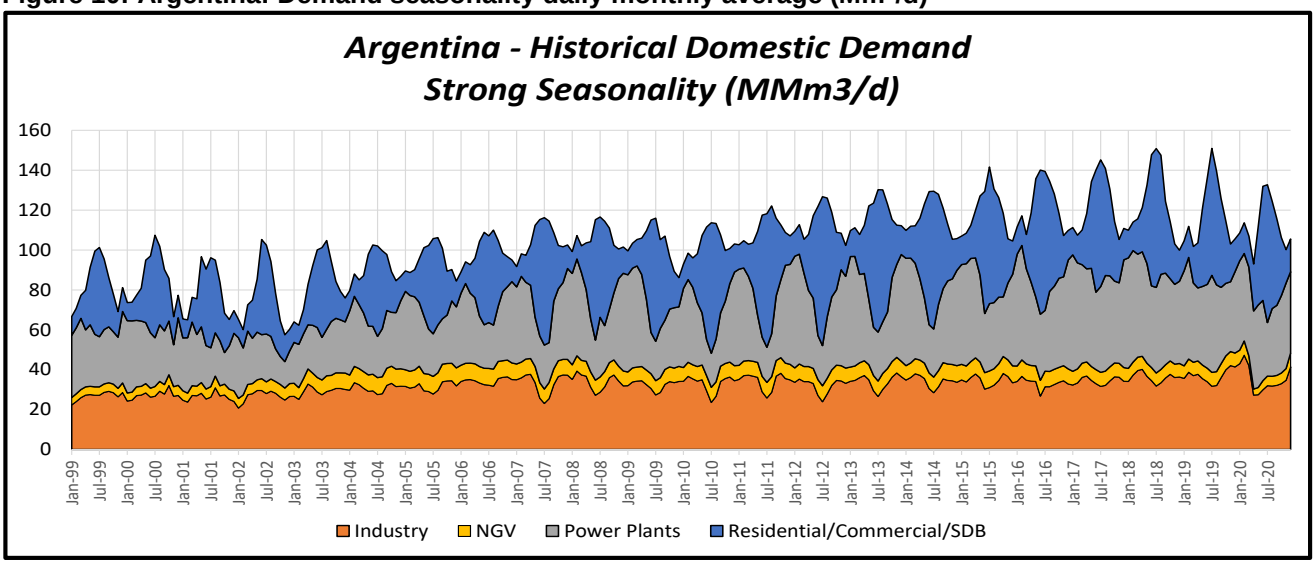
The main characteristic of Residential demand is a very strong seasonality during the winter months (April 1st to September 30th). The main reason is that in Buenos Aires (60 % of the total residential demand), the winter average temperature is around 7°C and houses are equipped with gas heating systems. Thus in winter, residential demand grows to six times its summer consumption. Argentina does not have underground storage to cope with winter demand and, during winter, the higher demand requires the full capacity of the transmission pipeline system. The residential demand displaces interruptible supplies mainly for industry and power plants and leads to power plants and interruptible industrial consumers burning gasoil and fuel oil in winter.

[25] Source IEASA website: http://www.ieasa.com.ar/index.php/secciones/gas/gnl/

[26] https://www.enargas.gob.ar/secciones/transporte-y-distribucion/datos-operativos-subsec.php?sec=3&subsec=2&subsecord=02

[27] https://www.enargas.gob.ar/secciones/transporte-y-distribucion/datos-operativos-

Figure 10: Argentina: Demand seasonality daily monthly average (Mm³/d)

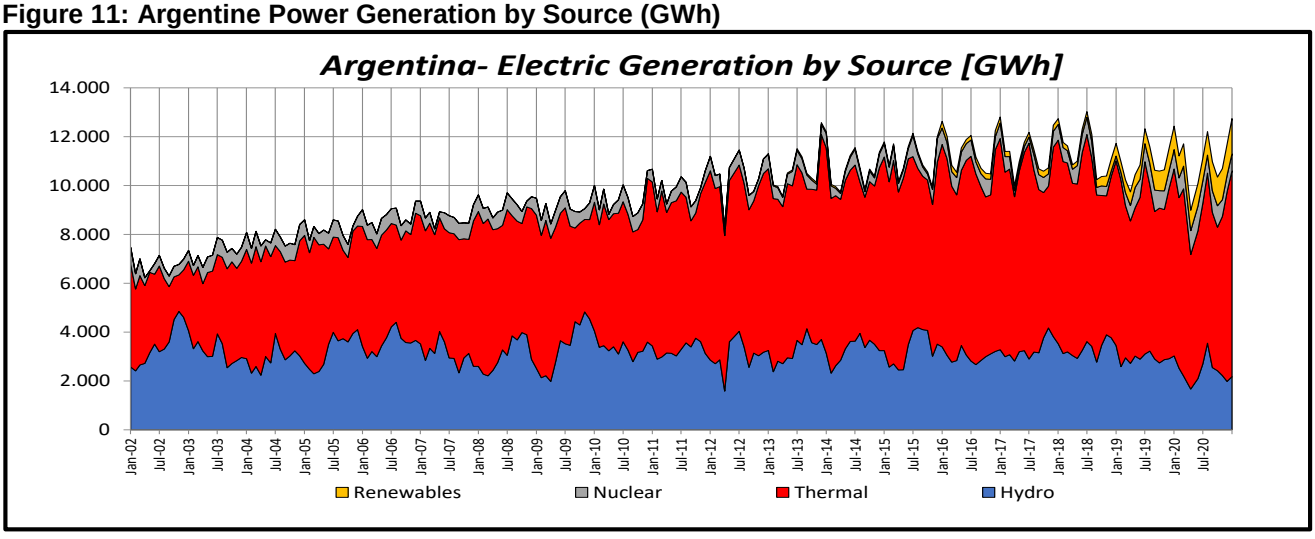


Source: ENARGAS

Peak daily residential demand can account for 90 MMm³/d of the 130 MMm³/d of total domestic demand. However, from 2017 seasonality demand in the residential sector had a lower impact on gas supplies to industry due to increased gas availability and the drop in residential demand driven by higher end user prices and the impact of COVID 19 on industrial and power demand.

As of May 2020, the installed capacity of the Argentine Interconnected Power System (SADI) is 40,212 MW. Of that total, 24,509 MW is thermal (61%), 10,834 MW hydroelectric (27%), 1,755 MW nuclear (4.3%) and 3,133 MW renewable (7.7%)[28]. SADI is a large consumer of fossil fuels, mainly natural gas. As shown in Figure 10 and Figure 11, gas consumption by power plants reached nearly 60 MMm³/day in early 2018.

Figure 11: Argentine Power Generation by Source (GWh)



