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The liquefied petroleum gas, a sectorial analysis

El gas licuado del petróleo, un análisis sectorial

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Abstract: This article shows the results of the analysis performed to the Liquefied Petroleum Gas (LPG) sector, covering aspects related to its production and consumption, initially addressing the international scenario with countries such as Spain, Brazil, China, India and Ghana, to later make the analysis of the national scenario with a look at the participation of the sector within the energy matrix. Finally, a comparison of the international scenario with the national reality is made, concluding that the contribution of the sector to the economy of the country is quite small, it is not competitive despite having favorable environmental characteristics, making urgent its intervention in order to take it to be competitive within the

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basket of liquid fuels, in such a way that it becomes a viable alternative energy and is established from a public policy sector structure, allowing supply a market and meet social and economic needs.

Keywords: Consumption, Demand, Liquefied Petroleum Gas (LPG), Market, Matrix, Production.

Resumen: El presente artículo muestra los resultados del análisis realizado al sector del Gas Licuado del Petróleo (GLP), cubriendo aspectos referentes a su producción y consumo, abordando inicialmente el escenario internacional con países como España, Brasil, China, India y Ghana, para posteriormente hacer el análisis del escenario nacional con una mirada a la participación del sector dentro de la matriz energética. Finalmente se hace una comparación del escenario internacional con la realidad nacional, concluyendo que la contribución del sector a la economía del país es bastante reducida, no es competitiva a pesar de contar con características ambientales favorables, haciendo urgente su intervención en aras de llevarlo a ser competitivo dentro de la canasta de combustibles líquidos, de tal manera que se convierta en una alternativa energética viable y se establezca desde una política pública su estructura sectorial, permitiendo abastecer un mercado y satisfacer las necesidades sociales y económicas.

Palabras clave: Consumo, Demanda, Gas Licuado del Petróleo (GLP), Mercado, Matriz, Producción.

1. Introduction

The Liquefied Petroleum Gas (LPG) sector, one of the oldest in the liquid fuels market, presents technical, operational, economic, legal and cultural limitations, compared with other economic sectors in Colombia; it undergoes continuous regulatory, operational and other changes arising from the fluctuation of international parameters such as the price of the dollar and the fall in oil prices, making it a growing factor in the basket of liquid fuels in countries of different latitudes, which for the Colombian case reflects a low and limited development, which responds to a production with a profile of consumption that expresses a defined market, which admits an analysis from the international context, allowing a comparison with the National reality.

This fuel has a wide use potential in large, small and medium-sized cities, many of them with Natural Gas coverage, understanding that this capacity has led it to become the most accessible cooking fuel for those municipalities and rural areas isolated from the system of Natural Gas networks.

This scenario allows analyzing and studying the perspectives, as well as the current state of the LPG sector in countries such as Spain, Brazil, China, Ghana and India, which represent an important link in the world economic development. For Spain, Liquefied Petroleum Gas has become one of the strategic sectors for the national economy, a reality that, for the last 20 years, has been immersed in opening and liberalizing this sector, in Brazil the fifth most populated country in the world , with more than half of the middle class population and with high levels of inequality, in the last two decades programs have been generated that have allowed 95% of the population to have access to LPG, the Chinese case, its structure of the LPG sector has been established on the demand side, but underdeveloped on the supply side, a country

that uses this fuel mainly for cooking, representing in 2009 1.2% of total energy consumption, finally for Ghana with a population of 27.5 million inhabitants, its economy has been strengthened, evidencing that the services sector manages to represent 50% of the Gross Domestic Product (GDP), with a growth in the consumption of LPG in a constant manner during the last decade, needing to import it to satisfy its demand, concentrated mainly in the residential and industrial sectors, India was considered with a population of 1.28 trillion people, a country that has transited to become an open market economy, taking it to meet its demand for LPG with the importation of more than 10 million tons per year and anticipating continue to grow with continuous demand.

Under this understanding in the second section of this article, the international scenario of countries such as Spain, Brazil, China, India and Ghana is addressed, for which variables such as; production and consumption, then in the third section the corresponding analysis of the national scenario is done under the same parameters, in the fourth section an analysis of the comparison of the two scenarios is shown, the international and national to finally conclude on the obtained results, allowing to establish the national needs of the sector in question.

2. International Environment

The sectorial analysis of Liquefied Petroleum Gas at the international level shows that during the last 18 years, the reality of the sector is framed by new developments and the growing production of Natural Gas Liquids (NGL), which unlike Liquefied Gas Oil (LPG) is an accessible fuel, easy to transport and store. Due to its composition, it is cleaner and less polluting, as long as it does not contain high contents of butanes and olefins. Its peculiarities as a liquid fuel can

be used in the residential, industrial, agro industrial, transport, electrical sectors and importantly as a raw material for petrochemical processes, which allow obtaining essential products for the manufacturing industry, which generate greater added value to the economy of a country [1]. However, despite important advances in economic development and increasing prosperity in recent years, as well as growing awareness of the health risks of cooking with dirty fuels, it is estimated that 3 billion people, equivalent to 41% of the world population, still do not have access to clean kitchen facilities, almost the same amount as in the year 2000 [2], it is important to observe the following table in which the use of type of fuel to carry out the cooking of food is presented.

| | Solid fuel | Kerosene | LP & natural gas | Electricity | Other |
|-------------------------------------|-------------------|-----------------|-----------------------------|--------------------|--------------|
| Middle East and North Africa | 2% | 6% | 88% | 1% | 3% |
| Latin America | 15% | 3% | 67% | 5% | 10% |
| Indonesia | 49% | 41% | 6% | 4% | 0% |
| China | 54% | 0% | 44% | 2% | 0% |
| India | 63% | 10% | 27% | 0% | 0% |
| Other developing Asia | 68% | 4% | 15% | 3% | 10% |
| Sub-Saharan Africa | 83% | 6% | 5% | 6% | 0% |
| Developing countries | 53% | 6% | 34% | 3% | 4% |
| Developed countries | 0% | 0% | 68% | 28% | 4% |

Table 1. Type of fuel for cooking food [2].

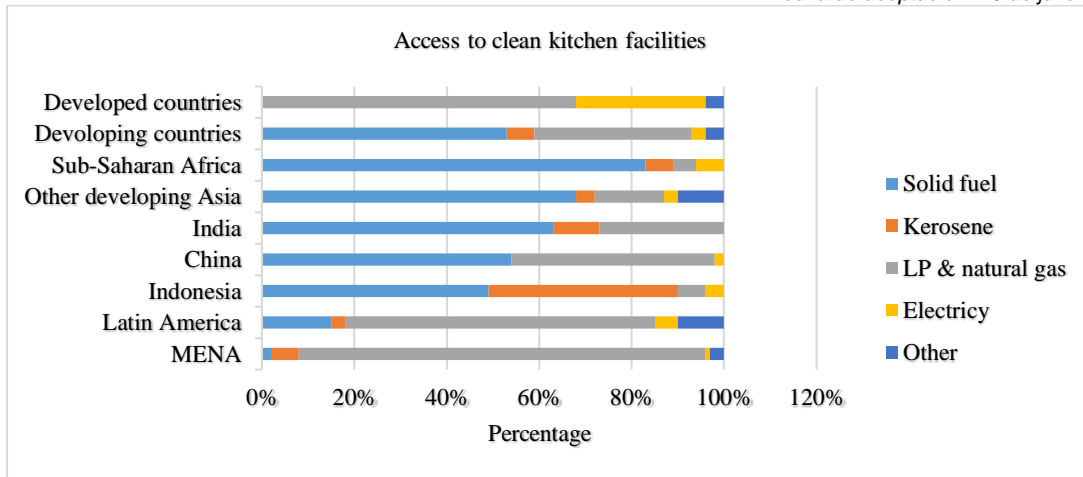


Figure 1. Participation of the population with primary confidence in various cooking fuels by region [3].

Figure 1 shows that solid biomass is one of the most widely used energy sources for cooking food, however, since 2000, the number of people in low and middle income countries with access to clean kitchens it has grown by 60%, but this progress has been surpassed by the strong population growth, which has left 400 million more people without clean kitchen today than in the year 2000 [4].

