REGIONAL ASSOCIATION OF
OIL, GAS AND BIOFUELS SECTOR COMPANIES
IN LATIN AMERICA AND THE CARIBBEAN

Trends of the Natural Gas Sector in Latin America and the Caribbean

April 2016

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EXECUTIVE REPORTS

Contents

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ARPEL, April 2016

1. Introduction

Natural gas currently represents 24 % of the global energy matrix and 26 % of the energy matrix in Latin America and the Caribbean. The advantages of natural gas as a substitute for coal and liquid fuels, both for industrial use and power generation, as well as transportation, suggest that this fuel will significantly increase its share in the world and regional energy matrices in the next few decades. There is currently consensus at the international level regarding this expected trend[1].

The region produces approximately 640 Mm^3/d of natural gas, which represents 7 % of the global production, while consumption is approximately 700 Mm^3/d. The natural gas deficit is covered by Mexican imports through gas pipelines from the United States, and through purchases of LNG from the 12 regasification terminals existing today[2]. Proven natural gas reserves in the region are estimated in 282.9 Tcf, concentrated mainly in Venezuela. However, there is a great potential for development both in unconventional resources[3], and in other underexplored conventional resources, such as offshore resources.

Currently some general trends are being observed regarding natural gas and the energy sector as a whole, which pose important challenges and opportunities both for companies and States.

Among these trends, it should be mentioned the steady growth in the regional energy demand, the necessity of de-carbonize the economy, reinforced by the COP21 agreement[4], the incorporation of unconventional renewable energy sources to the electricity mix, accompanied by increased demand for natural gas for electricity generation, the relaxation of LNG market due to the expected increase of global supply and availability and the rapid development of new technologies that will give more flexibility and competitiveness and will allow new investments in liquefaction and regasification.

Larger investments in regasification, greater process capacity and development of new infrastructure in new countries, the development of the unconventional potential, mainly in Vaca Muerta, and renewed efforts for natural gas regional integration emerge in the current scenario, as alternatives to increase the natural gas supply and achieve a better energy security.

[1] International consensus conclusion comes from reviewing the Outlooks of the main agencies, institutions and companies such as EIA, IEA, WEC, OPEC, Shell, BP, ExxonMobil, etc., which agree that natural gas will tend to increase its share in the world and regional energy matrixes

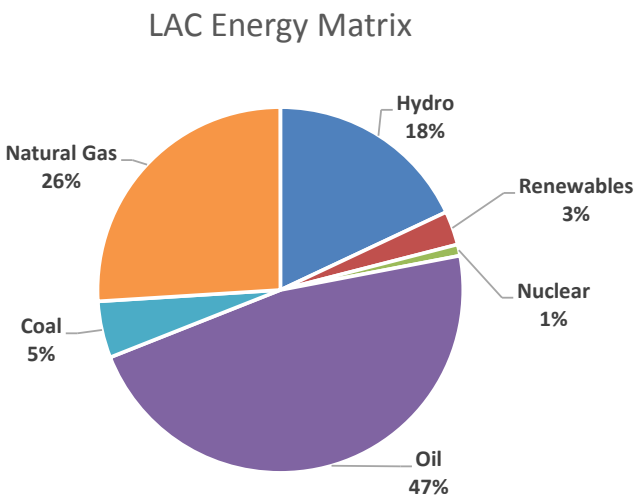
[2] Annex I: Regasification and liquefaction terminals

[3] According to EIA data. https://www.eia.gov/analysis/studies/worldshalegas/

[4] http://unfccc.int/resource/docs/2015/cop21/spa/l09s.pdf

1. Introduction

This Report was prepared by the ARPEL Natural Gas & Energy Committee, which gathers natural gas leaders of the most significant companies in the sector in the region. Its objective is to present a diagnose of the current situation of the industry and the natural gas markets of Latin America and the Caribbean, and also to show the main trends and possible scenarios for the forthcoming years. At the same time, a series of proposals are made for the sustainable development of the sector and to assure regional energy security.



Source: BP Statistical Review of World Energy 2015

2. Regional situation

Country Profile

The region presents different realities in each country depending on their resources, demand, infrastructure, legal framework, as well as other socio-cultural factors affecting the supply and demand of natural gas. Following, there is a chart which shows the countries production, consumption and reserves profile.

Country	R/P ratio (years)	Production (MM^3/d)	Consumption (MM^3/d)	Prod/Consumption Gap
Argentina	9,3	97,1	129,2	**-32,1**
Brazil	23,1	54,9	108,6	**-53,7**
Uruguay	NA	0	0,2	**-0,2**
Chile	108	2,5	13,1	**-10,6**
Bolivia	13,9	61,0	11,0	**50,0**
Peru	33,0	35,4	19,7	**15,7**
Ecuador	10,0	1,7	1,7	**0,0**
Colombia	13,7	32,4	30,0	**2,5**
Venezuela	+200	78,3	81,6	**-3,3**
Mexico	6,0	159,2	235,1	**-75,9**
T&T	8,2	115,2	60,2	**55,0**

Source: BP Statistical Review of World Energy 2015, ARPEL

Only for analysis purpose, it is possible to group the countries as follows:

Major producers and importers

The large countries of the region **Brazil, Mexico and Argentina** are major producers and also major importers of natural gas. They present a structural gap to meet domestic demand; therefore, they will continue depending on imports in the coming years.