Source: Cammesa

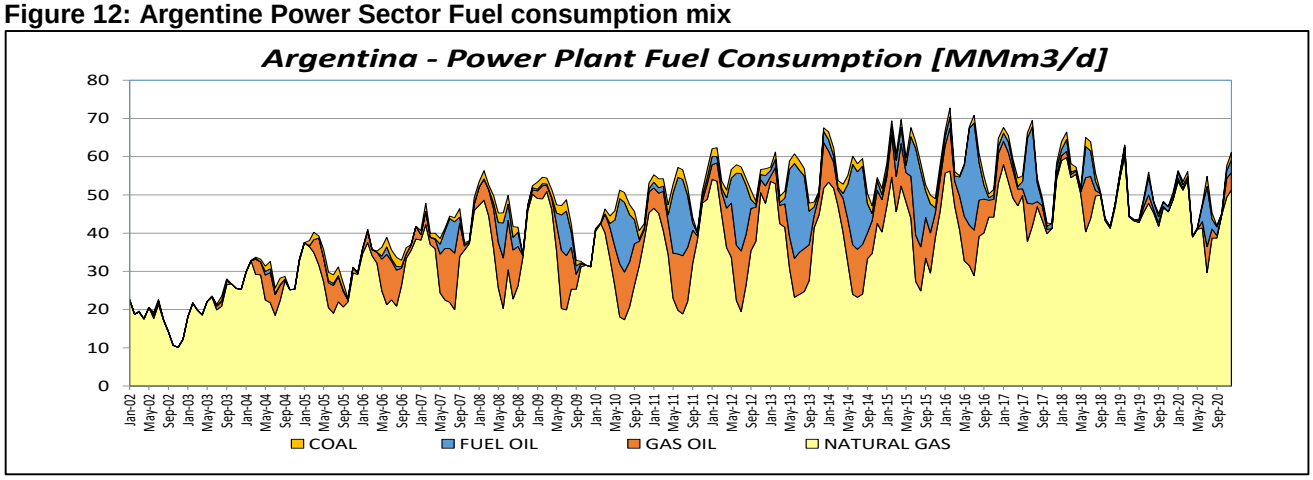
Figure 12 depicts the consumption of fuels by the power sector. Liquid fuels, increasingly imported, compensate insufficient gas availability in winter and affect further Argentina's energy trade balance. As can be seen from this figure, there are two peaks in power demand during the year. The summer

[28] CAMMESA (Compañía Administradora del Mercado Mayorista Eléctrico). https://www.cammesa.com/linfomen.nsf/MINFOMEN

peak (mostly from air-conditioning load) is met by a combination of gas supplies and liquid fuels. The winter peak requires a larger injection of liquid fuels because gas supply is diverted to the residential sector.

In winter, the average gas consumption by power plants is about 30 MMm^3/d, but in summer reaches 60 MMm^3/d. Since 2018 and up to 2020 supply constraints to power plants have also been caused by insufficient pipeline capacity to evacuate increasing amounts of some gas production areas in Vaca Muerta to the demand centres. In such circumstances, power plants have to consume imported gasoil and fuel oil. Both products are three to five times more expensive than domestic gas.

Figure 12: Argentine Power Sector Fuel consumption mix

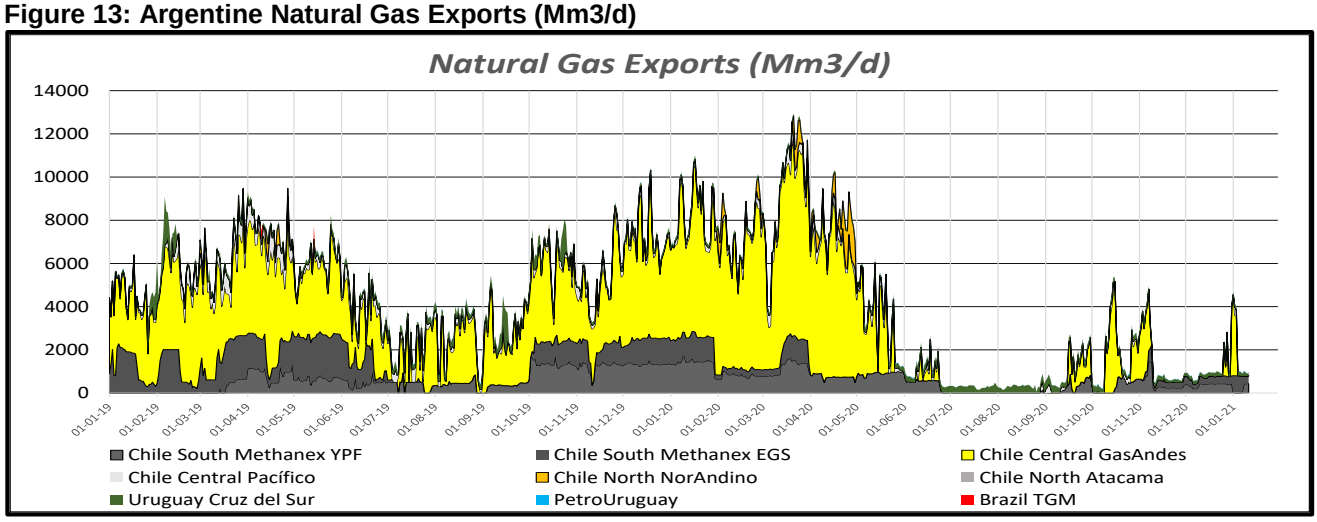


Source: CAMMESA

4.2 Gas Export Evolution and Supply Demand Balance

From mid-2004 to mid-2016, gas exports were kept at a minimum to meet the residential demand requirements of neighbouring import countries (Chile and Uruguay). Successive Decrees and Resolutions starting in July 2016, allowed for more flexibility on gas export authorizations, as mentioned previously. Figure 13 depicts the increase in gas exports by pipeline to Chile, Brazil, and Uruguay since January 2019. Exports had to adapt to the high seasonality of the demand in Argentina.

Figure 13: Argentine Natural Gas Exports (Mm3/d)



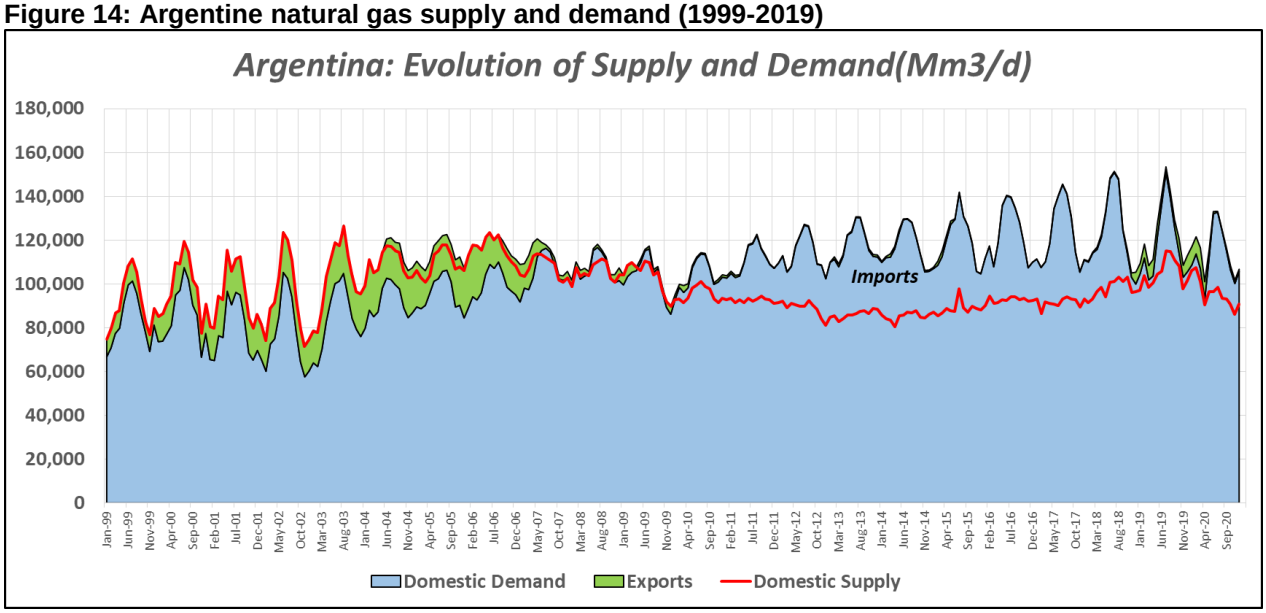
Source ENARGAS

It is worth noting that the Argentine government has decided to go further with exports and grant authorization for firm in addition to interruptible exports. That would bring much needed foreign currency to the producers. To test the possibility of exporting surplus summer volumes from Vaca Muerta, in

June 2019 YPF started producing LNG at the small floating facility, Tango FLNG (0.5 mtpa), moored at Bahia Blanca, under a ten-year charter agreement with EXMAR. Due to the small size of the FLNG, it takes 40 days to fill an LNG tanker for exports. The scheme allowed for the exports of five cargoes of LNG, but in June 2020 YPF sent a force majeure notice to EXMAR suspending payment of the charter charges alleging the impact of the COVID crisis. The dispute was settled in October 2020, with an early termination of the contract, ending the short-lived Tango LNG Project[29].