2.1. Global LPG production

LPG is a byproduct of the processing of natural gas (extraction of liquid fractions) or by the refining of petroleum, for this reason its production depends more on the motivation, capacity or production need of these other hydrocarbons, so since the year 2006, the production of LPG worldwide has been increasing, driven mainly by the increased supply of natural gas, being the main producers of LPG in the United States, China and Saudi Arabia [1].

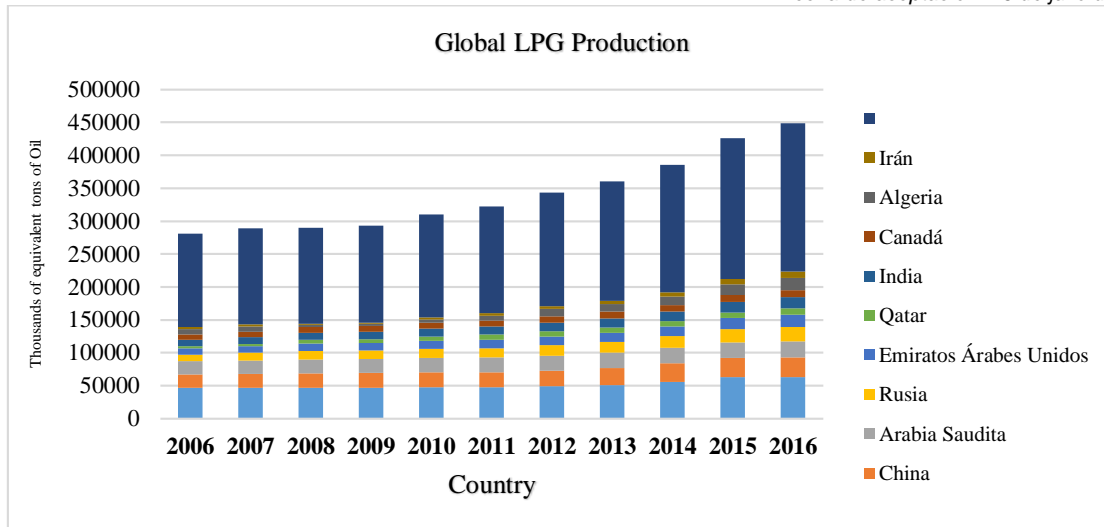


Figure 2. Global LPG Production [5].

Figure 2 shows how the production of LPG in the world has been growing steadily, due to the addition of other LPG producers in growing development such as Russia, the Arab Emirates, Qatar, India, Canada, Algeria and Iran. Therefore, the International Energy Agency (EIA) predicts that by 2020, an average production level of 580 Million Tonnes (MTON) will be reached, which would represent the largest volume of LPG available for export. Other producers such as Greece, Italy, India and China registered a relative increase in its production, the United Kingdom and Turkey grew significantly in the production of LPG between 2014 – 2015 [6].

2.2. Spanish scenario

For Spain, the Liquefied Petroleum Gas sector is one of the strategic sectors for the economy and for the last 20 years, has been ambitiously immersed in opening and liberalizing this sector, this process has been motivated, first, by the demands of the European authorities responsible

for the liberalization of Spanish public services, as a requirement to enter the European Union (EU); and secondly, because the Spanish authorities recognized that these actions would improve the welfare of the beneficiaries of this fuel [7]. This sector was formally liberalized by the Hydrocarbons Law of 1998, implementing a series of measures designed to promote openness, however, it is far from effective and active competition, since excessive industrial concentration is maintained, with a dominant operator like Repsol Butano, who controls practically all the vertical chain of the industry, imposing important vertical restrictions in the contracts with distributors [8]. There are restrictions that affect competition and require constant protection and control by the State and by the competent and regulatory authorities, in addition to this, the government has strictly controlled the final prices since 1992, setting maximum prices with the theoretical objective of preventing that the dominant company exercises its power and sets monopolistic prices.

Currently, LPG continues to be an important source of energy in the Spanish market, mainly for domestic use such as cooking and heating, with a demand of 2.53% of total energy consumption; Comparable figure with coal or renewable energy sources, there are around twelve million customers throughout the country, concentrated mainly in the residential segment, however, although LPG continues to be an important source of energy in Europe and throughout the world, there are not enough economic documents that have studied this industry in depth [9].

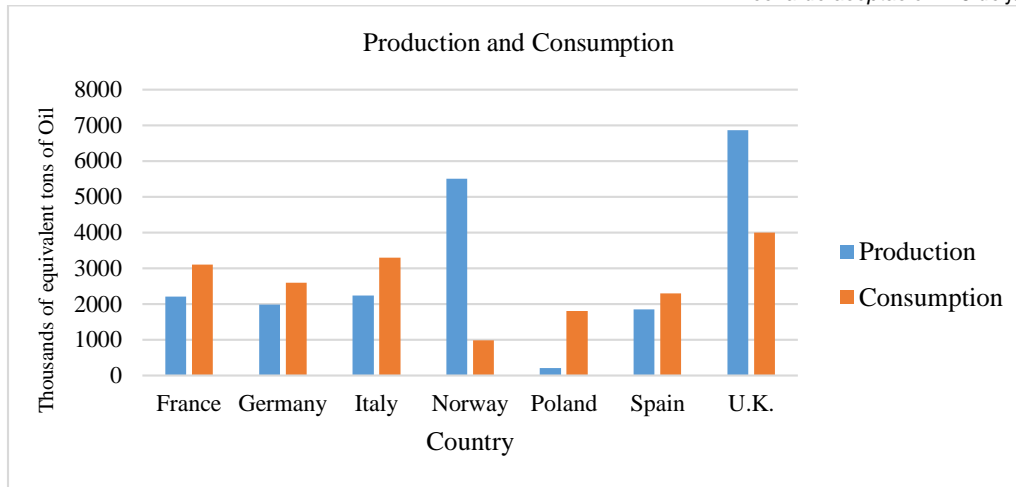


Figure 3. Production and Consumption world of LPG [5].

In the European market, there are significant differences, in terms of production levels and national consumption, that is why Figure 3 shows that there are important producing countries such as Norway with 5400 Thousands of Equivalent Oil Tons (KTep) and the United Kingdom with 6800 KTep, while, in other countries such as Poland, the LPG production is very low only 1900KTep, the case of Spain can be considered as a mid-level producer, as well as France, Germany and Italy [3].

2.3. The case of Brazil

The LPG industry started in Brazil at the end of the 1930s, where demand has exceeded production during the last two decades and the country has relied on imports to satisfy the growing demand for LPG. More than 70% of the demand for LPG in Brazil is in the residential sector, which allowed the national oil company Petrobras was established in 1953 and started to produce LPG in 1955, being that several of the new distributors joined the market in the

1950s turning the 13 kg cylinder into a distribution standard, that is why the latest statistics published by The World Liquefied Petroleum Gas Association (WLPGA) indicate that, in 2017, 5.45 Million Metric Tons were produced (mMT) at the local level and the balance was imported, indicating that the LPG demand grew steadily until 2001, when the subsidies were eliminated, and then the demand disappeared, since then it has recovered and has remained above 7 mMT / year since 2011.

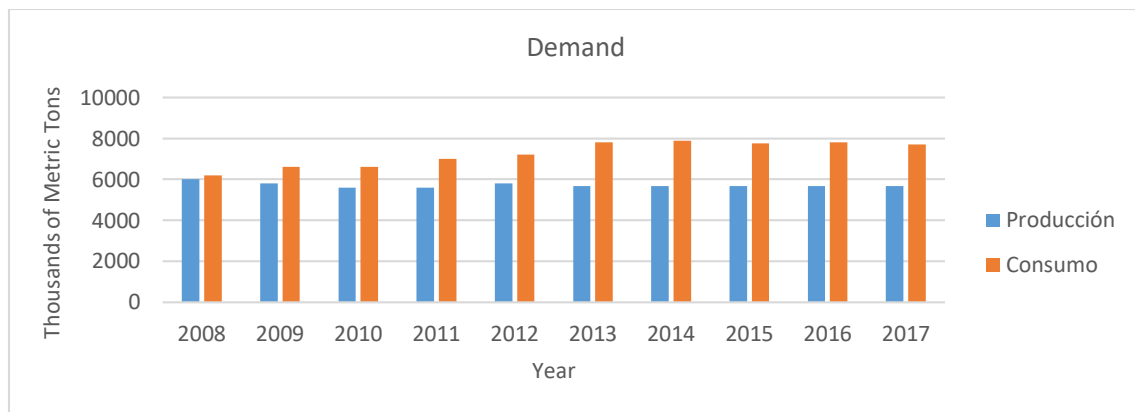


Figure 4. Profile demand LPG 2008-2017 [3].