Major exporters with reduced internal or emerging markets

There are countries with large surpluses intended for export: **Peru** exports LNG with the recent development of Camisea; **Trinidad and Tobago** is an already traditional exporter of LNG which began its operations in 1999; and **Bolivia** exports most of its production through gas pipelines to Brazil and Argentina.

2. Regional situation

Countries without natural gas in their matrix

In **Central America and the Caribbean**, excluding the cases of Mexico, Dominican Republic, Puerto Rico and Trinidad and Tobago, there is no development or share of natural gas in the energy matrix. In South America, the situation is similar in **Suriname, Guyana, Paraguay** and **Ecuador**, the latter with a very specific development of the production and consumption of natural gas. It must be noted that several of these countries are considering projects to incorporate natural gas in their energy matrices.

Importing countries with potential role in regional integration

Uruguay and **Chile** are importer countries, but given its geographic situation, both might have a greater role in international trade of natural gas in a potential scenario of greater regional energy integration.

Following is presented the liquefied natural gas regional infrastructure. There is also a description of the large projects under development that may affect the regional energy map.

LNG terminals

Source: IGU and GIIGNL

Large projects under development in the region

The main projects under development in our region are the South Peruvian Gas Pipeline (GSP), the Northeastern Argentina Gas Pipeline (GNEA), the industrialization of natural gas in Bolivia, the increase in the regasification capacity in Chile, Colombia and possibly other countries, such as Uruguay, the development of upstream activities in Vaca Muerta, and in the offshore resources of Colombia, Venezuela and Brazil.

South Peruvian Gas Pipeline (GSP)

It will join Camisea with Ilo in the south of Peru, it will be 1,000 km long with a transportation capacity of 14 mm^3/d. It is expected that the availability of natural gas in the south of the country will allow the development of the demand in this region. Also, given the proximity to Chile, it is possible to expect electricity exchanges between the two countries, produced in gas-fired power plants in the south of Peru. The Andean Electricity Interconnection System (SINEA) and the solar potential of northern Chile is a variable to take into account in the scenarios of electricity exchanges.

Source: CIER

Northeastern Argentina Gas Pipeline (GNEA)

Source: CIER

It will join the Juana Azurduy Integration Pipeline (GIJA) with the provinces of Formosa, Chaco, Santa Fe and Misiones. The main pipeline will be 1,500 km long and its transportation capacity will amount to about 28 mm^3/d. The route will bring natural gas near the border with Paraguay and it will open new markets in Argentina, and increased integration opportunities with Paraguay and Bolivia.

2. Regional situation

Industrialization of Natural Gas in Bolivia

Bolivia has large natural gas resources, which largely exceed its domestic demand. In the last few years, Bolivia has made significant investments for developing the industrialization of natural gas. An ammonia and urea plant was founded in Cochabamba, and also two liquid separation plants, Rio Grande and Gran Chaco, which will allow the production of LPG and LNG, with the potential to generate surplus for exportation. At the same time, there are projects to develop gas-fired power plants in the south of the country, near the border with Argentina, that would open new energy exchange possibilities between the two countries.

Upstream development

There are many zones in the region that are currently in exploration phase, with perspectives and potential to add reserves and production to the market. Depending on the success of the exploration campaigns, the regional energy map may be affected. Pre-salt in Brazil, shale and tight gas, in particular Vaca Muerta in Argentina, Venezuelan offshore, Colombian offshore and even the Argentinian offshore are the plays which have the greatest development potential estimated.

Regasification capacity increase

In **Colombia**, a regasification terminal is being built in the Caribbean Coast, with a send-out capacity of 11 Mm^3, and a storage capacity of 170,000 m^3. It is expected to be in operation in late 2016.

In **Chile**, the process of increasing the regasification capacity continues. it is currently under development the Penco Lirquén Terminal, a FSRU that will be placed near Concepción, with a regasification capacity of 10 Mm^3/d and a storage capacity of 150,000 m^3. It is expected to begin its operations in 2017-2018. At the same time, there are projects of increasing the capacity of the existent terminals, that may be executed depending on demand.

Uruguay is developing a regasification project in Montevideo. The project considers a FSRU with a regasification capacity of 10 Mm^3/d, and a storage capacity of 263,000 m^3. However, the project is now under review, considering the new demand scenarios.

There are also many projects with lesser extent of development in **Brazil**, and mainly in most countries of **Central America and the Caribbean**, associated with gas-fired power plants.

3. Trends in international and intraregional trade of gas

New global and regional dynamics of LNG

The international LNG market has shown great dynamism in recent years. The regasification capacity has doubled between 2007 and 2014, from about 350 mtpa in 15 countries to 751 mtpa in 30 countries. On the other hand, global liquefaction capacity is 298 mtpa, installed in 19 countries.

According to GIIGNL data[5], 239 million tons of liquefied natural gas were traded in the international market in 2014, mainly in Southeast Asia, which represents 75 % of the imports of this kind of energy.

In recent years there have been a series of events that will mark a future dynamics of LNG, which will make it much more attractive for purchasers in our region.

