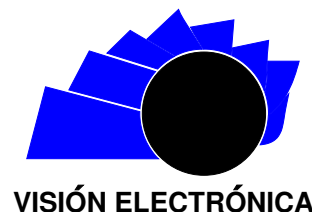




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A CONTEXT VISION

Sectorial analysis of liquefied petroleum gas

Análisis sectorial de gas licuado de petróleo

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ABSTRACT

This study shows the results of the analysis of the liquefied petroleum gas (LPG) sector, by covering aspects related to its production and consumption. Initially addressing the international scenario with countries such as Spain, Brazil, China, India and Ghana later, it makes the analysis of the national scenario with a look at the participation of the sector within the energy matrix. Likewise, a comparison with a matrix Colombian national level to investigate the participation of the sector within the energy matrix and compare international and national scenarios. Despite its favourable environmental characteristics such as lower emissions of carbon monoxides, hydrocarbons and nitrogen oxides, as well as fewer greenhouse gases. LPG has a low contribution to the national energy sector considering that energy demand is concentrated in 69% of liquid fuels, the LPG sector can barely reflect a growth of 0.4% and it is not competitive. Intervention of public policy is thus required to increase its competitiveness within the basket of liquid fuels, in such a way that it becomes a viable energetic alternative and its sectorial structure established from a public policy, allowing to supply a market and to satisfy the social and economic necessities.

RESUMEN

Este estudio muestra los resultados del análisis del sector del gas licuado de petróleo (GLP), cubriendo aspectos relacionados con su producción y consumo. Inicialmente se aborda el escenario internacional con países como España, Brasil, China, India y Ghana, posteriormente se realiza el análisis del escenario nacional con una mirada a la participación del sector dentro de la matriz energética. Asimismo, una comparación con una matriz a nivel nacional colombiano para investigar la participación del sector dentro de la matriz energética comparando escenarios internacionales y nacionales. A pesar de sus características ambientales favorables, como la reducción de las emisiones de monóxido de carbono, hidrocarburos y óxidos de nitrógeno, así como de los gases del efecto invernadero. El GLP tiene una baja contribución al sector energético nacional considerando que la demanda de energía se concentra en el 69% de los combustibles líquidos, el sector del GLP apenas puede reflejar un crecimiento del 0,4% y no es competitivo. La intervención de políticas públicas es necesaria para aumentar su competitividad dentro de la canasta de combustibles líquidos, de tal manera que se convierta en una alternativa energética viable y su estructura sectorial establecida a partir de una política pública, que permita abastecer un mercado y satisfacer las necesidades sociales y económicas.

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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 when compared with other economic sectors in Colombia. The LPG sector undergoes continuous regulatory, operational and other changes arising from the fluctuation of international parameters such as the value of the dollar and fall in oil prices, making it a growing factor in the basket of liquid fuels in countries of different latitudes. Colombia has seen limited development of its LPG sector, in which its production corresponds to a consumption profile that represents a defined market. Thus, an analysis of the international context is required to allow for a comparison with national reality.

The use of LPG has wide potential in large, small and medium-sized cities; many of them have natural gas coverage. This has made the most accessible cooking fuel for municipalities and rural isolated areas from the natural gas network [1].

However, the current state of the LPG sector in countries such as Spain, Brazil, China, Ghana and India should consequently be analysed, as they represent an important link in the economic development world. LPG has become a strategic sector in the Spanish national economy over the past 20 years, with continuous efforts being made towards opening and liberalising this sector. Brazil is the fifth most populated country in the world, with more than half of the population falling under the middle class category and with high levels of inequality; nevertheless, dedicated programmes have allowed 95% of the population to access LPG. In China, where it represented 1.2% of total energy consumption in 2009, LPG is mostly used for cooking. The LPG sector has been established on the demand side but is underdeveloped on the supply side. Ghana, with a population of 27.5 million, has seen its economy strengthen over the last few decades, evident by the growth of the service sector to 50% of the overall gross domestic product (GDP) [2]. Consequently, the LPG consumption in these countries, especially in the residential and industrial sectors, has risen to such an extent throughout the last decade that imports are required. For instance, India a country with an open market economy and with a population of 1.28 billion people, currently imports more than 10 million tonnes of LPG every year and this demand continues increasing [3].

The international LPG scenario will be discussed

in Section 2, touching upon both production and consumption of countries such as Spain, Brazil, China, India and Ghana. A corresponding analysis of the Colombian scenario is under the same variables in Section 3. The international and national scenarios are compared in Section 4, before conclusions regarding the needs of the Colombian national sector that are drawn in Section 5.