Figure 4 shows, as in Brazil, consumption is concentrated in two specific sectors, residential and industrial, in this scenario the auto gas is not reflected due to government policy, which does not consider it as one of the objectives of the actual's energy basket [10], under this reality these sectors operate with economies of scale and are considered "natural monopolies" [11].

2.4. Chinese scenario

For China gaseous fuels constitute a small but growing part of the energy system, several historical developments have taken place in the structure of the fuel gas sector, which was well

established on the demand side, but underdeveloped on the side of supply [12] in this region LPG is mainly used as domestic fuel for cooking of food which for the year 2009 represented 1.2% of the total energy consumption [13]; As in many regions, in China LPG is usually more expensive than competitive gases, however, its liquefaction facility allows it to reach markets without pipelines, leaving evidence that where pipelines are available, the price LPG is uncompetitive, although it is the most widely used gas fuel for cooking [14], as it is a more expensive fuel than other combustible gases, which reflects a per capita consumption of low LPG, as evidenced by Figure 5, which compares the total residential consumption of LPG, natural gas and manufactured gas in terms of calorific value [15].

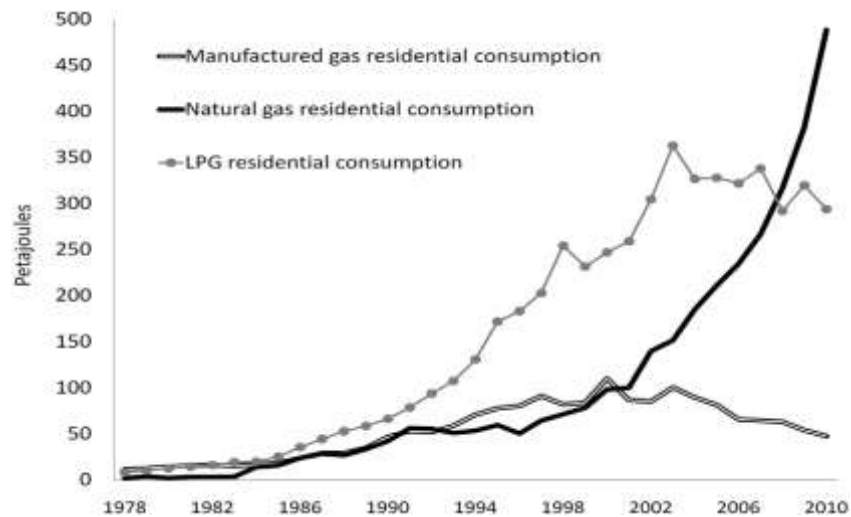


Figure 5. Residential consumption of the main combustible gases [11].

Although China has experienced rapid economic growth in the last decades, as well as its urbanization process, there are still approximately two thirds of its population that still does not have access to any type of fuel gas, these communities usually burn dirty solid fuels such as coal and biomass for each of its processes such as cooking and heat source, thus generating

greater indoor air pollution and the likelihood of acquiring lung diseases. Under this reality and given the previously exposed case, as it is the contamination, it is that LPG considers like the viable alternative and easily available compared with the solid fuels, nevertheless, many of its coastal cities are converting from LPG to Liquefied Natural Gas (LNG), but this reduction in the demand for LPG will be compensated by those rural regions, cities and less developed towns [12].

2.5. The case of Ghana

The country's history exposes a population of 27.5 million inhabitants, where almost half of it is linked to agriculture, mainly small landowners; It is important to highlight that its economy has strengthened in the last two decades, under a competitive business environment, reaching a sustained reduction in poverty levels [14].

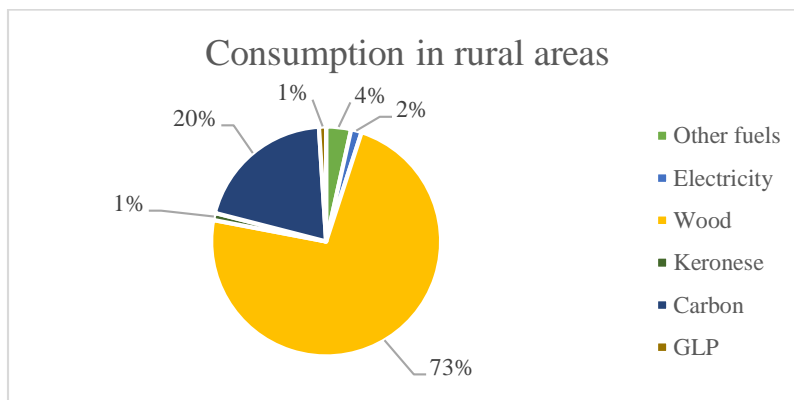


Figure 6. Consumption of fuels in rural areas for cooking food [14].

As can be seen in Figure 6, the dominant fuel for cooking food in Ghana is wood, followed by other types of fuels and in a very low percentage is LPG, however, in its capital Accra, see Figure 7 slightly different, understanding that wood and coal represent 66% of its use in the

cooking process, with 23% of LPG use, which occurs in communities located in urban areas, with little or no participation in areas rural areas, which continue to use coal and wood [14].

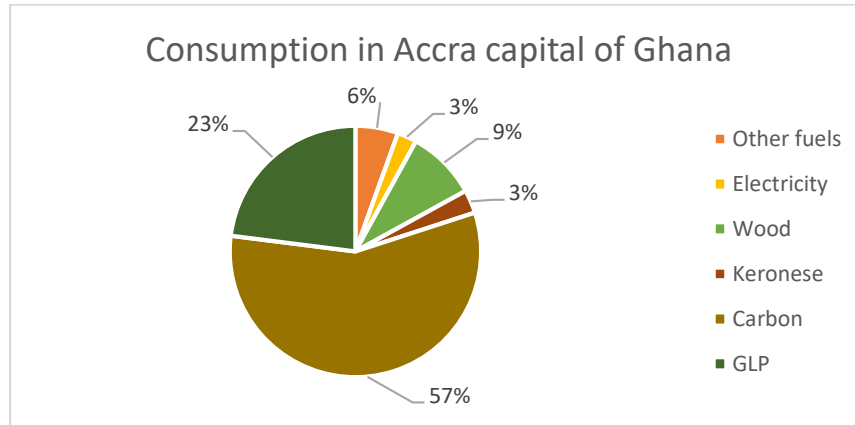


Figure 7. Consumption of fuel in Accra capital of Ghana [14].

Under this scenario, the government of Ghana seeks to stimulate the consumption and promotion of LPG based on the expansion of production and the application of a Petroleum Price Fund (UPPF), has also used gasoline sales to subsidize LPG and offer incentives for sales of LPG at distances greater than 200 km from the refinery, however, this program has been limited due to the following reasons as set forth by the WLPGA in its 2018 report:

- The rural population of Ghana is fragmented and constitutes a challenging target for LPG penetration.
- Income levels are low and even bartering takes place within communities.
- The entrance barrier to obtain a stove and an LPG cylinder is high for these communities.
- The size of the cylinder used was inadequate.
- Absence of a safety culture and poor compliance with regulations to ensure good commercial practices.

- The strong competition of kerosene, which has been subsidized.

This has led to LPG as fuel in Ghana being subsidized, which is why many commercial vehicles have been converted to LPG, since the subsidiary issue makes it cheaper than gasoline [14].