- The development of shale gas in the United States and the implementation of export projects - it is estimated that a liquefaction capacity of 70 mtpa will go to market in the next three years;

Name	Capacity t/a	Start-up
Sabine Pass, LA	20 - 25	1T 2016
Cove Point, MA	4.6 - 5.75	4T 2017
Freeport, TX	13.2 - 15.4	2018-19
Cameron, LA	12 - 14.95	2018-19
Corpus Christi, TX	7.7 - 10	2018-19

Source: Argus Media

- The development of LNG export projects in Australia[6], expecting that an additional capacity of liquefaction of 52.6 mtpa will begin operations between 2015 and 2017;

- The restart of operations of the nuclear plants in Japan, which will lead to reduce the demand of the main consumer country in the world;

- The slowdown of the world economy, which slows the energy demand increase of China and Europe;

[5] The LNG Industry in 2014 http://www.giignl.org/sites/default/files/PUBLIC_AREA/Publications/giignl_2015_annual_report.pdf

[6] http://www.appea.com.au/oil-gas-explained/operation/australian-lng-projects/

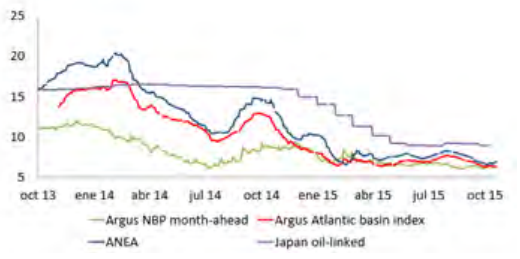
3. Trends in international and intraregional trade of gas

- Technological advances achieved in all phases of the natural gas value chain, such as optimization of the extraction of shale gas, regasification terminals and floating liquefaction or small scale distribution of liquefied natural gas (LNG), are increasingly enabling the exploitation and marketing of natural gas.

This series of events are outlining a new market dynamics. On the one hand, **excess of supply at the global level** is being created with a demand that grows in a less dynamic manner. This will tend to relax the conditions of purchase and create a sustained low-prices scenario for a while. On the other hand, as a result of the proliferation of regasification projects and the abundance of natural gas **the price formation will slowly separate from the market of liquids and generate its own dynamics**, with increased liquidity in the spot market and the generation of secondary markets where re-exported vessels are traded, after having been acquired under contracts and long-term commitments. As the market becomes more mature, natural gas becomes its own reference and tends to an international convergence of prices.

It should be emphasized also that the new technologies of floating liquefaction (FLNG) and regasification (FSRU) are reducing significantly the needs of investment for the development of LNG infrastructure projects, since they allow to distribute the risks and replace investment needs of capital (CAPEX) by operating expenses (OPEX), which provides greater flexibility for the investor. According to IGU data[7], the regasification capacity of the FSRU in 2013 represented 7 % of the total regasification capacity, with an annual growth rate of 34%. As regards FLNG terminals, while they are still in an early development stage and the first large-scale experience will be the Prelude FLNG project in Australia, they will tend to be incorporated quickly when economically viable, as did the FSRU.

Evolution of LNG Prices



Source: Argus Media

[7] World LNG Report – 2014 Edition (IGU). http://members.igu.org/old/gas-knowhow/publications/igu-publications/igu-world-lng-report-2014-edition.pdf

Regional dynamics

3. Trends in international and intraregional trade of gas

In Latin America and the Caribbean, LNG imports represent 21 mtpa (approximately 74 mm^3/d), the regasification capacity is 41 mtpa and it is distributed in Brazil, Argentina, Chile, Dominican Republic, Puerto Rico and Mexico[8]. On the other hand, there are two LNG exporting countries: Trinidad and Tobago and Peru. There are currently regasification terminal projects in many countries in the region, although the most advanced project is the one in Colombia.

As regards the gas trade through pipelines, Bolivia exports to Brazil and Argentina about 50 Mm^3/d, which represents more than 80 % of its production. There is also a gas flow of up to 300 thousand m^3/d that supplies the Uruguayan market from Argentina. In turn, Colombia supplied between 1 and 2 mm^3/d of natural gas to Venezuela but that flow was suspended in mid 2015, and it is expected to be reversed in the coming years.

At the regional level, it is expected that the gap between natural gas supply and demand will be covered via imports, without possibilities of satisfying the demand with domestic supply.

Flexibility expected in the LNG international market will be an advantage to importing countries in the region. It is expected that there will be several new regasification projects in Latin America and the Caribbean in the current scenario.

Exporting developments: Trinidad & Tobago, Bolivia and Peru

The analysis of the three main exporting developments in the region, Trinidad and Tobago, Peru and Bolivia, leads us to some conclusions on conditions common to the three experiences.

- The need to ensure demand so as to enable investment either for the development of infrastructure or the own gas production. In the case of Trinidad and Tobago, long-term contracts were signed to supply two complementary markets (the United States and Spain); in the case of Bolivia, two contracts were signed, one with Brazil (1996-2019) and another with Argentina (2006-2026), and in the case of Peru, export mainly leveraged agreements with Mexico;

[8] See Annex 1 Liquefaction and regasification terminals in the region

3.Trends in international and intraregional trade of gas

- The availability of natural gas well above the requirements of the internal market;

- The closeness to the destination markets (mainly in T&T and Bolivia) is a key comparative advantage which worked favorably for these countries;

- The exporting development as a driver of exploration and production has allowed the diversification of the downstream sector in each of the countries through investments in petrochemicals, fertilizers, small-scale separation of liquids and LNG, which will be used to meet the internal demand and generate a surplus for export.