Figure 14 depicts the evolution of supply and demand in Argentina over the last 20 years, the shift from exports to imports and the impact of increased unconventional gas production in generating seasonal exportable volumes since 2018.

Figure 14: Argentine natural gas supply and demand (1999-2019)



Source: MINEM

Gas Transportation and Bottlenecks

There are currently 10 existing export pipelines, connecting Argentina to Chile, Brazil and Uruguay (Appendix 2) so that pipeline exports could benefit from existing infrastructure without significant new investment. However, significant LNG exports would require the construction of new pipelines connecting Neuquén Basin and the Vaca Muerta fields to the main demand hub in Buenos Aires and to the proposed LNG export port of Bahia Blanca.

The Argentine gas transport system comprises five main gas pipelines: Gasoducto Norte and Gasoducto Centro Oeste, which belong to Transportadora de Gas del Norte S.A. (TGN); and Gasoducto San Martín, Gasoducto Neuba I and Gasoducto Neuba II, operated by Transportadora de Gas del Sur S.A. (TGS). As indicated by the name of the two transport licensing companies, they cover the North and South regions of the country and then connect to the High-Pressure Ring around Buenos Aires, where a large part of the demand is concentrated (map shown in Appendix 1).

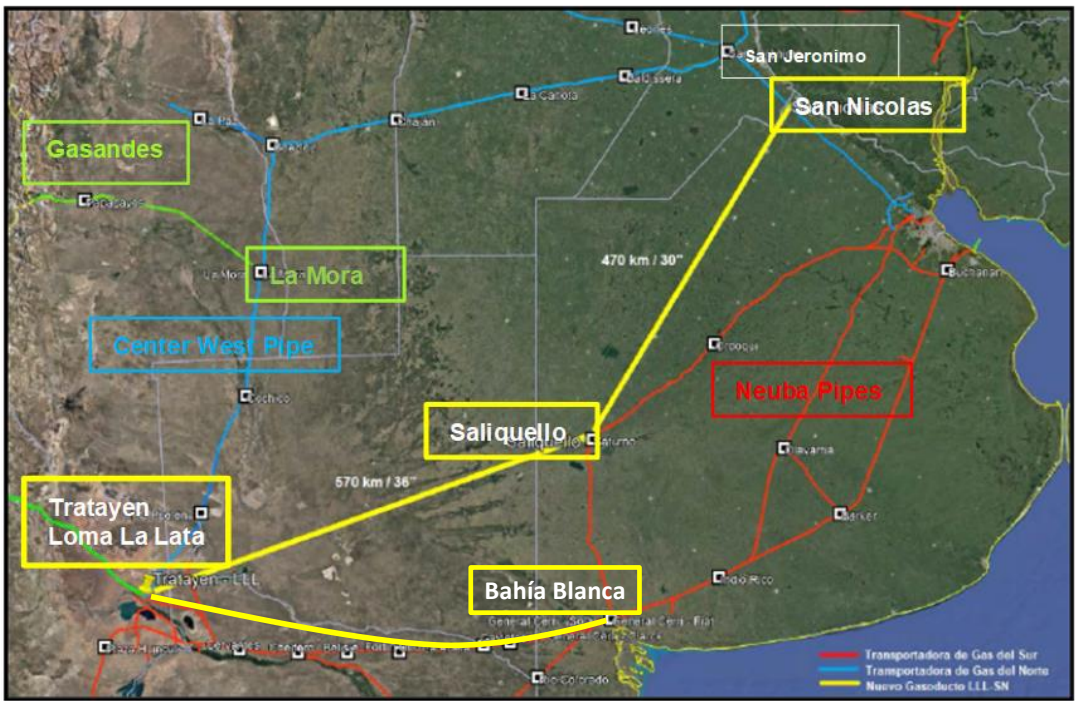
The total capacity of the domestic pipeline system is approximately 149 MMm^3/day. Argentina has no underground storage near the demand centres, so the transport system mostly operates at 100% capacity on peak-winter demand. It is thus necessary to build new major trunklines to evacuate additional gas from Vaca Muerta and to expand the San Martin pipeline from the Austral basin. Figure 14 depicts the two major projects, Tratayen – San Nicolas and Tratayen – Bahia Blanca.

[29] https://www.oedigital.com/news/482543-exmar-ypf-settle-dispute-terminate-tango-flng-charter

The Macri government started a tender process for the first phase of the Tratayen (Neuquén)-San Nicolas (Buenos Aires Province) pipeline in 2019, but it suspended the process in late 2019 due to the macro-economic situation. The current administration (President Fernandez) cancelled the tender in early 2021, alleging that they would be analysing other alternatives. Nevertheless, new pipelines are necessary to evacuate increasing domestic gas supply to replace imported natural gas and fuels to cover the current and future demands.

The project consisted of two phases and would enable the movement of larger volumes of Vaca Muerta to Buenos Aires. Phase 1 (Tratayén-Saliquelló) consists of a 36" pipe, 570 km long, designed to transport initially 15 MMm^3/day, and 40 MMm^3/day in the future. Phase 2 (Saliquelló-San Nicolás) consists of a 30" pipe, 470 km long, designed to transport initially 20 MMm^3/day of surplus unconventional gas from Neuquén and conventional gas from the southern basins to a proposed LNG plant in Bahia Blanca.

Figure 15: Tratayén - San Nicolás Pipeline (projected)



Source: authors' adaptation of https://www.argentina.gob.ar/sites/default/files/infoleg/res437-05.pdf

The construction of this pipeline would enable gas supply to both the Buenos Aires ring and the industrial zone of Rosario, also allowing gas provision to the North Gas Pipeline in reverse flow, from the San Jerónimo node to Córdoba. Once built, the Tratayén - San Nicolás Pipeline would free up capacity in the southern pipeline system (Neuba I and II, and San Martín), allowing part of the gas produced in the south to be allocated to the proposed liquefaction plant in Bahía Blanca. In this case, both conventional gas from the south and unconventional gas from Neuquén could supply a potential LNG plant. The Tratayén (Neuquén) – Bahía Blanca (Buenos Aires) pipeline would allow unconventional surplus gas from Neuquén and conventional gas produced in the southern basins to supply a proposed LNG plant in Bahia Blanca. Preliminary analysis of the project was being carried out by international companies without any further progress as of April 2021.

The volumes estimated for this pipeline range from 20 MMm^3/day to 40 MMm^3/day, depending on the project in question and the expected growth from the development of Vaca Muerta fields in the coming years.

5. Gas Monetization Opportunities

5.1 Petrochemicals and Fertilizer

The discussions around monetization opportunities for unconventional gas in Argentina have so far focused on the uses of natural gas in the domestic and export markets, overlooking the possibilities to develop other aspects of the value chain.

The pioneering shale gas projects in Loma Campana and El Orejano highlighted the wealth of natural gas liquids (NGL) in Vaca Muerta. The success of the shale project in Fortín de Piedra (2018) highlighted the fact that the shale resource in Argentina is significant, both in volume and in liquid content. During 2018 and 2019, Neuquén producers began to analyze the viability of several industrial investment projects:

i. LNG export

ii. Natural gas processing plants to produce LPG, natural gasoline and ethane

iii. Urea and methanol plants

The expectation of a strong exporting policy, decoupled from the domestic macroeconomics could enable the development of numerous export projects, both of primary and secondary products. However, the macroeconomics, aggravated by the pandemic, does not yet allow planning for the long term. Table 6 shows the wet gas composition in Vaca Muerta compared to the Barnet Basin in the USA.