2.6. The Indian reality

The LPG industry in India began in 1955, which is used exclusively for cooking, developing new applications for LPG in 1965 in the non-residential, industrial and transport sectors. Nowadays it is one of the markets of LPG's largest in the world with a demand in 2017 that exceeds 23 million metric tons (mMT) according to the Global Statistical Review 2018 WLPGA, see Figure 8, in it is clearly observable how its profile is low production Vs a high consumption.

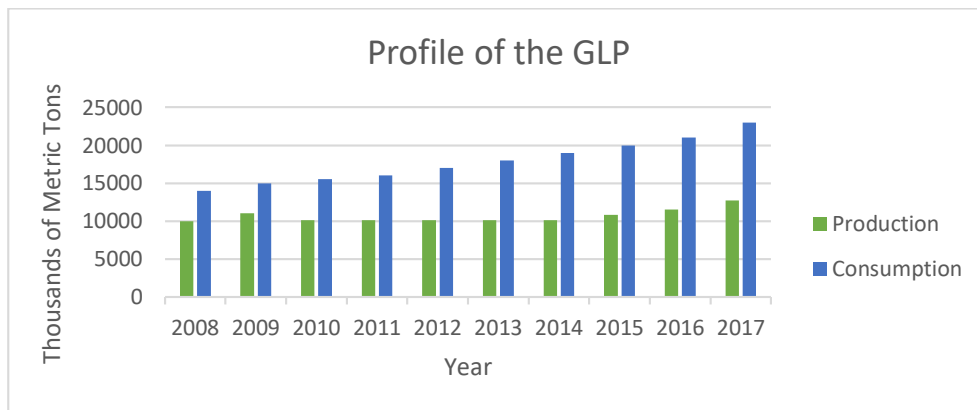


Figure 8. LPG profile of India 2008-2017 [3].

This led to a local LPG production maintaining a rhythm according to demand for a while, a scenario that has not been maintained, on the contrary it has been reducing, which has led to the importation of more than 10 million tons per year of LPG, with a growth trend as a result of its continuous demand, another factor that makes this scenario relevant is the subsidiary issue

as in Ghana, which for the situation in India has been increased, which in the end results in an improper use of the end user, who has no control over it.

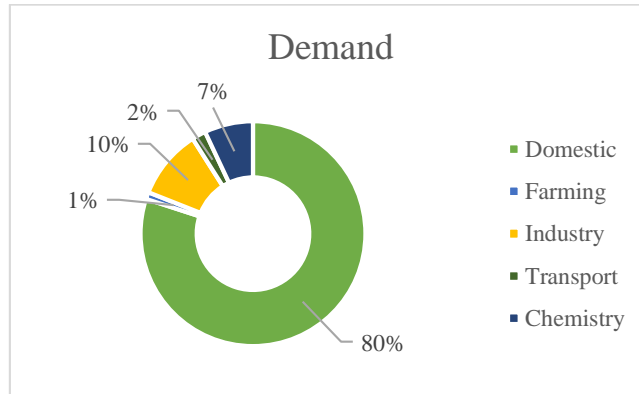


Figure 9. Demand for LPG by sector [3].

As was previously stated, consumption is on the rise and production does not have the same problem, so with Figure 9 it can be observed that the demand falls on the domestic sector, followed by the industrial sector and the lowest being that of agriculture; which in fact evidences a behavior of the residential consumers of LPG in increase, what demands that it must bear the availability with high levels of production, see figure 10.

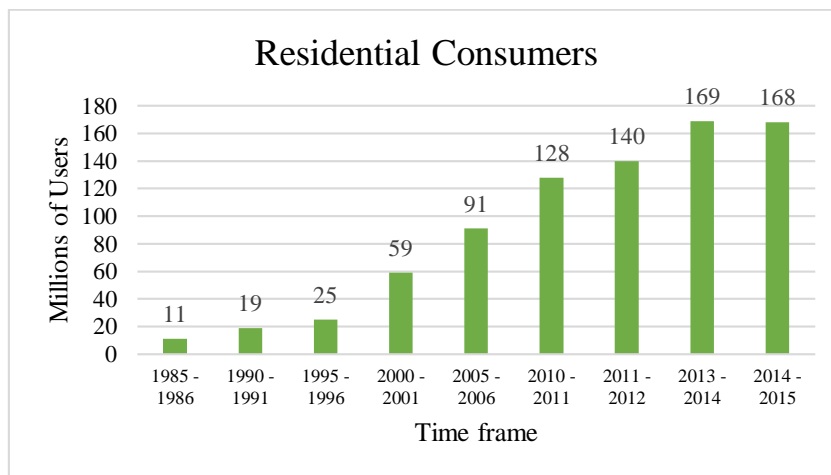


Figure 10. Behavior of residential consumers in LPG consumption in recent years in India. [16]

3. National environment

In the Colombian case, the situation does not change much, it must satisfy an energy demand which according to Figure 11 is supported in hydraulics, natural gas, coal, renewables and oil, concentrating 69% in liquid fuels, higher than what It is shown worldwide.

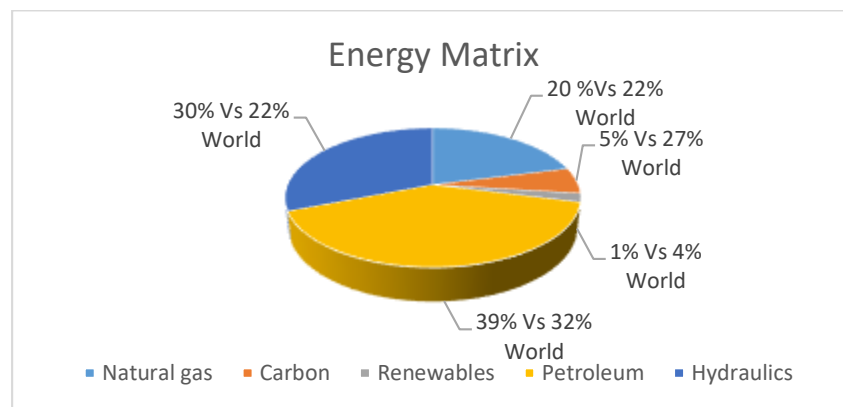


Figure 11. Colombia energy matrix 2017 [17].

Under the current scheme, the basket of fuels in Colombia during the last 18 years is concentrated around the ACPM mixed with Biodiesel, not considering and addressing the major air quality problems that this type of fuel causes and consequently the associated costs around this, this scenario leads to the mixture for biodiesel that is marketed in Colombia rising from 9 to 10 percent, however Jorge Bendeck, president of the National Federation of Biofuels draws attention because the companies of the large mining of coal, such as Cerrejón, Drummond and Prodeco, as well as Cerro Matoso have not yet been involved in the blending process [18]. The result of this mixture Biodiesel - ACPM shows a growing reality and this is reflected in Figure 12, because the crops palm crops are increasing, putting food security at risk, this figure shows

an exponential growth as the Crops grow faster and faster in the measure of annual time that arises.

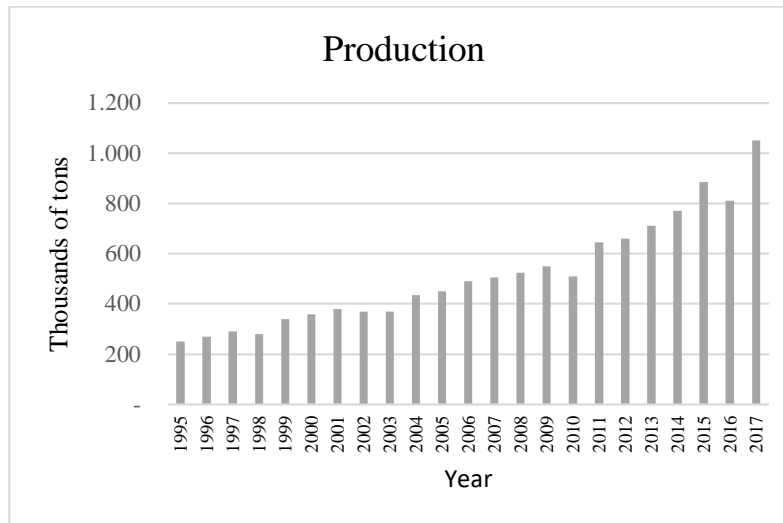


Figure 12. Palm oil production [19].