One of the main trends to highlight for the coming years is that, in addition to the contractual, technological and financial complexity in which these agreements were carried out, consideration should also be given to the commercial complexity, as the new LNG or export by pipeline projects will be inserted in more competitive markets with a tendency to oversupply.

On the other hand, the development of this type of business must be done with a global perspective and considering the different realities in the region since, as later discussed in this document, a reality is emerging with many possibilities of gas exchange among the countries of the region, optimizing the use of existing infrastructure.

In this context, it is expected that some countries in the region begin to export natural gas in the coming years. In the case of Venezuela, if the development of the offshore gas field, the first gas field (Perla) which has been put into production in 2015, continues to be successful, it will very likely generate surpluses to export to Colombia, a country with which it is interconnected through a gas pipeline. In the case of Chile, the idle LNG capacity and the expected flexibility of the gas purchase conditions, make it likely that it will be exported to Argentina, taking advantage of the infrastructure of pipelines currently underused, and the unsatisfied Argentinian demand, specifically during winter peaks. On the other hand, Uruguay could have potential to generate surpluses and export gas to Argentina, if the regasification project materializes.

Natural gas trade 2014

3. Trends in international and intraregional trade of gas

Source: BP Statiscal Review of the World Energy 2015

4. Trends in new natural gas business models (Small Scale LNG)

The advance in technology and, in particular, all those developments related to small scale liquefaction and regasification, is enabling new business models for natural gas, making investments viable and generating a paradigm shift in natural gas monetization schemes.

The main applications of Small Scale LNG are:

Peak-shaving

Terminals that are used to meet demand peaks. In general, they take gas from gas pipelines or other sources in times of low demand, store it and distribute it to the system during peak demand.

Development of gas production in isolated areas (stranded gas)

This kind of small scale scheme allows to take natural gas in wells that are isolated or away from pipeline systems, and connect them to the systems in a cost-effective way to monetize it.

Satellite distribution of natural gas (virtual pipelines to isolated areas)

This scheme is useful to supply gas to remote areas not connected to the network with small populations or power generation plants whose potential volume of gas purchase does not warrant the construction of a gas pipeline.

Long-distance transportation, mainly maritime

This scheme is to supply trucks and long-distance vessels that use LNG instead of diesel as fuel. Environmental restrictions and the increasingly affordable price are making this business model more and more competitive.

Small Scale LNG has been developed mainly in Norway, Japan and China. There are also some new experiences emerging in the region, which include, in particular, those in Chile, Argentina and Bolivia. Small Scale LNG business schemes can be divided into two large groups[9].

[9] Small Scale LNG (IGU, 2015) http://www.igu.org/sites/default/files/node-page-field_file/SmallScaleLNG.pdf

1. **Monetization:** The whole LNG value chain is integrated and is a small value chain (Norway);

2. **Distribution:** Use of small scale for distribution in barges or trucks, taking LNG from a hub that may be a conventional regasification or liquefaction terminal. Not all of the value chain is integrated in small scale. Only distribution is Small Scale, the rest is conventional or large scale (Japan).

The difference between the two schemes is that in the first case, liquefaction is performed on a small scale, in the upstream, to be later distributed also on a small scale. In the second case, liquefaction can be conventional, in large plants, or even developed from a hub, such as a conventional regasification terminal that transfers liquefied natural gas to barges or trucks for small scale redistribution and regasification.

World total liquefaction capacity, 2014

Type	MTPA
Conventional Liquefaction	298
Small Scale LNG	20

Source: IGU, GIIGNL

Since the development of small scale technologies, a large number of fields with small reserves become monetizable. In addition, this technology allows the development of fields of crude oil with associated gas.

Norway is a typical case of small scale LNG development for monetization, while models from Japan or China are clear examples of small scale distribution. Japan has strongly developed distribution by barge. In turn, China has further developed virtual gas pipelines by road and the installation of LNG service stations to use LNG as fuel for transport, being the largest world producer of Small Scale LNG. In Latin America and the Caribbean there are already some developments in Chile, Bolivia and Argentina and several projects under study, since they are considered to be very competitive business schemes in the region.

4. Trends in new natural gas business models (Small Scale LNG)

Virtual LNG Pipeline Quintero - Bío Bío Refinery (Chile): In Chile, the environmental driver, and in particular air quality, led to the conversion of oil refineries to be provided with energy through natural-gas powered electricity plants. To feed the Bío Bío Refinery (8th region) and after having considered various options (pipelines, trains, etc.) it was concluded that transportation by truck from the Quintero Terminal was the most viable option. There is today permanent traffic (on a 24/7 basis) of 21-22 trucks per day, with a capacity of 50 m^3 each. This totals daily deliveries of approximately 1100 m^3/d of LNG, which, after regasification, is equivalent to about 650 thousand m^3/d of natural gas. Bío Bío owns one of the largest regasification satellite plant in the region. At the same time, it is a constantly growing business, as there are today some 20 of these plants under construction. This scheme was successful thanks to an innovative business model in which ENAP and gas and LPG distributors already existing in Chile participate.