2. International environment

In the last 18 years, the LPG sector has framed by new developments and the growing production of liquefied natural gas (LNG). Which, unlike Liquefied Gas Oil (LPG) is easy to transport and store [4]. All this, because of its composition the LNG is a cleaner fuel, as long as it does not contain high contents of butanes and olefins. As a liquid fuel, the LPG can be used in the residential, industrial, agro-industrial, transport and electrical sectors; it is also used as a raw material for petrochemical processes essential in the manufacturing industry, thus generating greater benefit for a country's economy [5].

In 2000, approximately three billion people were estimated not having access to clean cooking facilities. Since then, the number of residents of low- and middle-income countries with access to clean kitchens has grown by 60% [6]. Nevertheless, this progress has been surpassed by strong population growth; despite advances in economic development and the growing awareness of the health risks of cooking with dirty fuels, approximately 3 thousand million more people (representing 41% of the world's population) do not have access to clean kitchen facilities. A breakdown of worldwide cooking fuel consumption is presented in Table 1 [3].

Table 1: Cooking fuel used worldwide [3]

	Solid fuel	Kerosene	LPG & LNG	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%

On the other hand, it is clear that solid biomass is widely used as a cooking fuel in developing countries, as shown in Figure 1 [1].

2.1. Global LPG production

LPG is a by-product of the processing of natural gas (extraction of liquid fractions) or by the refining of petroleum. The production of LPG depends on the motivation, capacity and production requirements of other hydrocarbons likewise Gasoline, turbine fuels, diesel and motor oils. As such, the worldwide production of LPG has increased drastically since 2006, driven mainly by the increased supply of natural gas and it is mainly produced by The United States, China and

Saudi Arabia [7].

Global LPG production has been growing steadily, as shown in Figure 2, owing to the increased participation of Russia, the United Arab Emirates, Qatar, India, Canada, Algeria and Iran. Additionally, United Kingdom and Turkey significantly increased their LPG production between 2014 and 2015 [8]. The International Energy Agency (IEA) has predicted a continued global increase and an average production of 580 million tonnes (MTON) of LPG by 2020. Other producers such as Greece, Italy, India and China registered a relative increase in production, and the production of LPG in the United Kingdom and Turkey grew significantly in the between 2014 and 2015 [8].

Figure 1: Proportion of the population in terms of primary reliance on various cooking fuels by region [1].

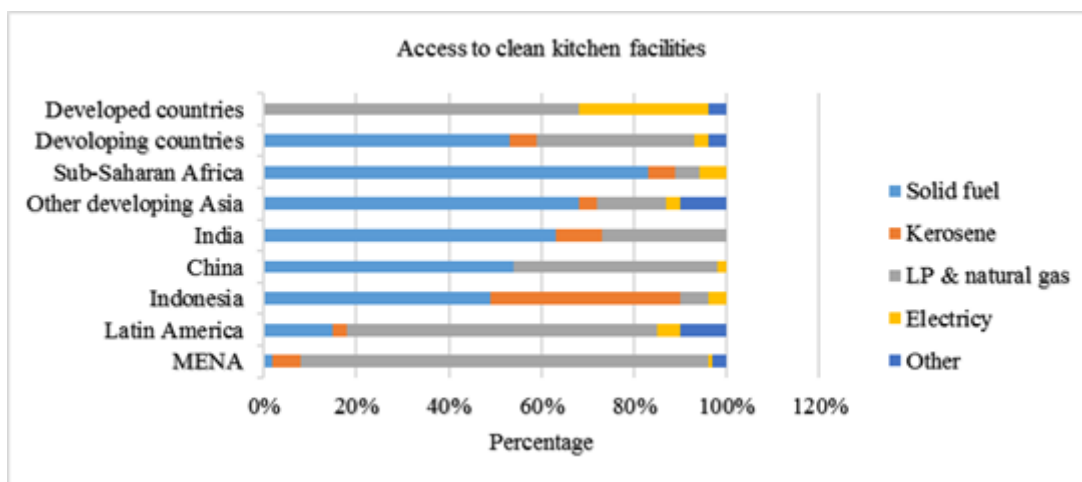
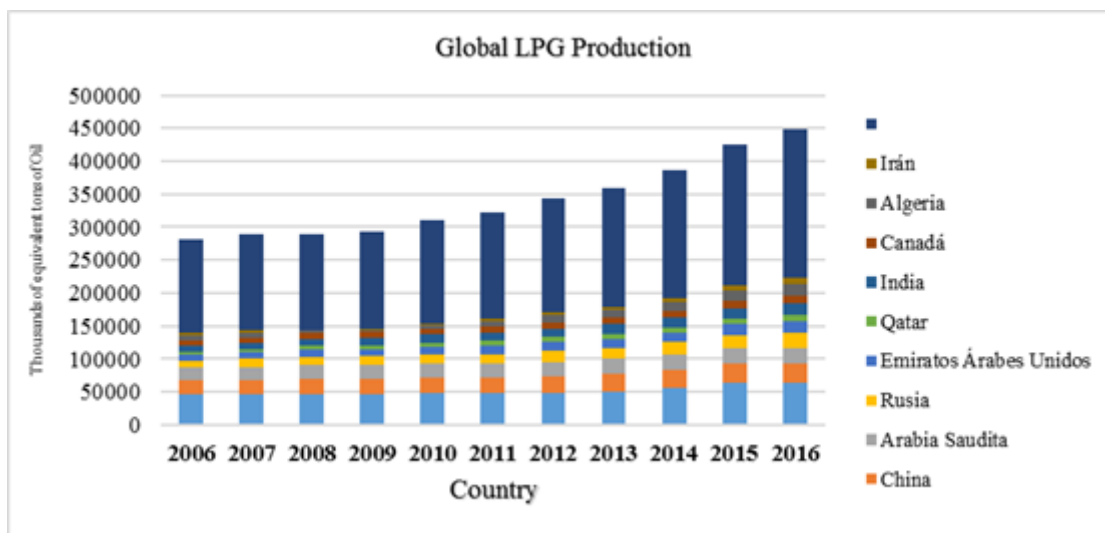