In 2016 the demand for LPG was 18,136 Barrels per Day (BPD), with a growth trend with respect to 2015 of 5.72%, with a history of consumption at the residential level and an industrial market that is managed with tanks stationary as of 2015, thereby increasing the demand for this energy; Nowadays, the companies in the LPG sector supply close to 69% of users located in stratum 1 and 25% of stratum 2; likewise, 922 municipalities are reached, giving coverage of 83% of the total national territory [20]. Although the current scenario reflects an evolution of the basket of fuels, there is a transition from kerosene to fuel oil, which is a residual fuel oil, derived from the distillation of crude oil, used for the generation of electricity, which contains significant amounts of oil. Ashes, sulfur and nitrogen, and is used mainly in industrial processes and major commercial applications, including electricity generation [21], under this same analysis it is observed that Liquefied Petroleum Gas showed a considerable decrease in the last 18 years

of 7 percentage points from 12% in the year 2000 to 5% in the year 2017, as evidenced in Figure 13.

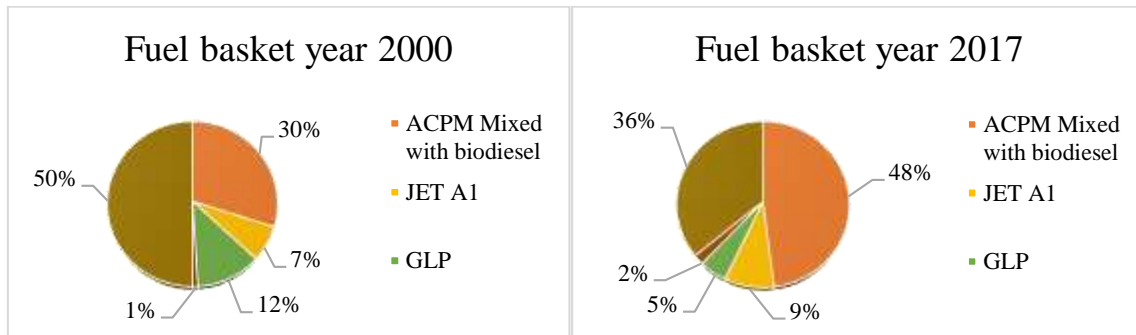


Figure 13. Evolution of fuel basket [19]

Although the LPG sector grew from 2015 to 2016, in the current basket of liquid fuels a reduction in its participation can be observed, its environmental advantages are unknown on conventional fuels and some alternatives, the reality is that the emissions of butadiene and benzene, including evaporative emissions, are particularly lower than those emitted by gasoline and diesel, showing that this fuel helps reduce greenhouse gas emissions, which cause climate change problems [22]. Thus, the national supply of LPG until the beginning of 2005 was served by a monopolized production, which allowed the entry into production of oil fields with contribution of associated gas, giving a total turn to the production of LPG, however, despite of having new sources of supply the offer is not enough to meet the current demand for this fuel. Currently, 7% of the LPG marketed in Colombia comes from independent private producers other than Ecopetrol, establishing production projections by source as of 2016 with a 5-year horizon that would reflect an average production of 19,000 barrels per day by 2019 (BPD) and from 2020 onwards, production would average 17,000 BPD [20].

| SECTOR | MARKET SHARE |
|-------------|--------------|
| COMMERCIAL | 50.78% |
| INDUSTRIAL | 35.92% |
| OFFICIAL | 1.84% |
| RESIDENTIAL | 11.46% |

Table 2. Size of the sector market [23].

For this sector the uses are diverse, since the current demand presents a series of potential customers, making it an important player in the basket of liquid fuels, in this order, the advantages as liquid fuel are reflected in low CO₂ emissions, comparable to those of diesel and gasoline; compared to diesel, LPG reduces NO_x emissions by 96% and particles by 99%, with respect to diesel / biodiesel, there is a 96% reduction in NO_x emissions and 99% in particle emissions, to gasoline presents a reduction of up to 14% of CO₂ emissions and 50% of operating costs, related to Compressed Natural Gas presents a reduction of up to 5% of NO_x emissions and 4.5 % of CO₂ emissions, it can finally be exposed that another of the great advantages is the availability of fuel at any point of the geography, reducing by up to 200% the costs of investment in points of sale [24].

Thus, the Ministries of Mines and Energy, Social Protection and Environment, Housing and Territorial Development by resolution 2604 of December 24, 2009 determined clean fuels having as a fundamental criterion the content of its components and considered LPG as fuel clean diesel fuel up to 50 ppm sulfur, mixtures of diesel with biodiesel, gasoline and mixtures of gasoline with fuel alcohol or denatured anhydrous ethanol.



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In relation to the price, the Energy and Gas Regulation Commission (CREG) contemplates defining the price of the product through the auction mechanism, considering two variables: the international prices of propane and butane, and the source of production of which comes the LPG; this means that the selling price to the end user is affected by the variation in international prices, as well as the variability in the composition (mixes) of the product delivered for consumption.

Consequently, the current situation shows that the Liquefied Petroleum Gas sector as an alternative energy is uncompetitive and participatory, and this is supported by the Confecámaras report, which presents the participation of the following sectors within the national economy as follows: 38.7%, accommodation and food services 15.6%, manufacturing 9.9%, which could represent consumption of LPG, however the sector only manages to reflect 0.4% growth, a situation very different from what happened with sectors such as hotels, restaurants, bars and similar, which grew by 1.4%, trade by 0.8%, transportation by 0.7%, agriculture, livestock, hunting, forestry and fishing increased by 4.4%, and the extraction of crude oil and natural gas in 2% [5], the foregoing makes clear that the Liquefied Petroleum Gas sector as a public service, which must respond to the needs of the population, does not manage to position itself as a competitive fuel, because with low levels of growth does not provide coverage or cover the current and projected demand.

The national dynamics shows that the sector has not generated its own intelligence, today the LPG market is still waiting for regulatory modifications that improve its competitiveness compared to other energy sources such as Natural Gas, a sample of this is that of the 7 off-shore blocks for exploration in the Caribbean Sea offered by Ecopetrol, only one was awarded,

and the proved gas reserves of 6.8 cubic therapies allow the country to meet the current and expected demand in the medium term, this, together with the existing contractual structure and the current regulations that restrict exports, regulate prices and do not stimulate greater exploratory activity [1]. The reality is evident, the sector presents a series of factors that affect the supply of LPG, among which are highlighted variables such as: oil production and prices, demand and prices of petroleum derivatives, demand for natural gas, projects of expansion of refining capacity, natural gas processing, consumption and prices of LPG for each of the different sectors in which it can participate and the low growth in the production of refinery LPG, Figure 14 shows a production scenario with low levels of growth, practically with a stagnation, with an average of production of 567,328,982 kilograms of LPG.

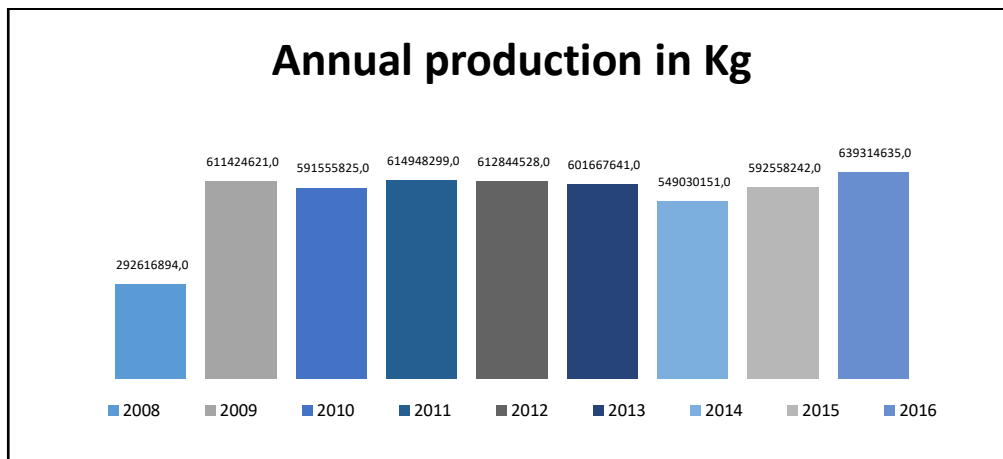


Figure 14. Annual LPG production in Kg [23].