Table 6: Natural gas composition of Vaca Muerta and the Barnett basin (% volume)

	Vaca Muerta	Barnett
C1-Methane	83	77.81
C2-Ethane	10.2	10.82
C3-Propane	4.3	5.02
C4-Buthane	1.7	1.84
C5-Penthane and above	0.45	1.02
CO2	0.24	2.26
N2	0.21	1.2

Source: Permian/Barnet: Howard et al. / Journal of the Air & Waste Management Association 65 (2015) 856–862. Vaca Muerta: authors' adaptation from several producer sources.

5.2 LPG Outlook

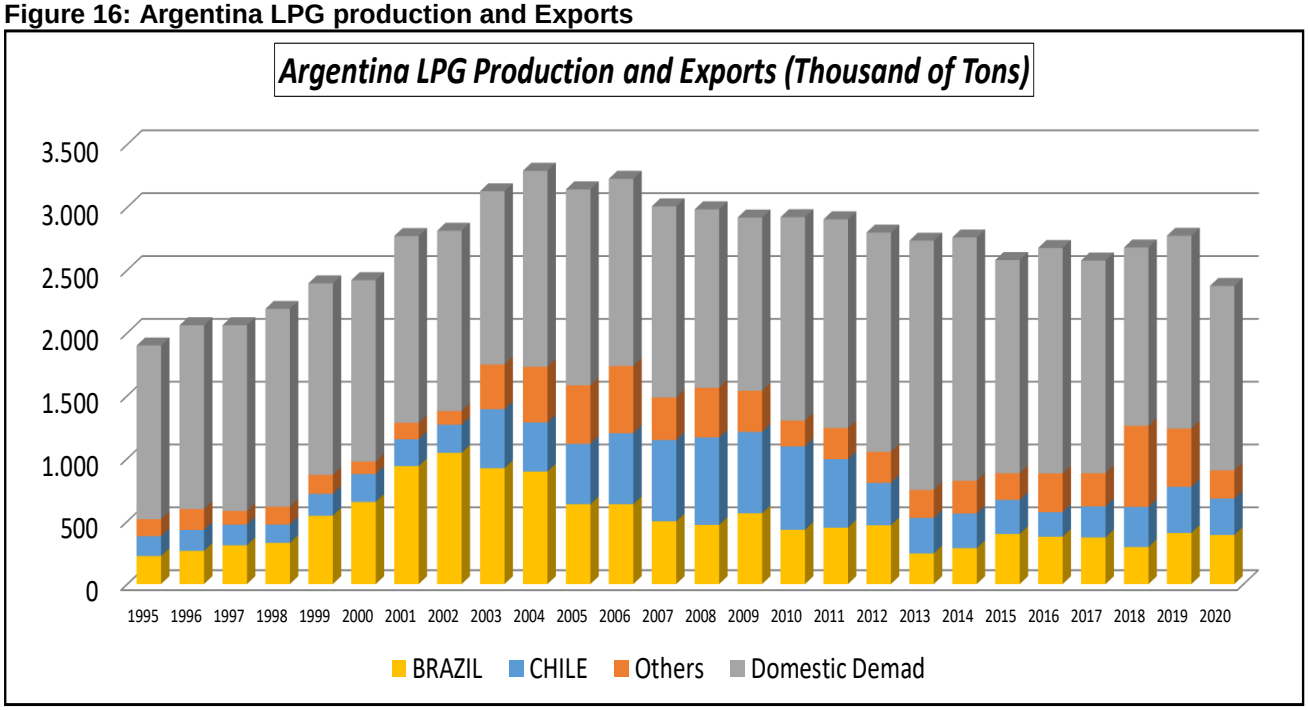
Global LPG demand (2019) is approximately 310 MMton[30], with Asia as its main growth engine. South America is an LPG deficit region; Brazil (-2 MMton) and Chile (-1.2 MMton) are the largest importers followed by Ecuador, Uruguay and Paraguay.

After the commissioning of the Camisea Project, Peru became an important LPG producer but does not currently have relevant export surpluses. The expansion of the Rio Grande and Gran Chaco plants in Bolivia generated export surpluses specially to meet the demands of Paraguay and southern Peru. Bolivia does not separate propane and butane, which is inconvenient for exports.

Argentina is the main LPG exporter in South America, with a total capacity of 3.2 MMton, but currently producing 2.6 MMton/year (2019). The evolution of domestic and export demand is shown in Figure 16. In the period 2005-2011, Chile's LPG demand was met by Argentine exports. Argentina exports LPG at Mont Belvieu (USA Gulf Coast) parity, but there are restrictions to export during the winter.

[30] Dr. Walt Hart, Vice President, NGLs. IHS. Global LPG: Opportunities and Challenges in an Evolving Market. March 2019.

Figure 16: Argentina LPG production and Exports



Source: MINEM[31]

Argentina produces LPG from gas processing plants (2.1 MMton/year) and refineries (1.1 MMton/year). The main plants are placed in Bahía Blanca, Mega (0.78 MMton/year with gas from Cuenca Neuquina), and Gral Cerri (0.65 MMton/year with gas feedstock from from Neuquen and Austral basins). Other smaller plants are the Cañadón Alfa (capacity of 0.25 MMton/year, production of 0.165 MMton/year) in Cuenca Austral and Refinor in Campo Duran (North West Basin).

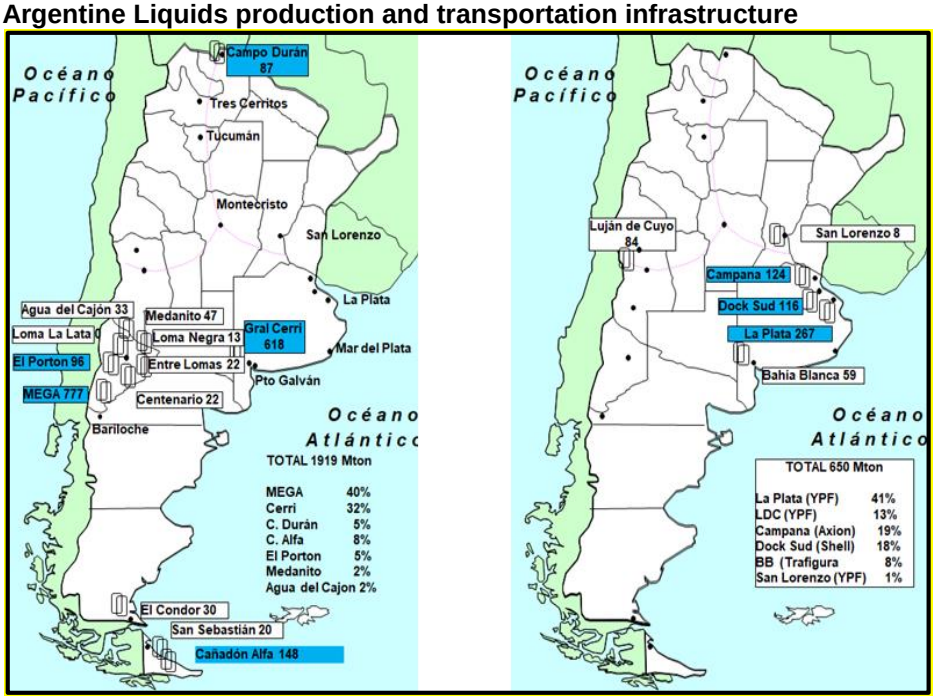
Since the Northwest Basin has been showing a strong decrease in natural gas production and the gas from Bolivia is mostly methane, Refinor currently only produces 0.085 MMton/year although it has a capacity of 0.360 MMton/year.