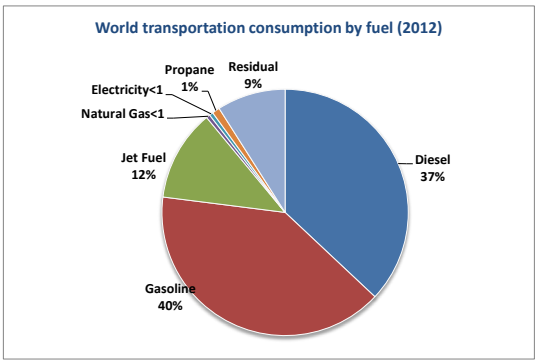
Buenos Aires - Montevideo Ferry: There were developed the small scale liquefaction terminals to supply the ferry between Buenos Aires and Montevideo. It began operations in 2014 and currently produces 70 ton/d of LNG, taking as a source the gas pipeline network of Buenos Aires. The plant has a 4-day fuel storage capacity for the routine use of ferry and the project was developed in one year. The conversion of the ferry is producing large fuel savings and also allowing a faster and more efficient operation than with diesel oil.

The incorporation of these technologies lead us to a new paradigm in natural gas markets, in which LNG production tends to be developed not in large plants located in a single point, with long-term deadlines and investments and the rigidities they entail, but it is becoming a more flexible scheme, smaller scale and decentralized, closest to producers and demand. This flexibility will bring natural gas more competitiveness in comparison with other fuels like fuel oil and diesel, in one of the aspects in which it presents the greatest disadvantages.

5. Trends in transportation

The environment, climate change, the air quality in cities and the strong process of urbanization are issues that lead us to think creatively about the future of urban and inter-urban mobility, as well as the transportation of cargo, currently consisting predominantly of liquid fuels.

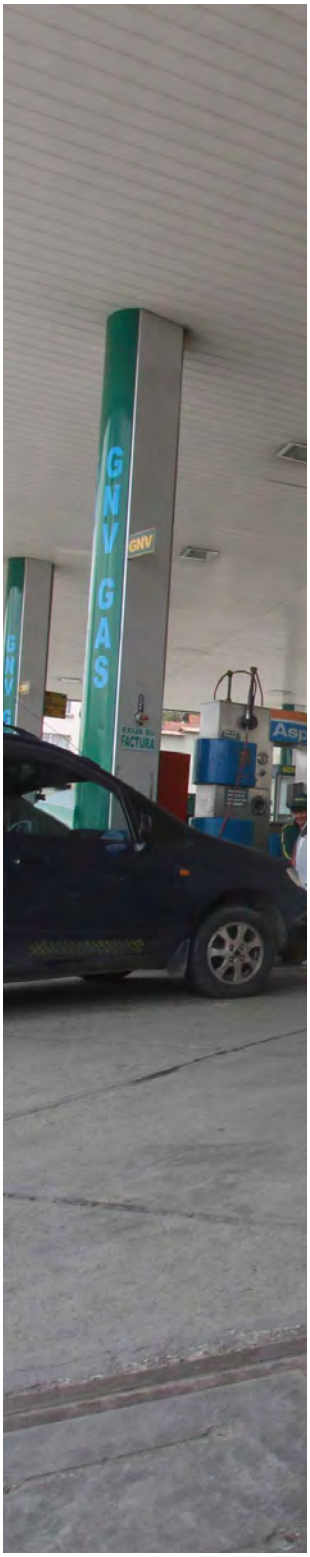
According to EIA data, the transportation sector is the 2nd at the global level in terms of consumption of energy, with 27 % of the total, of which 94 % is covered by oil products. It is also important to mention that 55 % of the crude oil production is intended for the transportation sector.



Source: EIA

Natural gas has had a minimum penetration in this sector in spite of the advantages it offers, mainly at the environmental level. In addition, the penetration of natural gas in this sector has been very specific, as only four countries today have 70 % of the 17 million cars that operate with NGV at the global level (Argentina, Pakistan, Brazil and China).

In the region, in addition to Argentina and Brazil, NGV has developed strongly in Colombia, and countries with availability of natural gas, such as Peru or Bolivia, are expected to develop this type of fuel for urban mobility.



5. Trends in transportation

Electric mobility vs natural gas mobility

Transportation is a systemic issue that must be addressed in a comprehensive manner, for all its forms and all energy sources, prioritizing collective over individual transportation, since it covers other dimensions, such as public health, land management, social cost of the average time of mobility, etc. The environment will be a strong driver for the demand for natural gas for transportation, as well as of new technologies, such as electric mobility, mainly in urban areas and in the collective transport.

Electric transportation and mobility is previous to the development of internal combustion engines and its massive use in the twentieth century and the beginning of the current century. The first trams, trolley buses and electrical underground trains date from the late nineteenth century, but the development of electric transport has been limited mainly to public transport.

It is important to make a distinction between urban and road transportation, individual, collective and cargo transportation, in order to address this issue in a comprehensive manner.

The development of **electric mobility** presents **benefits** in terms of energy efficiency, care for the environment (emissions, particulates, noise pollution, land management), if compared to internal combustion engines, but there are currently several barriers which hinder its incorporation, in particular with regard to electric cars for individual mobility:

- High initial investment in electric vehicles and long payback time (for an average use of urban households);
- Battery life and ways of recharging;
- Need to develop infrastructure (recharging network);
- Autonomy (although for urban use normal electric cars have sufficient autonomy, they are still not able to cover long distances);
- Resistance to change vehicles with remaining useful life.

5. Trends in transportation

Since a few years ago, the development of hybrid and purely electric vehicles has regained momentum, but the above-mentioned barriers suggest that the penetration of the electric car (urban individual mobility) will be slow in the automotive markets, and it will only be possible if there are incentives that allow to address the demand and generate the market. Before thinking about the massification of electric cars, technology must close the gap between the cost of the initial investment, a recharging network must be available and greater autonomy must be offered.