Figure 2: Global LPG Production [4].



2.2. Spanish scenario

The Spanish LPG sector has ambitiously grown over the last 20 years into a strategic sector for the economy. The motivation behind this growth has been two-fold: by the liberalisation of Spanish public services as a requirement to enter The European Union (EU) and owing to the recognition that these actions would improve the welfare of the beneficiaries [9]. This sector was formally liberalised by the Hydrocarbons Law of 1998, which implemented a series of measures designed to promote openness. Spite of the law was far from being effective and did not encourage active competition; an excessive industrial concentration was maintained, (with a dominant operator like Repsol Butano, which controls practically the entire vertical chain of the industry). This was by imposing important vertical restrictions in the contracts with distributors [10]. Besides, there are restrictions that affect competition and require constant protection and control by the State and competent and regulatory authorities. Furthermore, the government has strictly controlled the final prices since 1992, setting maximum prices with the objective of preventing monopoly. LPG continues to be an important source of energy in the Spanish market, encompassing 2.53 % of total energy consumption, mainly for domestic use such as cooking and heating issues. There are approximately 12 million customers throughout the country; most of them are obviously residential. Figure 3 below is comparable with those for coal or renewable energy sources. Although, LPG continues to be an important source of energy in Europe and the rest of the world, economic researchers have not investigated this industry in depth [2].

Within the European market, there are significant variations in terms of production and consumption levels, as shown in Figure 3. Norway and the United Kingdom are important producers for the region, producing 5400 and 6800 thousand of equivalent oil tonnes (KTep), respectively, whereas Poland only produced 1900 KTep. Spain, France, Germany and Italy were mid-level producers [1].

2.3. The case of Brazil

The LPG industry began developing in Brazil at the end of the 1930s. As demand has exceeded its production over the past two decades, the country has relied on imports more than 70 % of the demand for LPG in Brazil is in the residential sector, which led to the establishment of the national oil company Petrobras in 1953 [11]. It started LPG production in 1955. Several new distributors joined the market in the 1950s, and the 13 kg

cylinder turned into a distribution standard. The latest statistics published by The World Liquefied Petroleum Gas Association (WLPGA) indicate that in 2017, 5.45 million metric tonnes (mMT) were produced at the local level and the balance was imported, indicating that the LPG demand grew steadily until 2001 (when the subsidies were eliminated) , that caused a steep drop-off in demand. Since then, the demand has recovered and remained above 7 mMT/year since 2011.

Figure 4, shows that since in Brazil consumption is greater than production, this consumption is concentrated in two specific sectors, residential and industrial. In relation to this scenario, Autogas is not reflected due to government policy, which does not contemplate it as one of the objectives of the current energy basket [11], under this reality these sectors operate with economies of scale and are considered "natural monopolies" [12].