4. Comparison of international scenarios vs national

The comparison of the two scenarios starts from the analysis of quantitative variables such as production, consumption, participation and number of vehicles converted to LPG.

| PRODUCTION PER YEAR IN THOUSANDS OF METRIC TONS | | | | | | | | | | |
|---|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| PAÍS | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Brasil | 6.000 | 5.900 | 5.250 | 5.250 | 5.900 | 5.800 | 5.250 | 5.300 | 5.288 | 5.288 |
| Gana | 65 | 75 | 30 | 50 | 30 | 25 | 10 | 90 | 110 | 100 |
| India | 9.990 | 12.000 | 10.500 | 10.500 | 10.500 | 10.500 | 10.500 | 11.000 | 12.000 | 13.000 |
| Indonesia | 1.800 | 1.750 | 2.100 | 2.100 | 2.100 | 2.050 | 2.100 | 2.400 | 2.400 | 2.300 |
| Kenia | 20 | 15 | 20 | 20 | 10 | 5 | - | - | - | - |
| Perú | 1.010 | 1.500 | 1.490 | 1.400 | 1.500 | 1.800 | 1.700 | 1.600 | 1.600 | 1.550 |
| Senegal | 150 | 140 | 130 | 110 | 100 | 105 | 110 | 150 | 160 | 160 |
| Sri Lanka | - | - | 40 | 30 | 10 | 20 | 40 | 10 | 10 | 10 |
| Turquía | 900 | 800 | 800 | 850 | 900 | 900 | 900 | 1.000 | 1.100 | 1.100 |
| Estados Unidos | 4.775 | 5.048 | 5.457 | 6.139 | 6.548 | 6.821 | 8.186 | 9.550 | 9.959 | 10.232 |
| Colombia | 2.865 | 2.701 | 2.619 | 2.592 | 2.387 | 2.428 | 2.456 | 2.524 | 2.442 | 2.660 |

Table 3. Annual production [3].

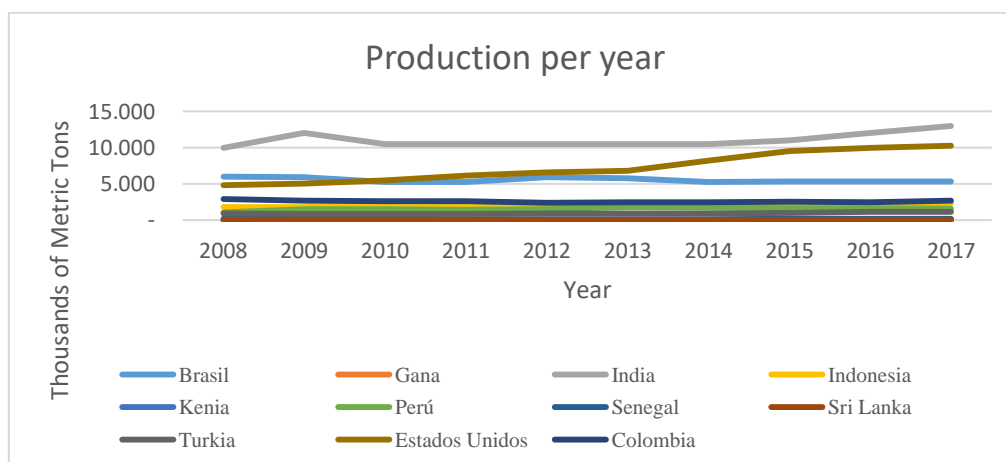


Figure 15. Production per year [3].

Figure 15 shows the growth of LPG production in the United States, the other countries do not show such growth, the behavior is very similar to the Colombian case, that is, it is stagnant

production over time, however the Colombian production It is well below international scenarios, production in Colombia is below 2,900 metric tons.

| CONSUMPTION PER YEAR IN THOUSANDS OF METRIC TONS | | | | | | | | | | |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Country | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Brasil | 6.250 | 6.500 | 6.500 | 7.000 | 7.000 | 7.250 | 7.500 | 7.250 | 7.500 | 7.250 |
| Gana | 160 | 180 | 180 | 210 | 260 | 250 | 240 | 290 | 290 | 320 |
| India | 14.000 | 15.000 | 15.500 | 16.000 | 17.000 | 17.500 | 19.000 | 20.000 | 22.000 | 24.000 |
| Indonesia | 2.900 | 3.000 | 3.900 | 4.200 | 5.100 | 5.900 | 6.000 | 6.200 | 6.400 | 6.900 |
| Kenia | 70 | 90 | 90 | 100 | 110 | 120 | 130 | 150 | 180 | 200 |
| Perú | 800 | 1.100 | 1.250 | 1.250 | 1.350 | 1.500 | 1.600 | 1.600 | 1.600 | 1.700 |
| Senegal | - | 8 | 8 | 8 | 6 | 6 | 5 | 5 | 4 | 4 |
| Sri Lanka | 200 | 200 | 190 | 200 | 200 | 210 | 250 | 300 | 380 | 390 |
| Turquía | 3.900 | 3.900 | 3.900 | 3.990 | 3.999 | 4.000 | 4.050 | 4.200 | 4.100 | 4.100 |
| Estados Unidos | 5.033 | 5.048 | 5.280 | 5.416 | 5.457 | 6.139 | 6.139 | 6.412 | 6.480 | 6.548 |
| Colombia | 2.742 | 2.729 | 2.606 | 2.592 | 2.428 | 2.387 | 2.456 | 2.551 | 2.606 | 2.619 |

Table 4. Annual consumption[3].

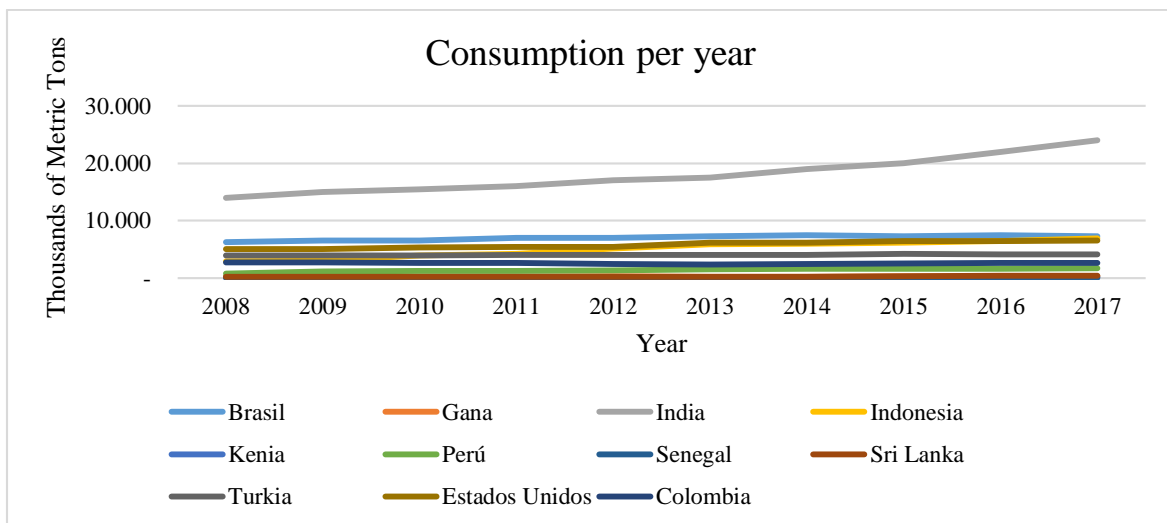


Figure 16. Consumption per year [3].

Figure 16, shows that production is not enough to meet the demand, because it grows every year, as seen in the Colombian case, it is observed that the production compared with countries like Brazil, India and the United States is quite low in percentages of 54%, 77% and 65% respectively.