On the other hand, because of eminently technological reasons, and given the energetic density of fossil fuels, electric vehicles are not expected to be competitive in the short term in relation to those fueled by gas or liquid fuels in long-distance transportation.

It should also be mentioned that greater electrification of the energy uses in urban areas is expected in the coming years. This is a process that urban transport will follow in the medium or long term, either through traditional solutions as metro, light trams or trolley buses, or with new developments, such as hybrid or purely electric buses. In this regard, a multimodal transport is envisaged that combines corridors of important flow of passengers with points of distribution and in-transit passengers in more local or lower density circuits, with greater participation of electric mobility.

It is very difficult to establish clear trends regarding the future of transport, because it depends mainly on the different technological developments in course, and the potential of these developments to penetrate into the market.

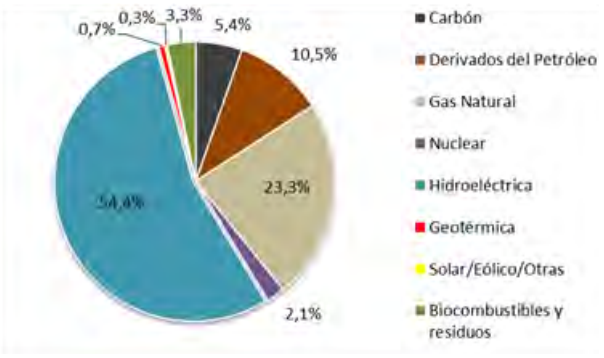
6. Trends in the electricity sector

The growth of the power demand in the region is about 3 % per annum, so electricity generation needs are doubled every 15 or 20 years, driven by population growth, economic growth, the growth of the middle class and urbanization.

The installed electric power generation was multiplied by 2.4 between 1990 and 2013, increasing from 112,571 MW to 268,553 MW. The generated energy grew from 433,354 GWh to 1,1640,940 GWh in the same period, multiplying by 2.7. This poses a great challenge for the regional energy sector and also a great opportunity for the development of natural gas, as a strong support for hydroelectric generation and the growth of unconventional renewable energies. It is noteworthy that the electricity sector has been the sector that contributed with the greatest dynamism to the growth in the demand for natural gas in the last two decades, representing 44 % of the new demand in the 1990-2009 period[10].

Electricity Mix

As shown in the graph, the electricity mix in the region has a strong hydraulic component: 54.4 % of the generation. Oil supplies 10.5 % of the mix, 23.3 % of which corresponds to natural gas.



Source: CIER

[10] Energía: Una visión sobre los retos y oportunidades en América Latina y el Caribe (CAF, 2013) http://www.caf.com/_custom/static/agenda_energia/assets/caf_agenda_energia_vision.pdf

6. Trends in the electricity sector

The two major trends at the regional and global levels are the growth of Non-Conventional Renewable Energy, mainly wind and solar photovoltaic, and the growth of natural gas-fired power generation, both through open cycle plants and combined cycle plants. Environmental restrictions, reinforced by the agreement reached during the COP21 in Paris, will make the share of coal and oil derivatives tend to lower slowly in the electricity generation mix, with the purpose of decarbonizing it. As discussed in this chapter, natural gas and renewable energies have interesting complementarities for their joint development and the development of a cleaner energy mix.

The electricity sector is precisely the main sector of regional demand for natural gas and, in addition, is expected to maintain a great dynamism in the coming years.

Natural gas and air quality

A recent paper of IGU[11] states that natural gas, if compared to coal, can reduce in average up to 50 % the emissions of CO2, 80 % those of NOx, and virtually eliminate those of SOx and particulate matter. In addition, natural gas shows more complete combustion than diesel, which also reduces the amount of unburned hydrocarbons.

The growth of Non-Conventional Renewable Energy[12]

Chile, Brazil and Uruguay are the countries that show a greater development and interesting examples of the growth of renewables. The three countries are deficient in energy and had a strong leadership of the State for the development of renewables through the application of appropriate incentives, as well as a great acceptance of the private sector in the development of investments.

The three countries have mapped the quality of their unconventional renewable resources and it was concluded that there is a great quality of renewable resources, where the figure of maximum installable power would allow a virtually infinite rate of growth of renewables[13].

[11] Case studies in improving urban air quality (IGU, 2015)

[12] Non-Conventional Renewable Energy are all renewable sources of energy, including mini-hydro (<20MW), which are not large-scale hydroelectric generators.

[13] In Chile, the URE potential has been estimated in 2.2 million MW according to the document entitled Energías Renovables en Chile: el potencial eólico, solar e hidroeléctrico de Arica a Chiloé (Ministry of Energy of Chile) http://www.minenergia.cl/archivos_bajar/Estudios/Potencial_ER_en_Chile_AC.pdf

6. Trends in the electricity sector

In addition to the abundance of this resource, the technological improvements in the area, the entry of China into the market and other providers of panels and turbines, as well as a greater local and regional know-how have been important factors in the development of renewables, as it was possible to reduce the investment costs per MW.

As a consequence, there is currently in our region an important and rapid development of renewables, in particular wind and solar photovoltaic. However, given their inherent variability and random nature, they are not manageable, and therefore a firm energy basis to support them is required to achieve their insertion into the energy matrix.