2.4. Chinese scenario

Gaseous fuels constitute a small but growing part of China's energy economy. Actually, several historical developments have occurred in the structure of the fuel gas sector, which was well established on the demand side, but underdeveloped on the supply side [13]. LPG has mainly been used as a domestic cooking fuel; LPG represented 1.2 % of the total energy consumption in 2009 [14]. As in many regions, LPG is usually more expensive than its competitors. However, as its liquid state allows it to reach markets without pipelines; the price of LPG is uncompetitive where pipelines are available. Although LPG is the most widely used gas fuel for cooking [15], it is more expensive than other combustible gases. This is evidenced in the low per capita consumption of LPG, as shown in Figure 5 below, which compares the total residential consumption of LPG, natural gas and manufactured gas in terms of calorific value [16].

Despite China's rapid economic growth and urbanisation in the past decades, approximately two thirds of its population does not have access to any type of fuel gas . Due to these communities, usually burn solid fuels such as coal or biomass, for cooking or as a heat source, thus generating greater indoor air pollution and health risks. Accordingly, LPG is a viable alternative and easily available compared with solid fuels. Nevertheless, many of China's coastal cities are converting from LPG to LNG. This reduction on the demand for LPG will be compensated by such rural regions, cities and less developed towns [13].

Figure 3: European LPG production and consumption [4].

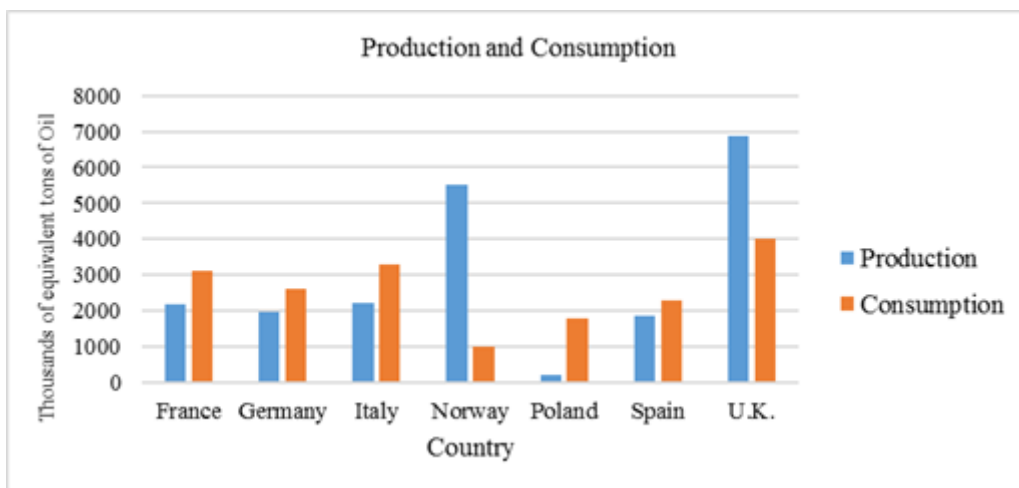
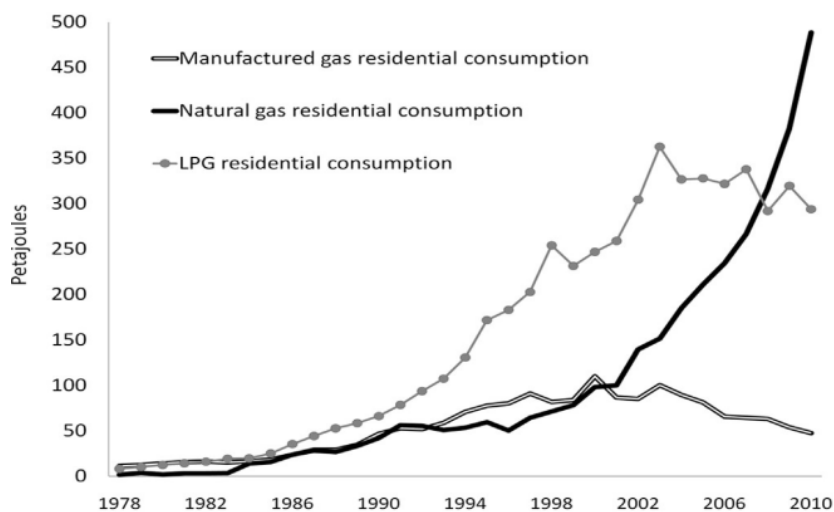


Figure 4: Production and consumption of LPG in Brazil 2008–2017 [1].



Figure 5: Residential consumption of the main combustible gases [12].