The main refineries are located in the province of Buenos Aires: La Plata (267 Mton), Campana (124 Mton) and Dock Sud (116 Mton). The pipeline network to transport refined products especially from Campo Duran and Lujan de Cuyo to central Argentina is shown on Figure 17.

The liquid content from Vaca Muerta gas raises the question of the need to adapt the Mega and Cerri plants as well as to develop a completely integrated project (Gas pipeline from Neuquén, processing plant, liquefaction plant and port). Thus, investment in new plants or expansion of existing ones would perfectly cover deficits in the two countries bordering Argentina, in addition to meeting the growing demands in other parts of the world. At present, the competition in the regional market is propane produced in the USA. A natural gas processing and fractionation plant of 20 MMm^3/day from Vaca Muerta gas would entail the production of 0.6 MMton/year of LPG (greenfield plant investment about USD 0.35 Billion). An LPG plant would be accretive to the economics of an LNG export project.

[31] https://datos.minem.gob.ar/dataset/produccion-de-glp

Figure 17: Argentine Liquids production and transportation infrastructure



Source: authors' adaptation of https://glp.se.gob.ar/pv_glp/publico/filtro_produccion_por_planta.php

5.3 Urea Outlook

Out of 177 MMton of urea produced globally in 2018, 14 MMton were consumed in South and Central America, whereas local production totalled only 5 MMton[32] [33]. Brazil is the main consumer in the region with a 1.25 MMton/year plant in operation in Tres Lagoas and 6 MMton/year of imports (2018). Argentina follows in demand with 3 MMton/year. There is only one urea plant in Argentina, Profertil, jointly owned by the Canadian company Agrium and YPF. The plant is located in the petrochemical hub of Bahía Blanca, and has a production capacity of 1.35 MMton/year. On balance, there is a potential demand in excess of 8.0 MMton/year in South America, which could be met by future production in Argentina. Vaca Muerta gas potential generates high expectations for new plants as well as the expansion of the Profertil plant (doubling production).

Given the growth expectations in natural gas offshore production in Tierra del Fuego, the Austral basin is another potential destination for new urea projects, for example the 0.7 MMton/year urea plant of Total, Milgor. According to recent studies from the International Energy Agency, the total required capital to build an integrated ammonia/urea plant, producing respectively 1350 tons/day and 2260 tons/day is circa USD 1.02 Billion.[34] The plant would require a gas input of circa 3.5 MMm^3/day (1.3 Bcm/year). A study produced by Brazil's Energy Research Company (EPE) for a plant with similar capacity located in Brazil with a discount rate of 10% and urea FOB prices would require a gas price of USD 3.6/MMBtu at the plant inlet. Therefore, at a gas price of USD 3.5/MMBtu Argentina could export urea to Brazil at competitive international prices. [35] In 2019, Profertil (YPF-Agrium) announced its intent to double the capacity of the Bahia Blanca plant. However, as of March 2021, the increase has not yet materialized.

[32] Instituto Petroquímico Argentino
[33] Nutrien Fact Book 2019
[34] https://ieaghg.org/exco_docs/2017-03.pdf
[35] (Empresa de Pesquisa Energetica - EPE, 2019)

5.4 LNG Exports

Over the last few years, several private studies have assessed the technical and economic viability of developing a large LNG export scheme in Argentina in addition to pipeline exports. YPF has been exploring the possibility of building a 5-10 mtpa liquefaction complex in Bahia Blanca. In order to produce 5-10 mtpa of LNG it would be necessary to unlock a firm supply feed of 21-42 MMm^3/day, which includes circa 10% of gas consumed in the LNG production process.

One great drawback to developing a viable LNG export scheme is the fact that Argentina's gas demand shows a highly seasonal profile in winter, notably in the period May-September (as shown previously on Figure 10). This would entail a lower utilization factor for the LNG plant and affect the economics of the project.

In 2019, the Energy Secretariat of the Argentine Government produced a detailed energy study with supply and demand projections for the horizon 2030. [36] The study assumed a wellhead price range of USD 2.0-3.0/MMBtu for domestic production and estimated the investments in wells and upstream facilities necessary to unlock production from unconventional oil and gas. The authors revised the demand projections of the Trend Scenario from this study, using a more conservative approach, with investment delayed 3-5 years and extending the analysis to 2035, with the objective of assessing the potential for pipeline and LNG exports. Key assumptions include:

- Amended domestic Demand (Trend Scenario):
  - Business as usual, without carbon constraint on gas usage
  - CAGR of 2.1%, assuming GDP growth below 2.5% (2021-2035)
  - Renewable energy amounts to 25% of power capacity by 2030
- Regional Demand: Chile (20 MMm3/d), Brazil (8 MMm3/d)[37], and Uruguay (2 MMm3/d)
- Gas imports in 2025 according to Government projections, delayed by one year
- Gas imports no longer necessary by 2030 (only swaps with Bolivia).
- Upstream CAPEX and wells projection based upon Government and industry projections
- No constraints on the gas resources, with production output as a result of upstream investment
- Regional gas exports adjusted to domestic demand seasonality
- Gas feed for LNG plants - volumes shown on Table 7.

Table 7: Feedgas for LNG plants vs Capacity and Availability

Gas feed LNG plant (MMm3/day)	100% availability	80% availability	70% availability
1 mtpa	4.1	3.28	2.87
2.5 mtpa	10.24	8.19	7.18
5 mtpa	20.47	16.38	14.35
10 mtpa	40.95	32.76	28.7

Source: authors estimate based on industry information

[36] (Secretaria de Gobierno de Energia, 2019)

[37] To cover Brazilian demand, it would be necessary to increase the transmission capacity from Neuquina basin to San Jerónimo Hub, and to build a new pipeline connecting Uruguayana with Porto Alegre (see Appendixes). The current capacity is up to 1 Bcm to supply Uruguayana power plant (2.4 MMm3/d).

Assuming a sustained recovery in Argentina`s economic situation, the authors produced a Base Case Scenario, as shown in Table 8.

Table 8: Natural gas supply demand balance (2025-2035) - Supply Base Case

ARGENTINE NATURAL GAS BALANCE (2019-2035) BASE CASE (MMm3/d)												
				LNG 1 mtpa			LNG 5 mtpa			LNG 10 mtpa		
	2019*			2025			2030			2035		
	Summer	Average	Winter	Summer	Average	Winter	Summer	Average	Winter	Summer	Average	Winter
Gross Supply Base Case	**130**	**134**	**141**	**184**	**182**	**179**	**219**	**216**	**212**	**275**	**283**	**295**
Net Supply Base Case	99	104	110	147	145	143	186	183	180	220	227	236
Demand Trend Scenario	106	118	135	123	137	157	136	152	174	150	167	191
Regional Exports	5	4	4	20	14	6	30	20	6	30	24	15
Available LNG Exports	-	-	-	4	2	-	20	12	-	40	36	30
Imports	11	18	28	-	8	20						
Surplus/Deficit	(0)	0	(0)	0	0	-	(0)	(0)	-	0	0	-
% Increase Production (Base 2019)					135%			161%			211%	
Cumulative Number of Wells					1.327			2.292			4.192	
Cum. Unconventional Gas Upstream Capex (Billon USD)					22,29			38,51			70,43	
**Historical data*												

Source: authors estimate based on information from (Secretaria de Gobierno de Energia, 2019)