Due to its characteristics, natural gas-fired power generation is manageable and versatile, which makes it the ideal complement for renewables. Between both types of energy there is also additional compatibility at the contractual level, since the dynamics of both wind and solar resources makes them highly variable in the very short term, i.e. there may be 3 or 4 day- "wind droughts," or the capacity factor during the same day may lower dramatically. However, they are very stable over longer periods, such as one year, so they are compatible with typical contract models of natural gas as a take-or-pay volume.

The progress of renewables

In **Chile**, there are today 2,500 MW of installed power of unconventional renewable energy sources, which is expected to double in the next 2 years with the conclusion and implementation of projects that are already underway. **Brazil** has an installed power of 8,000 MW, and it is constantly growing. In the case of **Uruguay**, throughout 2015, 19 % of the electricity demand was covered with Non-Conventional Renewable Energy, reaching record levels of 55 % on 11/13/2015, with peaks higher than 80% in some sections on certain days.

The support of Non-Conventional Renewable Energy is hydroelectric generation. However, given the availability of the resource and the difficulty of developing this type of large-scale projects due to the social and environmental impact of the creation of large dams, natural gas is the back-up power with the highest growth potential for the development of Non-Conventional Renewable Energy.

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6. Trends in the electricity sector

In the coming years, the environmental driver will boost the development of the high-potential renewable energy resources in Latin America and the Caribbean. The success stories of Uruguay, Chile and Brazil, and the maturity that renewable energy industry is achieving, at the regional and global level, reinforces this trend. In this context, natural gas will tend to be incorporated as a complement and support for renewables in the development of a cleaner electricity mix.

Fuente: CIER

7. Potential scenarios for regional integration

Regional energy integration has a great potential to provide efficiency to the energy system. This report highlights the existence of resources and infrastructure in our region, which open many potential scenarios of energy optimization and complementarity.

A model of energy integration, is the one that allows to obtain a secure supply and at the lowest cost to all parties. The larger and more integrated the energy system is, the more robust it will be, allowing a better adaptation to the needs of all stakeholders. Considering the need to supply a growing power demand, as well as to make a more efficient use and sustainable management of natural resources, it is necessary to think about the future of energy in a more holistic and integrated manner.

Below are the most likely scenarios of energy integration in the coming years:

Gas integration

Chile – Argentina

Use of the Chilean regasification capacity to introduce gas into Argentina;

Use of the Chilean transportation system to transport gas from the north to the south of Argentina (gas swap).

Bolivia – Argentina

Introduction of natural gas to the Argentinean system after the startup of operations of the Northeastern Argentina Gas Pipeline (GNEA).

Bolivia – Paraguay

Exports of LNG and LPG from Bolivia to Paraguay, after the startup of operations of the Gran Chaco Liquid Separation Plant.

Bolivia – Peru

Connection of the Bolivian system of pipelines with the South Peruvian Gas Pipeline;

Exports of LPG from Bolivia to Peru.

Uruguay – Argentina

Introduction to the Argentinean system of potential surplus of natural gas from the regasification project, after startup of operations.

Venezuela – Colombia

Flow reversal in the TransCaribbean Gas Pipeline, after the startup of operation of the Venezuelan offshore projects.

Central America and the Caribbean

The good electrical interconnection, low consumption levels of each country, the possibility of taking advantage of economies of scale, dependence on imported hydrocarbons and the startup of operations of liquefaction projects in the Gulf of Mexico open an interesting opportunity to introduce LNG into the energy matrix in the Central American and Caribbean countries.

7. Potential scenarios for regional integration

Electricity integration

Brazil-Uruguay

Interconnection of networks and a frequency converter is completed, tests have been performed, and the marketing conditions are being defined.

SINEA Project

It involves transmission grids connecting Colombia, Ecuador, Peru, Chile and potentially Bolivia. This leads to the construction of interconnecting transmission grids and the reinforcement of national grids. The first stage is the Ecuador-Peru interconnection. The stage Peru - Chile, originally intended as export from Peru (gas-to-wire) has been modified by the advance of solar energy in the north of Chile.

Hydroelectric projects

Inambari (Peru-Brazil); Cachuela Esperanza (Bolivia-Brazil); Garabí (Argentina-Brazil); Corpus (Argentina-Paraguay)

Others

SIEPAC II. Central American Electrical Interconnection System; Northern Section (Brazil-French Guyana-Guyana-Suriname); Colombia-Panamá; Interconnections between Bolivia and neighbor countries

As it was already said, appropriate energy integration has potential benefits for all the involved parties. Current market conditions, the need to reinforce energy security and the infrastructure that is under development in the region, both for electricity interconnection and natural gas transportation, pose a series of complementarities between the countries of the region, that has the potential to be used for the benefit of Latin American and the Caribbean countries.

7. Potential scenarios for regional integration

On the other hand, there are several regional challenges to overcome in order to achieve greater energy integration, which will result in a more efficient use of resources and greater energy security.

Main challenges identified

- *Building trust among the parties in order to develop the agreements required for energy integration, taking advantage of the lessons learned from experiences that were unsuccessful in the past;*
- *Developing the aspects of trade integration, which involves the integration of energy;*
- *Working multilaterally in the harmonization of the legal framework to enable the transportation of natural gas, for example for the shared use of infrastructure;*
- *Adopting a collective and inclusive view that envisions energy investments on a regional level, inserted in a system and energy infrastructure that exceeds the political boundaries of each country;*
- *Developing bi-national or multi-national projects to make use of existent complementarities;*
- *Generating a block of LNG importing companies with the aim of optimizing contractual conditions and taking advantage of existent synergies and complementarities between the countries.*

8. Final remarks and conclusions

This document presents the main trends expected for the natural gas sector in Latin America and the Caribbean.