2.5. The case of Ghana

Nearly half of Ghana’s economy is attached to agriculture and this consists of small landowners. Then, under a competitive business environment, Ghana has achieved sustained reduction in poverty levels for its 27.5 million inhabitants over the last two decades [15].

As it is seen in Figure 6 above, with data of 2008 up 2017 wood is predominately used as a cooking fuel; only a very low percentage of LPG is used overall. This composition is different from Accra, where solid fuels account for 66% of cooking fuel, with 23% of the population using LPG. Urban areas have moved more towards LPG usage, whereas rural areas have continued to use coal and wood [15].

To stimulate the consumption and promotion of LPG, Ghana’s government has expanded production from 10% in 2007 to 50% in 2015 of population and the Petroleum Price Fund (UPPF) to include LPG. It has also used gasoline sales to subsidise LPG and offer incentives for LPG sales at distances greater than 200 km from the refinery. However, the 2018 WLPGA reported that this programme has been limited due to the following reasons:

- Ghana’s rural, fragmented population constitutes a challenge for LPG penetration.
- Income levels are low and a barter economy still exists within some communities.
- The high entrance barrier: obtaining a stove and LPG cylinder is too expensive for many rural households.
- The cylinder used was too small.

- Poor education on necessary safety standards led to poor regulation compliance to ensure good commercial practices.
- Kerosene subsidies in these areas resulted in strong competition.

In response, the Ghanaian government subsidised LPG. Since then, many commercial vehicles have been converted to LPG, as LPG has become cheaper than gasoline [15]

2.6. The Indian reality

The LPG industry in India, which is used exclusively for cooking, it began in 1955, by developing new applications for LPG in 1965 in the non-residential, industrial and transport sectors. Today it is one of the world’s largest markets, with a demand exceeding 23 mMT in 2017 according to the Global Statistical Review 2018 WLPGA, and it is shown in Figure 8. The increase in demand has significantly outpaced the increase in production.

This led to the local production of LPG maintaining a rhythm in accordance with the demand for a time. Keeping this in mind, a scenario that has not been maintained, on the contrary, it has been reduced, which has led to the import today of more than 10 million tons per year of LPG, with a growth trend resulting from 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 increasing, that in the end translates into an improper use of the end user, who has no control over it.

Figure 6: Consumption of fuels in Ghanaian rural areas for cooking food [15].

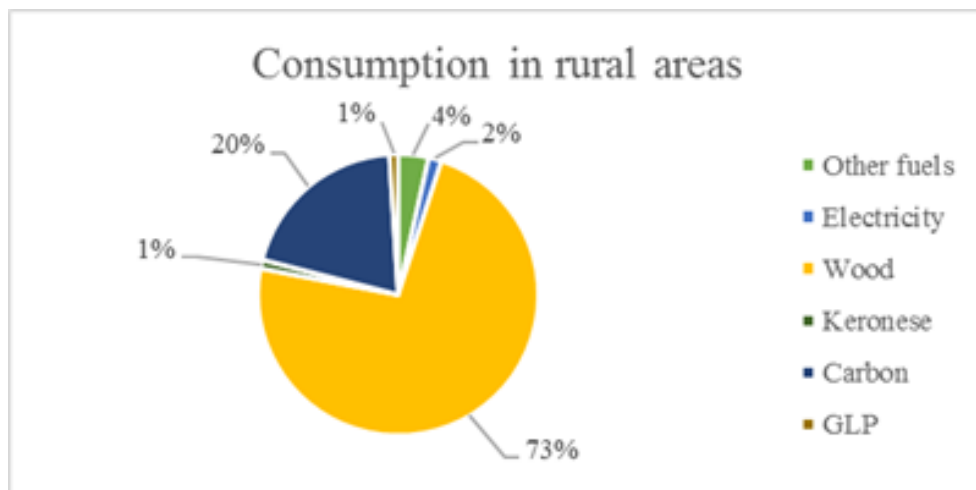


Figure 7: Consumption of cooking fuel in Accra, the capital of Ghana [15].