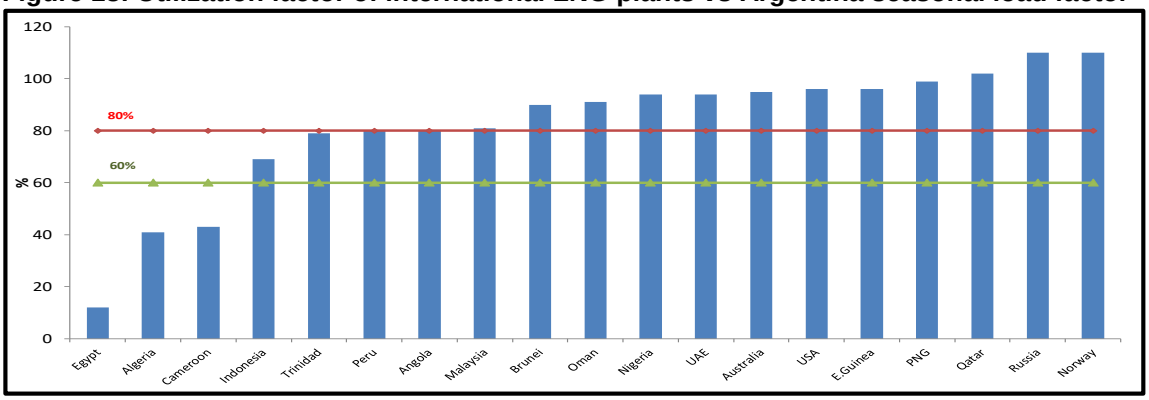
Comparing the data in Tables 7 and 8, one can reach the following conclusions:

- By 2025, the surplus exportable as LNG would be sufficient to feed a 1-mtpa plant operating with at least 50% availability factor. This alternative is under assessment by a group of Argentine and international companies. From 2025 to 2029, the assumption is that domestic natural gas production will increase faster than the domestic demand growth, in which case the availability factor would be higher.
- By 2030, the volumes available for LNG exports could feed a 2.5 mtpa plant operating at full capacity, or a 5 mtpa plant operating with a 60% availability factor, which is below optimum, unless there are no exports to regional markets in winter, freeing more gas to produce LNG. From 2030 to 2035, the availability factor would increase under the previous assumption.
- By 2035, the volumes available for LNG exports could feed a 10-mtpa project operating at 87% of availability.

The operation of an LNG plant for 8-9 months, in tandem with the seasonal demand would affect the economics and competitiveness of the proposed LNG project. It would entail utilization factors of 60-80%, which are below the utilization factors of the most competitive LNG plants in the world, which run above 85% (Figure 18). This is a common issue for countries with strong domestic demand seasonality. In order to solve this situation, it would be necessary to invest in gas storage, divert gas from regional markets to the LNG plant or to develop an LNG hub with fields, pipeline, LPG processing plant and LNG plant dedicated exclusively to exports. Over the last few years, producers have been analyzing options to for gas storage in the Neuquina Basin[38] similar to what has been done in Austral Basin[39] but no concrete project has been implemented yet because of the economic uncertainties aggravated by COVID-19.

[38] https://www.rionegro.com.ar/usaran-pozos-viejos-para-almacenar-el-gas-de-vaca-muerta-FI5857755/
[39] https://econojournal.com.ar/2020/02/cgc-inauguro-el-primer-sistema-de-almacenamiento-de-gas-en-la-cuenca-austral/

Figure 18: Utilization factor of international LNG plants vs Argentina seasonal load factor



Source: Gomes, 2020

Assuming liquefaction costs of USD 750-1000/ton and 80% availability factor, the netback to the producers would range from USD 0.77-3.59/MMBtu (Table 9). The netback calculation also takes into account a range of LNG prices and shipping costs for LNG delivered to Japan (JKM and Brent-indexed contracts) and northern Europe (TTF) and assumes a transportation tariff of USD 0.8/MMBtu for the pipeline Neuquén-Bahia Blanca.

As shown on Table 9, for most of the LNG price cases the netback price would not be very attractive for the producers in Neuquén for 80% factor availability or lower and CAPEX of USD 1000/ton. If CAPEX is kept at around USD 750/ton, netback prices to sales into Japan or markets with similar prices (JKM and oil indexed) then one could expect netbacks around USD 3.59/MMBtu. Pipeline exports to Chile, Uruguay and Brazil would result in netback prices more attractive to producers, and would require less CAPEX when compared to the LNG projects. Assuming that these markets would pay international parity prices of USD 4.0-6.0/MMBtu, producers would benefit from higher netbacks, around USD 3.0 - 4.5/MMBtu.

As an example, in 2019-2020 export prices to Chile have ranged from USD 3.1-5.0/MMBtu in summer and winter respectively. City gate prices in Brazil range from USD 6.6 to 7.3/MMBtu. It is also worth noting that the existing pipeline capacity to export to Chile is 13.2 Bcm/year (36 MMm^3/day), whereas the pipeline capacity for Brazil and Uruguay is respectively 1.0 and 2.2 bcm/year (2.7 and 6.1 MMm^3/day). Therefore, there is already export potential capacity in place of about 44 MMm3/day. But the increasing development of renewable energy in northern Chile and Uruguay, will likely reduce the potential regional demand to 30 MMm^3/d. However, it might also be an issue for Chilean, Uruguayan and Brazilian buyers to be able to accommodate long-term contracts with the seasonal supply swings proposed by Argentina.

Table 9: Range of netback prices to Neuquén – LNG and pipeline exports[40]

	LNG Bahia Blanca		Pipeline exports
USD/MMBtu	TTF **[40]	Japan (JKM/ 12%Brent) **[41]	Chile, Brazil, Uruguay City-Gate
Destination price	5.97-6.49	6.51-8.39	4.0-6.0
Shipping costs	0.8	1.3	0
Liquefaction costs	2.7-3.6	2.7-3.6	0
Pipeline from Neuquén	0.8	0.8	1.0
Netback to producer	0.77-2.19	0.81-3.59	3.0 – 5.0

[40] (Gomes, 2020)
[41] Source CME Group (JKM and TTF March and July 2021), Brent USD 60/barrel

Source: authors estimate based upon industry information and (Secretaria de Gobierno de Energia, 2019)

Another important consideration is the substantial investment required to implement the Base Case, with cumulative investment in excess of USD 50 Billion for the gas and LNG components up to 2030, as summarised in Table 10. Due to the current macro-economic uncertainties, in 2020 YPF decided to shelve its plans to develop a greenfield LNG plant.[42]

Table 10: CAPEX required to develop and export LNG from Vaca Muerta

Base Case Scenario 2030	
USD billion	**CAPEX**
Upstream (gas only)	38,5
Pipelines from Neuquen	6.3
LNG plant and terminal (5 mtpa)	3.75 – 5.0
Ammonia/Urea	1.0
Total	**49.6 – 50.8**

Source: Secretaria de Gobierno de Energia, 2019

6. Conclusions

Argentina has certainly world-class gas resources and it has proved its capability to export gas to multiple markets. However, regulation and energy policy in Argentina have been key drivers for boom and bust. Over the last 20 years the Government has used price subsidies and price control as a tool for inflation control and for populist reasons. Argentina is heavily dependent on natural gas in the residential and power sectors, which are highly seasonal and price-sensitive.

Post 2015, the use of incentives to producers and the reduction in subsidies for end-users (residential and power) have encouraged investment and the development of non-conventional gas. These measures allowed the acceleration of the learning curve, producing an extraordinary increase in the number of fracture stages allowing unconventional gas to reach 45% of Argentine production. Tight gas began to develop more actively from 2013, reaching its peak in March 2018; while shale gas growth began in 2017, reaching its peak in June 2019. However, this boom was short-lived, as domestic production, which peaked in 2019, was affected by the pandemic, lack of investor confidence and discontinued price incentives. The Plan Gas.AR, assuring a capped price of USD 3.21/MMBTU for four to eight years contracts, covering Residential and Power Plant demand, encouraged an increase in production. Although production started to recover in early 2021, this might have come a bit too late and will not be sufficient to prevent LNG imports in winter 2021. In 2020, the bill for importing LNG was relatively low, as Argentina benefited from low international LNG spot prices when IEASA bought cargoes for the winter period. In 2021, IEASA is paying LNG prices 174% higher than in 2020.