It is highlighted that the sectors that have consumption of LPG are those that are reflected in the following table.

| CONSUMPTION BY SECTORS IN THOUSANDS OF METRIC TONS | | | | | | |
|---|-----------------|-----------------|--------------------|-----------------------|-----------------|-------------------|
| Country | Domestic | Industry | Agriculture | Transportation | Chemical | Commercial |
| Brasil | 2.000 | 800 | - | - | - | |
| Gana | 2.000 | 50 | 50 | 1.000 | - | |
| India | 6.000 | 500 | 50 | 50 | 100 | |
| Indonesia | 5.000 | 100 | - | 50 | - | |
| Kenia | 2.000 | 360 | - | - | - | |
| Perú | 2.000 | 500 | - | 1.000 | - | |
| Senegal | 2.000 | 100 | - | - | - | |
| Sri Lanka | 2.000 | 500 | 50 | 30 | - | |
| Turquía | 500 | 50 | - | 2.000 | 100 | |
| Colombia | 1.910 | 273 | - | - | - | 546 |

Table 5. Consumption by sectors [3].

Figure 17 shows the low participation of this energy in the industrial and commercial activities of the various countries, the Colombian case is no stranger to this reality also demonstrating that it is well below other countries, India and Indonesia highlight the participation that they give to the fuel in the domestic subject, Colombia relegated in the subject of Agriculture, transport,

chemical and commercial, Peru surpasses us as far as the use that it gives in the subject of transport and in the industrial sector.

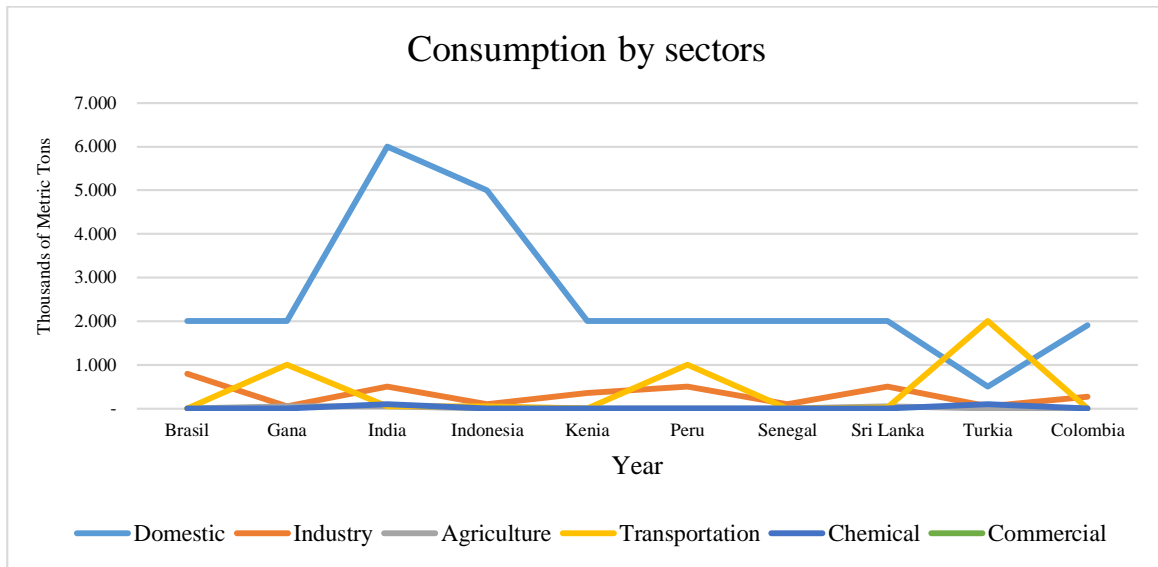


Figure 17. Consumption by sectors in thousands of metric tons [3].

| LPG CONSUMPTION AS A VEHICULAR FUEL IN THOUSANDS OF METRIC TONS | | | | | | | | | | | | | | | | | |
|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Country | 2.000 | 2.001 | 2.002 | 2.003 | 2.004 | 2.005 | 2.006 | 2.007 | 2.008 | 2.009 | 2.010 | 2.011 | 2.012 | 2.013 | 2.014 | 2.015 | 2.016 |
| Australia | 1.490 | 1.390 | 1.220 | 1.205 | 1.120 | 1.160 | 1.160 | 1.100 | 1.060 | 1.055 | 1.070 | 1.020 | 950 | 805 | 750 | 600 | 560 |
| Bulgaria | 125 | 210 | 245 | 255 | 275 | 305 | 298 | 360 | 340 | 340 | 350 | 335 | 330 | 355 | 360 | 380 | 395 |
| China | 320 | 390 | 450 | 500 | 400 | 375 | 570 | 580 | 530 | 540 | 590 | 630 | 610 | 720 | 970 | 995 | 995 |
| República Checa | 65 | 70 | 68 | 68 | 85 | 85 | 75 | 78 | 77 | 77 | 76 | 75 | 74 | 70 | 75 | 90 | 95 |
| Francia | 220 | 210 | 180 | 160 | 150 | 140 | 130 | 120 | 110 | 105 | 110 | 125 | 110 | 101 | 90 | 80 | 70 |
| Alemania | - | - | 9 | 12 | 15 | 25 | 100 | 150 | 310 | 410 | 505 | 501 | 510 | 500 | 470 | 420 | 400 |
| Grecia | 20 | 15 | 12 | 10 | 7 | 6 | 5 | 5 | 7 | 6 | 20 | 75 | 140 | 185 | 195 | 250 | 260 |
| India | - | - | - | 3 | 35 | 75 | 140 | 275 | 248 | 320 | 350 | 352 | 345 | 320 | 310 | 334 | 349 |
| Italia | 1.150 | 1.395 | 1.110 | 1.200 | 1.100 | 1.010 | 995 | 985 | 1.000 | 1.100 | 1.205 | 1.290 | 1.380 | 1.560 | 1.590 | 1.620 | 1.640 |
| Estados Unidos | 710 | 750 | 740 | 720 | 740 | 752 | 770 | 680 | 600 | 590 | 310 | 305 | 410 | 510 | 480 | 525 | 620 |
| Colombia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Table 6. LPG consumption [3].

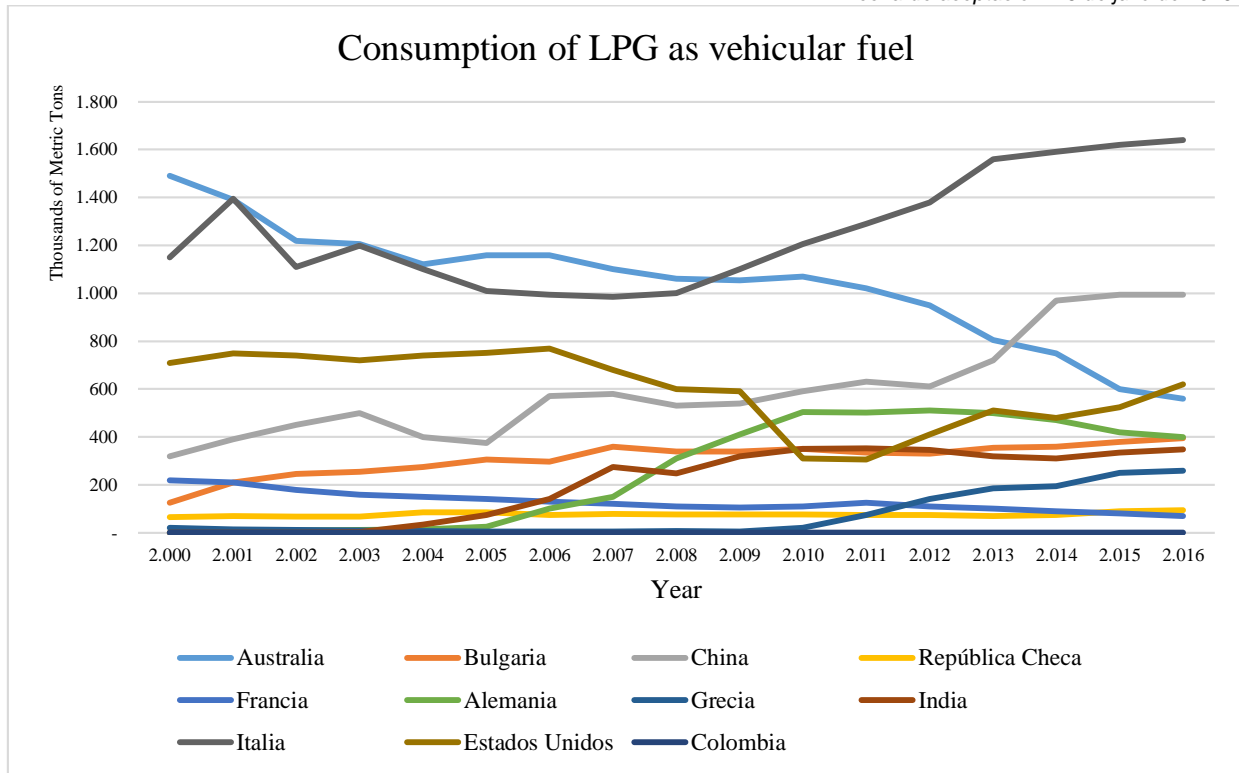


Figure 18. Consumption of LPG as a vehicular fuel in thousands of metric tons [3].