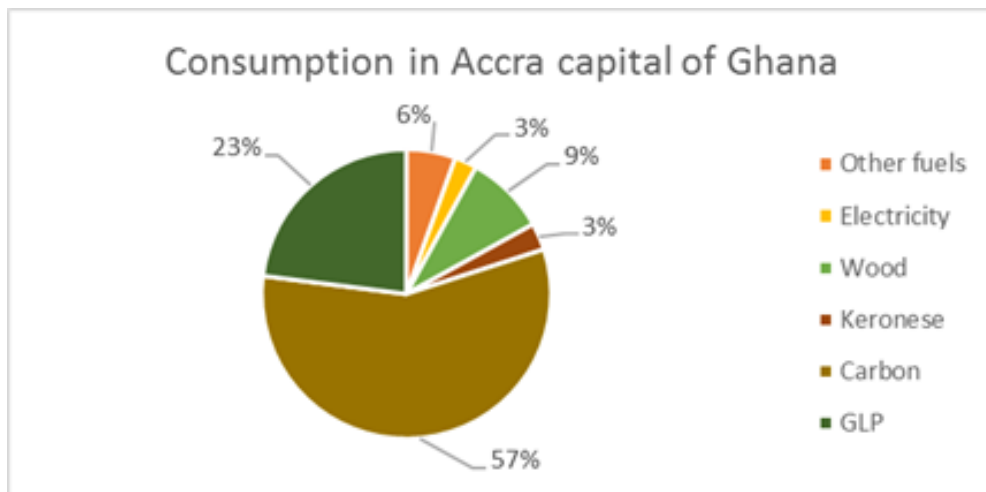


Figure 8: LPG profile of India 2008–2017 [1].

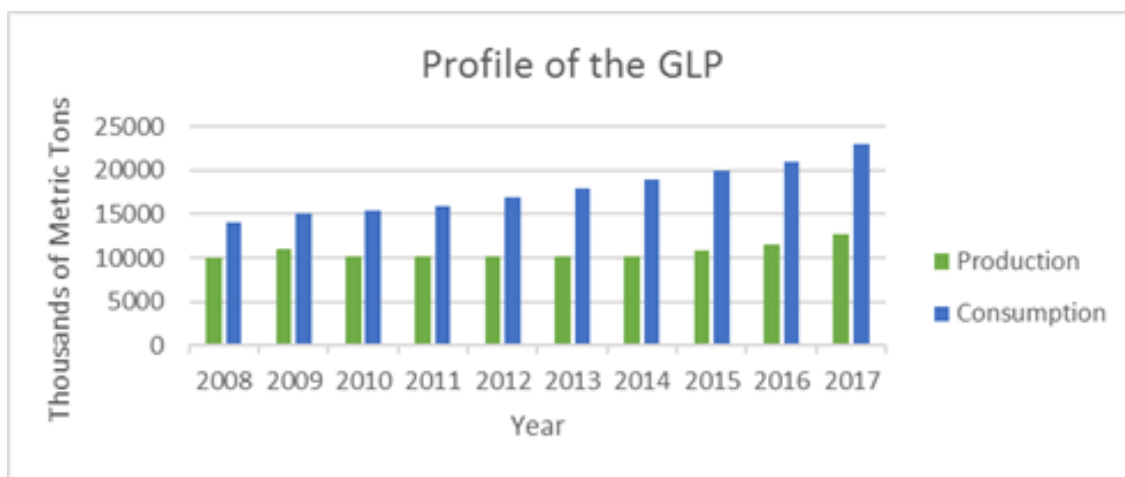
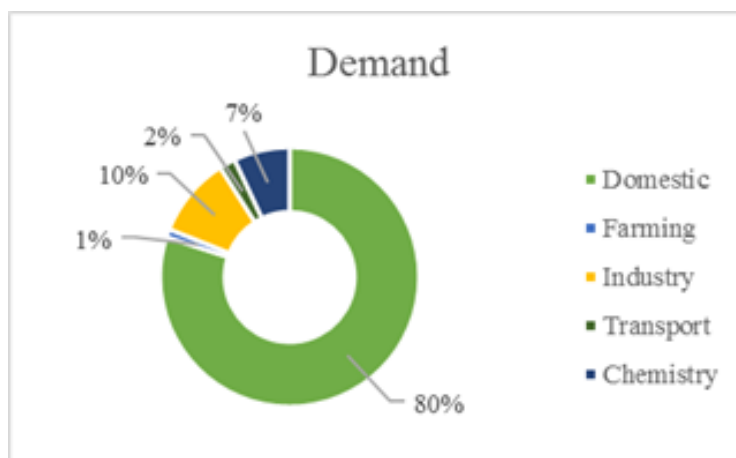


Figure 9: Chinese demand for LPG by sector [1].