The growth in energy demand, estimated at 3 % per year, the need to decarbonize the economy, reinforced by the COP21 agreement, the growth renewable energy sources, the technological possibilities and market possibilities offered by the new dynamics of natural gas at the global level, and the existence of natural resources will be the main drivers for the development of natural gas in the region, which will follow the world trend of relative growth of this energy source in the matrix.

On the other hand, the existence of resources in the region, both conventional and unconventional, as well as the existence of idle infrastructure and the development of new projects, opens a regional map that will enable new natural gas and energy integration businesses that should be used to optimize the use of natural resources.

In regard to the domestic supply of natural gas, Latin America is expected to remain a net importer in the coming years, for which it is expected to increase the regasification capacity, seeking for a greater energy security.

The main growth in the demand for natural gas is expected to be for power generation and as firm and flexible support to the incorporation of renewables. On the other hand, some sectors, such as transportation, offer a great potential mainly in the maritime or road cargo transportation, relegating the development for urban mobility (NGV) to certain countries with abundance of natural gas, such as Bolivia or Peru.

The development of new technologies, mainly small scale LNG and floating regasification and liquefaction technologies, are changing the paradigm of the natural gas business, providing greater flexibility, which would result in greater competitiveness of this energy compared to diesel and fuel oil mainly.

8. Final remarks and conclusions

Natural gas will increase its share in the energy matrix at the world and regional levels, which brings with it a series of challenges that must be addressed by the countries and companies in the region to make a more effective use of the opportunities offered by the new dynamics of natural gas. Some of these challenges are building confidence, developing trade integration, working multilaterally in the harmonization of regulations, and adopting a collective and inclusive approach that envisions energy investments at the regional level, inserted into a social and environmental system and energy infrastructure that exceeds the borders of each country.

ANNEX I: Regasification and Liquefaction Terminals

Terminal	Type	Country	Start-up	Capacity MTPA	Owners
Atlantic LNG	Liquefaction	Trinidad and Tobago	1999	15.5	BP, BG, Shell, NGC Trinidad
Peru LNG	Liquefaction	Peru	2010	4.45	Hunt Oil, Shell, SK, Marubeni
Pañuelas (EcoEléctrica)	Regasification onshore	Puerto Rico	2000	1.2	GasFenosa, IP, Mitsui, GE Capital
AES Andres	Regasification onshore	Dominican Republic	2003	1.7	AES
Altamira LNG	Regasification onshore	Mexico	2006	5.4	Vopak, Enagas
Costa Azul	Regasification onshore	Mexico	2008	7.5	Sempra
Bahia Blanca	Regasification FSRU	Argentina	2008	3.8	YPF
Pecem	Regasification FSRU	Brazil	2009	1.9	Petrobras
GNL Quintero	Regasification onshore	Chile	2009	2.7	Enagas, ENAP, Endesa, Metrogas, OmanOil
GNL Mejillones	Regasification FSRU	Chile	2010	1.5	GDF Suez, Codelco
Escobar	Regasification FSRU	Argentina	2011	3.8	Enarsa
Guanabara	Regasification FSRU	Brazil	2012	3.8	Petrobras
Manzanillo	Regasification onshore	Mexico	2012	3.8	Mitsui, Samsung, KOGAS
Bahia	Regasification FSRU	Brazil	2013	3.8	Petrobras

Source: IGU

ANNEX II. Glossary of Acronyms

BCM: Billion Cubic Meters

FLNG: Floating Liquefied Natural Gas Units

FSRU: Floating, Storage and Regasification Unit

GIIGNL: International Group of Liquefied Natural Gas Importers

GIJA: Juana Azurduy Integration Pipeline

GNEA: Northeastern Argentina Gas Pipeline

GNL / **LNG:** Liquefied Natural Gas

GSP: South Peruvian Gas Pipeline

IGU: International Gas Union

LAC: Latin America and the Caribbean

LPG: Liquefied Petroleum Gas

Mm^3/d: Millions Cubic Meters per day

MTPA: Millions Tons per Annum

NCRE: Non-Conventional Renewable Energy

NGV: Natural Gas for Vehicles

SIEPAC: Central American Electrical Interconnection System

SINEA: Andean Electricity Interconnection System

TCF: trillion cubic feet

EXECUTIVE REPORTS

Trends of the Natural Gas Sector in Latin America and the Caribbean

REGIONAL ASSOCIATION OF
OIL, GAS AND BIOFUELS SECTOR COMPANIES
IN LATIN AMERICA AND THE CARIBBEAN

ARPEL is a non-profit association gathering oil, gas and biofuels sector companies and institutions in Latin America and the Caribbean. Founded in 1965 as a vehicle ofcooperation and reciprocal assistance among sector companies, its main purpose is to actively contribute to industry integration and competitive growth, and to sustainable energy development in the region.

Its membership currently represents over 90% of the upstream and downstream activities in Latin America and the Caribbean and includes national, international and independent operating companies, providers of technology, goods and services for the value chain, and national and international sector institutions.

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