Argentine producers seem encouraged with the current Plan.AR price subsidies of USD 3.21/MMBTU[43] [44]. However, there are key questions looming on the horizon. The current plan puts a heavy burden on public finances. A government study estimates that the cost of meeting the demands of the distribution companies (“priority demand”) should reach USD 2.1 Billion in 2021, for an average supply price of USD 3.9 MMBtu[45], compared to an end-user price of only USD 1.75/MMBtu. The Treasury contributes with 55% of the cost, and is already running into a deficit. This begs the question whether the Government will align end-user prices with real costs or will run into problems to pay the producers.

[42] https://www.argusmedia.com/en/news/2107725-ypf-shelves-plan-to-expand-lng-exports
[43] https://www.ypf.com/english/investors/Lists/Presentaciones/YPF-Investor-Presentation-August2020.pdf
[44] https://m.es.investing.com/news/commodities-news/vaca-muerta-el-gigante-energetico-de-argentina-vuelve-a-despertar-2084970
[45] https://www.argentina.gob.ar/sites/default/files/informe_complementario_audiencia_publica.pdf

The plan provides assurance to producers about cash flows and price predictability for the next 4 years. However, there is a lack of visibility of the Government's plans for price policies post 2024, which is coincidentally the year when presidential elections will take place.

If successful, the Gas.AR will halt part of the production decline and will increase unconventional production to meet priority demand, but it might not be enough to transform Argentina into a large LNG exporter. Under the Plan, domestic production will rise from 110 MMm^3/day to 113 MMm^3/day in the period 2020-2024. According to a commentary posted by IHS Markit [46] wellhead prices of 4.0/MMBtu might be insufficient to encourage the development of the full potential of unconventional gas. Assuming prices of USD 4.0/MMBtu in 2022, inflated at 2% thereafter, IHS concluded that production would peak at 189 MMm^3/day by 2030, compared to a maximum of 325 MMm^3/day for prices at USD 6.0/MMBtu.

In order to compete with USA and Qatar LNG, wellhead prices might need to come down to USD 2-3/MMBtu. The issue of seasonal supply is an obstacle to delivering LNG at competitive prices when compared to projects in the USA and Middle East.

Unless the macro-economic situation improves, the projected domestic gross gas production of 216 MMm^3/day may not materialize in 2030, as it requires investment in excess of USD 50 Billion. In the period 2014 to 2019, the average invested in upstream was USD 7.5 Billion/year (USD 4.5 Billion for unconventional in 2019)[47].

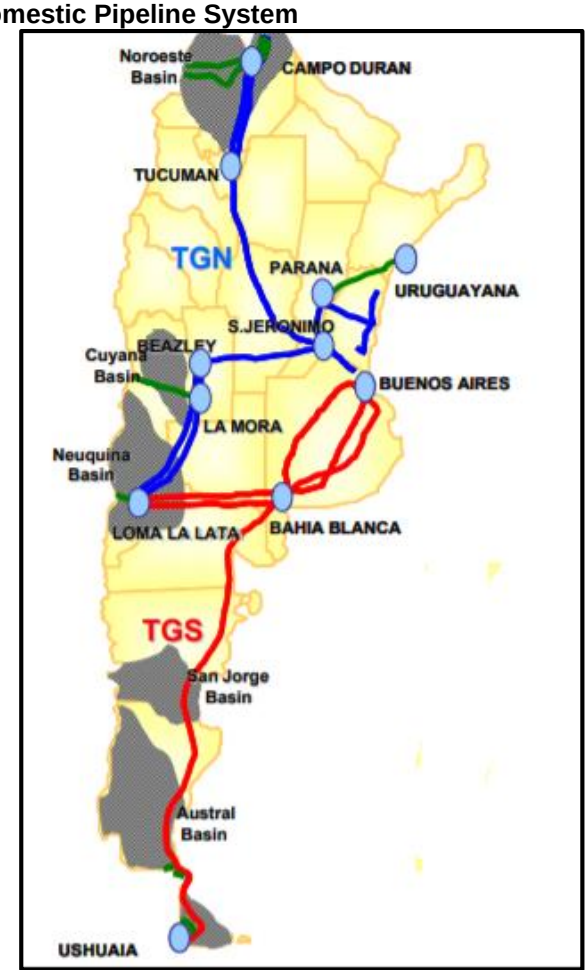
Production costs have been decreasing to levels that are more competitive since 2018. Argentine producers have expressed that they do not need subsidies since the learning curve for productivity has shown steady progress. Also by end 2019-20, the auction average price for power plant and industrial demand was close to Henry Hub[48]. There is a large and untapped potential for LPG and ammonia/urea production, serving domestic and regional markets.

Under the current economic scenario with a lack of political and economic predictability, and the absence of clear long-term energy policies, it is reasonable to assume that new full scale LNG projects are unlikely to be developed before 2030. New projects may happen post-2030 but would entail a risk of stranded assets in light of industry and government pledges for carbon neutrality by 2050. Therefore, Argentina might not become a relevant LNG exporter in this decade but it will continue to play a significant role as a regional seasonal exporter through its existing infrastructure of exporting pipelines.

[46] https://ihsmarkit.com/research-analysis/effect-of-gas-price-incentives-on-argentina.html
[47] MINEM. http://datos.minem.gob.ar/dataset/inversiones-en-mercado-de-hidrocarburos-upstream
[48] MEGSA (Mercado Electronico de Gas). https://negociacion.megsa.ar/Usuario/CAMMESA/RondasHistoricasCAMMESA.aspx

Appendix 1. Argentina: Domestic Pipeline System

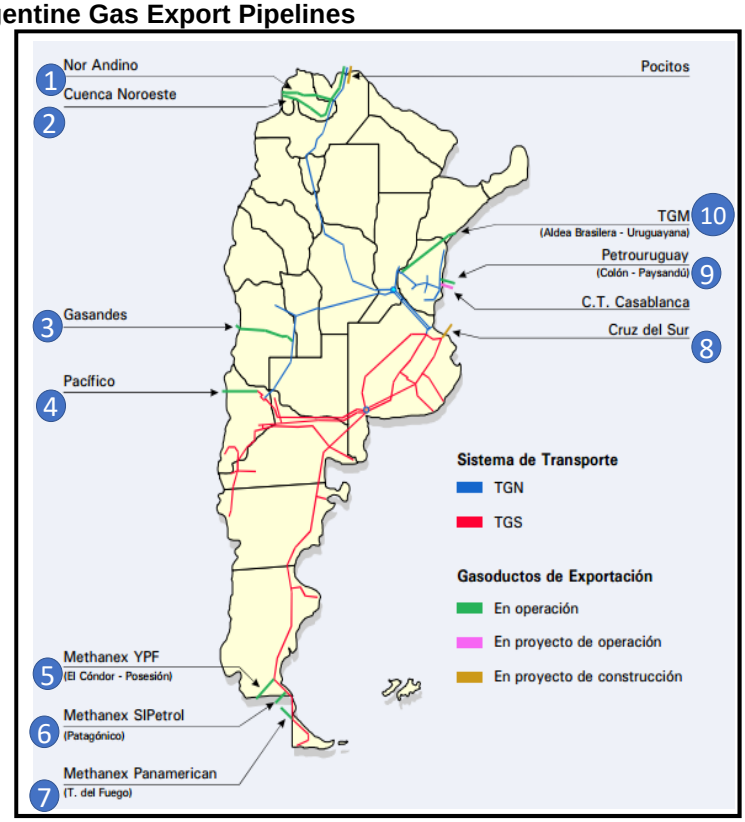
Figure 19: Argentine Domestic Pipeline System



Source: (Rodriguez, 2012)

Appendix 2: Argentina's Gas Export Pipelines

Figure 20: Argentine Gas Export Pipelines



Source: adapted from ENARGAS[49]

Pipelines Argentina-Chile (Total capacity: 13.2 bcm/year)

Nor Andino Pipeline (01)

The Nor Andino Pipeline was commissioned in 1999. It starts at the Pichanal Compressor Station, located in the Argentine province of Salta. With a total length of 1,070 km – of which 337 are installed in Argentinean territory, the pipeline was designed to transport 1.5 bcm, with the possibility to double to 3 bcm/year.