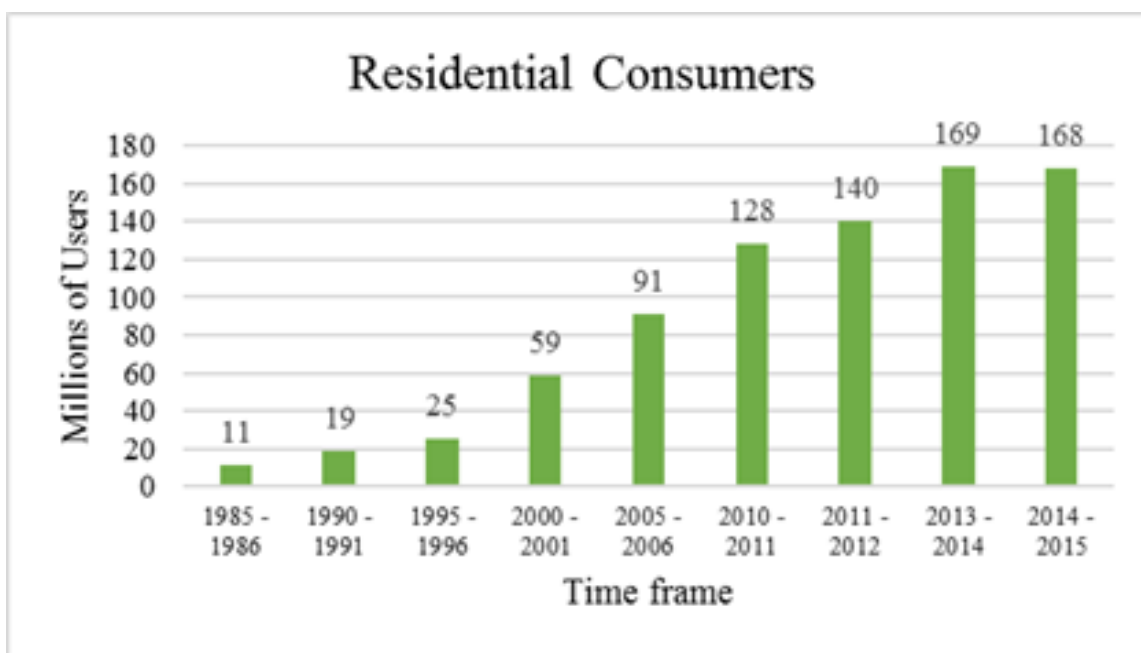


LPG consumption is on the rise and production does not have the same problem. As shown in Figure 9 above, 80% of the demand from 2000 to 2016 was from the residential sector, followed by the industrial sector at 10%, and only 1% of demand arising from the

agriculture industry.

Overall, the residential demand has been increasing with a slight decrease in 2015 as it is shown in Figure 10 below.

Figure 10: Residential LPG consumers in India [17].



3. National environment

The breakdown of fuels used to satisfy Colombia’s energy demand is similar to that used worldwide, as presented in Figure 11. Liquid fuels are used to satisfy 69% of Colombia’s energy demand, as opposed to 54% worldwide.

In the last 18 years, there have been a steady rise in the use of Engine Fuel Oil (ACPM) mixed with biodiesel to satisfy energy demands. However, the use of this fuel causes air quality problems and consequently, associated costs. This scenario has led to the mixture for biodiesel, which is marketed in Colombia, rising from 9 to 10 percent. Jorge Bendeck, president of the National Federation of Biofuels has drawn attention because large coal- mining companies, such as Cerrejón, Drummond, Prodeco and Cerro Matoso have not yet been involved in the blending process [19]. The result of this biodiesel- ACPM mixture shows a growing reality, and this is presented in Figure 12, because of the palm crop cultivation is increasing, putting food security at risk; this figure shows an exponential annual growth of palm crops.

In 2016, LPG demand was 18,136 barrels per day (BPD), with a growth trend compared to 2015 of 5.72%, with a historical consumption at residential level and an industrial market that can be found with stationary tanks from 2015. This also allows it to increase the demand for this energy; today companies in the LPG sector, supply about 69% users located in stratum 1 and 25% of stratum 2, also reaching 922 municipalities covering 83% of the total national territory [21], also reaching 922 municipalities covering 83% of the total national territory cite21. Although, the current scenario reflects an evolution of the fuel basket. Additionally, there is a transition from kerosene to fuel oil, which a residual fuel oil is derived from the distillation of crude oil used to generate electricity. On the other hand, this contains significant amounts of ash, sulphur and nitrogen and it is mainly used in industrial processes and major commercial applications, including the generation of electricity [22]. Under this same analysis, it is observed that Liquefied Petroleum Gas (LPG) showed a considerable decrease in the last 18 years of 7 percentage points from 12% in 2000 to 5% in 2017, as evidenced in Figure 13 below.