Figure 18 makes the national reality even more clear regarding the participation of the LPG sector as vehicular fuel, the Colombian case is distant enough from this great reality, since there are no figures that show how many vehicles of the private automotive fleet or public make use of this fuel, finally Figure 19 shows the number of vehicles converted and this adjusted to the WLPGA Global Statistical Review report for the year 2018.

| VEHICLES CONVERTED TO LPG | | | | | | | | | | | | | | | | | |
|---------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Country | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Australia | 590 | 600 | 495 | 480 | 590 | 510 | 540 | 625 | 640 | 630 | 510 | 510 | 500 | 490 | 480 | 410 | 350 |
| Bulgaria | 130 | 160 | 195 | 200 | 202 | 210 | 210 | 215 | 205 | 220 | 475 | 480 | 485 | 490 | 490 | 495 | 500 |
| China | 70 | 80 | 110 | 115 | 110 | 115 | 145 | 80 | 75 | 100 | 120 | 120 | 142 | 142 | 160 | 170 | 170 |
| República Checa | 155 | 152 | 150 | 150 | 170 | 170 | 195 | 195 | 195 | 210 | 165 | 165 | 165 | 175 | 168 | 168 | 175 |
| Francia | 200 | 210 | 185 | 175 | 175 | 155 | 150 | 140 | 140 | 115 | 165 | 255 | 260 | 265 | 220 | 210 | 215 |
| Alemania | 5 | 7 | 8 | 10 | 20 | 55 | 115 | 200 | 300 | 490 | 425 | 455 | 495 | 500 | 490 | 485 | 400 |
| Grecia | 5 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 50 | 160 | 180 | 220 | 390 | 400 | 415 |
| India | 5 | 5 | 5 | 50 | 100 | 220 | 220 | 510 | 600 | 1550 | 1680 | 1750 | 1990 | 2100 | 2200 | 2225 | 2270 |
| Italia | 1250 | 1270 | 1400 | 1125 | 1050 | 995 | 920 | 915 | 910 | 1550 | 1750 | 1775 | 1820 | 1950 | 1965 | 2225 | 2250 |
| Estados Unidos | 1950 | 1980 | 2010 | 2055 | 2100 | 2112 | 2250 | 2145 | 2085 | 2103 | 1509 | 1500 | 1521 | 1521 | 1527 | 1575 | 1680 |
| Colombia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 7. Vehicles converted to LPG [3].

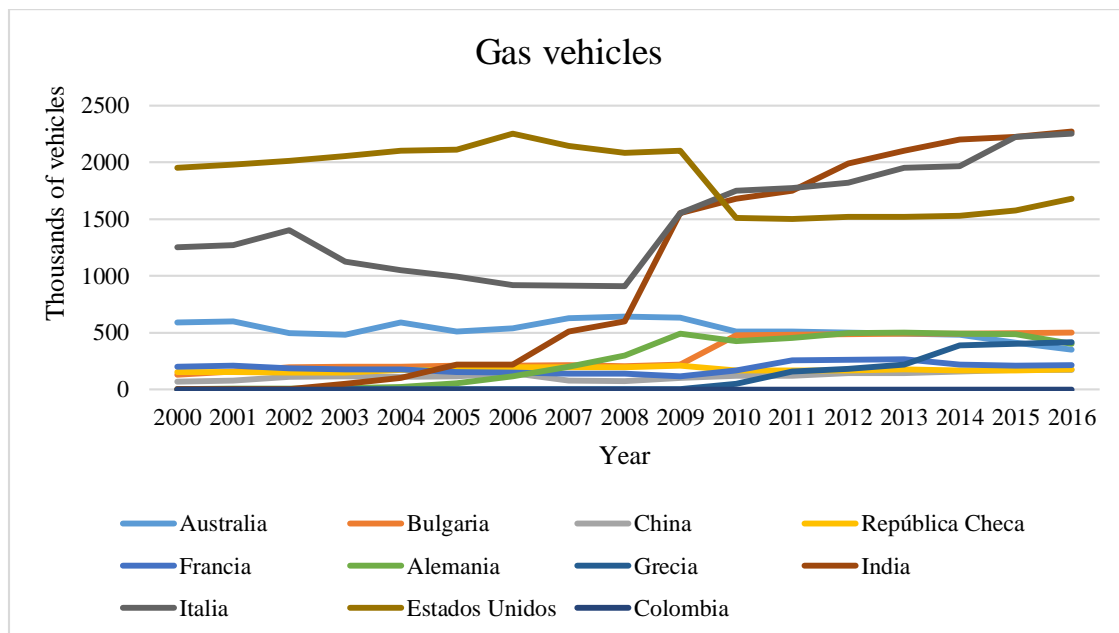


Figure 19. Vehicles converted to LPG and consumption in thousands of metric tons [3].

5. Conclusions

The LPG constitutes a strategic economic for the local, regional, national and international development and this is presented in the advanced analysis. In Colombia, it is necessary to make visible the economic, social and environmental scopes and benefits, establish plans and policies that guarantee greater fuel supply and demand, supplying unexplored markets and not covered by other energy sources.

The demand for LPG is given by sectors such as residential, industrial, agricultural, transport and commercial, today it is concentrated in the residential sector served with cylinders, where the highest consumption occurs in the departments of Antioquia, Nariño , Santander, Valle, Cundinamarca and Norte de Santander, for a total of 27 departments that have the supply of this fuel in the country, that is to say a coverage of 83%, without this evidencing a coverage of 100% of the municipalities of the national territory, with the precedent that in Colombia is consumed 17 a thousand barrels of propane gas every day, not covering other productive sectors of the country and that are using liquid fuels with higher levels of contamination.

There is clarity about the energy needs of Colombia and this is shown by the Inter-American Development Bank (IDB) when it states that these will grow by 110.3% by the year 2040, which will require an unprecedented amount of infrastructure to support this demand, without leaving aside that the current energy crisis in the country opens the reflection on the challenges that must be faced to support the demand of the coming years, at the same time, the IDB points out the need to plan a significant amount of new energy infrastructure capable to meet future needs. If you think of Liquefied Petroleum Gas only as a public utility service, this is not guaranteed, since Ecopetrol is using huge quantities of fuel as a diluent for heavy crude oils or for internal



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electricity generation, using the LPG it produces, and not releasing the fuel for distribution in households, it is desirable that there be more national supply to avoid shortage problems in Colombia.

The comparison of the national and international scenarios and analyzing the production, as well as the consumption, shows that the LPG sector within the national energy basket presents a fairly low participation in relation to countries such as Brazil, the United States, India and Indonesia. The contribution of the sector to the economy of the country is quite small, it is not competitive despite having favorable environmental characteristics, as energy addresses three of the domestic, industrial and commercial sectors, without participating in the agricultural, chemical and transport sector, this makes it urgent the intervention of the sector to take it to be competitive within the basket of liquid fuels, so that it becomes an alternative energy and is established from a public policy sector structure to supply a market and satisfy social and economic needs.

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