From its initial point, it heads west and crosses to Chile by the International Jama Pass. In Chile, it goes through the Atacama Desert and finally arrives at the coastal cities of Tocopilla, Mejillones and Coloso.

Atacama Pipeline (02)

The 20", 3.1 bcm/year pipeline was commissioned in 1999. It provides natural gas transmission services to electric power plants, industrial and mining consumers of the Chilean Regions II and III, as well as to users of the same characteristics located in the influence area of this pipeline in the Argentinean provinces of Salta and Jujuy.

The owner and operator of the Atacama Pipeline, is an affiliate of the ENDESA Group. The pipeline transports natural gas from the Argentinean province of Salta, to Chile's Norte Grande. It has a total length of 911 km, of which 530 km are in Argentina and 411 km in Chile. Along its route, it supplies gas to industrial and mining consumers in the Argentinean provinces of Salta and Jujuy and to generation plants and consumers of equal characteristics installed in Chile.

[49] https://www.energiaynegocios.com.ar/2019/01/la-vuelta-a-la-integracion-gasifera-argentina-chile-en-la-era-del-shale-gas/

Gas Andes Pipeline (03)

The 24" Gas Andes pipeline was built in 1987 to supply the central zone of Chile. It has a total length of 459 km, of which 311 km are located in Argentinean territory and 146 km in Chile. The connection with the Centre-West Pipeline is made in the Argentinean province of Mendoza; from where natural gas is transported to Santiago de Chile. The total transport capacity is 3.3 Bcm/year.

This pipeline connects with the LNG Regas terminal at Quintero, Chile, through a system of pipes operated by Electrogas, following the route Chena-Quillota-Quintero. The Reception station, which connects the system operated by Electrogas with the Gas Andes Pipeline, is located at Chena. This station enables either the reception of natural gas from Argentina or the delivery of the gas provided by the LNG Regas Quintero Plant to Argentina, being reversible for either flow condition.

Del Pacífico Pipeline (04)

This pipeline was built in 1999 to supply natural gas to the area of Concepción in the Eighth Region of Chile. The pipeline has a total length of 527 km, of which 299 km is in Argentinean territory and 228 km in Chile.

This pipeline links the field of Loma de la Lata, located in the Province of Neuquén, Argentina, with the city of Concepción, in Chile. It has currently a transport capacity of 1.9 Bcm/year, expandable by means of the installation of an intermediate Compressor Station.

Pipelines Connecting the Austral Basin to Methanex in Chile (05, 06, 07)

There are three pipelines connecting production zones in Southern Argentina to the methanol complex operated by Methanex in the south of Chile: Methanex YPF, Methanex PAN and Methanex SIP, with total transportation capacity of 1.9 Bcm/year.

Pipelines Argentina-Uruguay (Total capacity: 2.2 bcm/year)

Cruz del Sur Pipeline (08)

The 193 km, 18-24", Gasoducto Cruz del Sur S.A. (GCDS) connects Punta Lara, Argentina to Montevideo, Uruguay with 200 km of spur lines supplying other customers in the southern region of Uruguay and a 40 km link in the Argentine side. The pipeline crosses the La Plata River, and was designed to transport 1.8 Bcm/year. The pipeline was commissioned in 2002.[50]

Litoral Pipeline - Cr. Federico Slinger Pipeline (09)

The pipeline was commissioned in 1998, connecting the Argentine province of Entre Rios and the town of Paysandú in Uruguay. The 27.2 km pipeline was designed to transport 0.4 Bcm/year[51]

Pipeline Argentina-Brazil (Total capacity: 1 bcm/year)

Aldea Brasilera-Uruguayana Pipeline (10)

The 451 km, 24" pipeline was completed in 2000 and its primary objective was the supply of gas to the 600 MW Uruguayana power plant located in Southern Brazil. The pipeline, designed to transport 1.0 Bcm/year, connects the Argentine province of Entre Rios to the power plant. There were plans to extend the pipeline to the city of Porto Alegre, Brazil but the Project ran out of steam due to the declining gas production in Argentina and lack of sponsors. In order to complete this project, it is necessary to expand the capacity of the gas pipelines from C. Neuquina, to satisfy this new demand. It is not only the investment of the Uruguayana Porto Alegre section, but the need for investment in the expansions and new gas pipelines.

[50] https://www.ogj.com/pipelines-transportation/article/17247726/first-argentine-gas-flows-to-uruguay-through-southern-cross-system

[51] https://www.ancap.com.uy/1572/1/gasoducto-del-litoral.html

Bibliography

Ambrosetti. (2020). *Global Attractiveness Index 2020.* The European House - Ambrosetti. Retrieved from https://www.ambrosetti.eu/wp-content/uploads/RAPPORTO-GAI-2020_PUBBLICAZIONE_EN.pdf

Argentina Secretaria de Gobierno de Energia (a). (2019, November). *Evolución de subsidios, oferta y demanda de energia 2015-2019.* Retrieved from http://www.energia.gob.ar/contenidos/archivos/Reorganizacion/sintesis_balance/2019-11-20_SE_Subsidios_oferta_y_demanda_de_energia_Argentina_2015-2019_dist.pdf

Bertero, R. (2020, August). *Aspectos técnicos de la industria del gas natural.* Retrieved from CEARE : https://www.ceare.org/tallerenargas/2020/taller105.pdf

Brandt, R., & Gomes, I. (2016, October). *Unconventional Gas in Argentina: Will it become a Game Changer?* Retrieved from OIES: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/10/Unconventional-Gas-in-Argentina-Will-it-become-a-Game-Changer-NG-113.pdf?v=7c78ebb4c223

Empresa de Pesquisa Energetica - EPE. (2019). *Estudo de Caso na Industria de Fertilizantes Nitrogenados.* Rio de Janeiro: EPE.

Gomes, I. (2020, August). *The dilemma of gas importing and exporting countries.* Retrieved from Oxford Institute for Energy Studies: https://www.oxfordenergy.org/publications/the-dilemma-of-gas-importing-and-exporting-countries/

Rodriguez, J. &. (2012). Escobar: A challenge gasification entreprise in the Parana River, Argentina. *World Gas Conference.* Kuala Lumpur: International Gas Union.

Secretaria de Gobierno de Energia. (2019, 12). *Escenarios Energeticos 2030 - Sintese.* Buenos Aires: Ministerio da Hacienda. Retrieved from http://www.energia.gob.ar/contenidos/archivos/Reorganizacion/planeamiento/escenarios/2019_12_05_escenarios_energeticos_2030_sin_nom.pdf

YPF. (2014, March). *Vaca Muerta Update.* Retrieved from YPF Inversores: https://www.ypf.com/inversoresaccionistas/Lists/Presentaciones/Presentacion_de_actualizacion_de_informacion.pdf

YPF. (2014b). *YPF Investor Presentation.* Retrieved from YPF Inversores: http://www.ypf.com/inversoresaccionistas/Documents/YPF%20Investor%20Presentation%20Q1%202014.pdf

Walt Hart, NGLs. IHS. Global LPG: *Opportunities and Challenges in an Evolving Market. March 2019.* Obtenido de https://www.lpgc.or.jp/corporate/information/images/Ph.D.,P.E.Hart.pdf