Even though, the LPG sector grew from 2015 to 2016, a reduction in its share in the current basket of liquid fuels can be observed. The environmental impacts of LPG relative to conventional fuels and some alternatives have not been well documented. In fact, butadiene and benzene emissions, including evaporative emissions, are lower when LPG is used than those using gasoline and diesel, showing that this fuel helps to reduce greenhouse gas emissions [23]. LPG was supplied nationally by monopolised production until the beginning of 2005, which allowed the entry of oil fields with contribution

of associated gases into production, giving a total turn to the production of LPG. However, national LPG production cannot meet the current demand. As such, 7% of the LPG marketed in Colombia comes from independent private producers other than Ecopetrol. This has established production projections by source as of 2016 with a 5-year horizon that would reflect an average production of 19,000 BPD by 2019, and from 2020 onwards, production would average 17,000 BPD [21].

Figure 11: Colombian energy matrix as of 2017 [18].

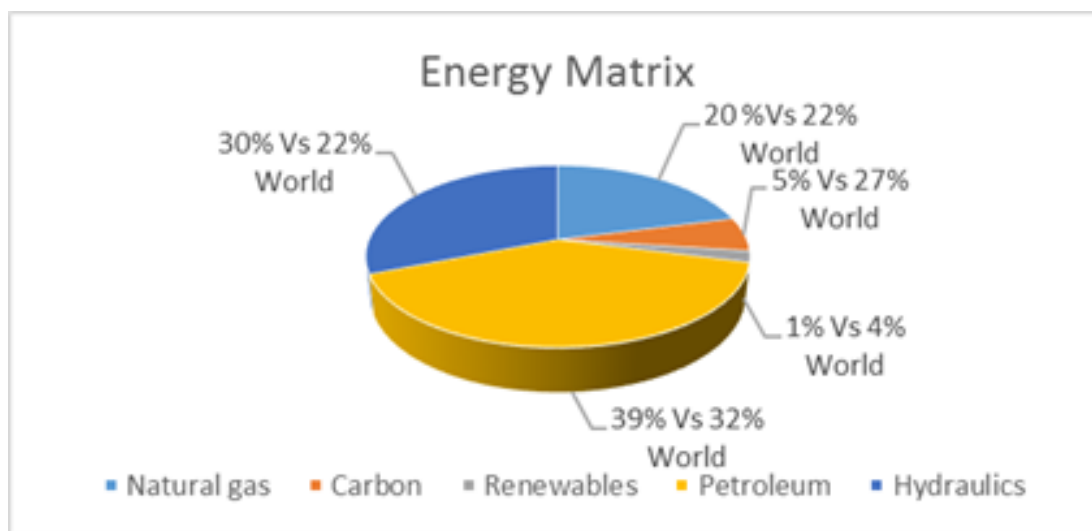


Figure 12: Palm oil production [20].

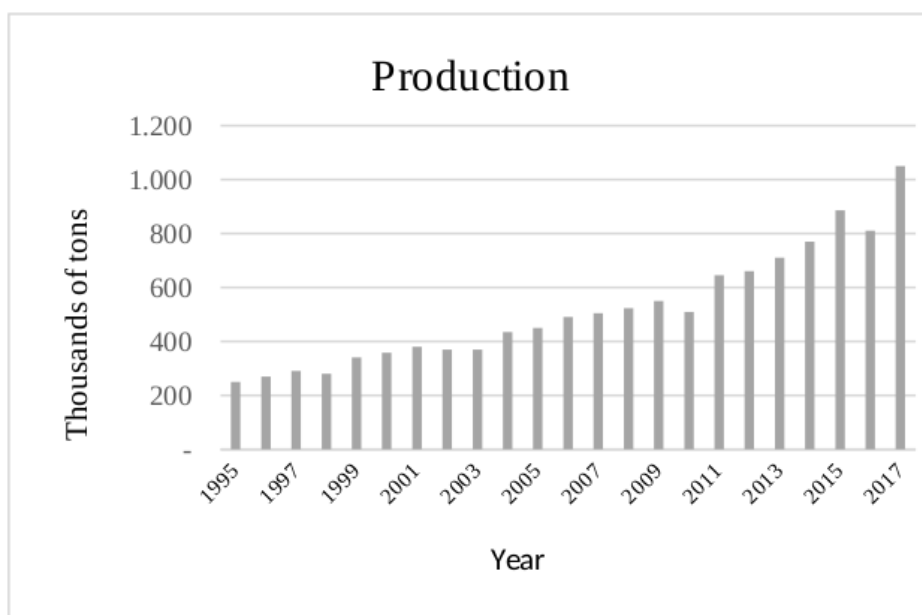
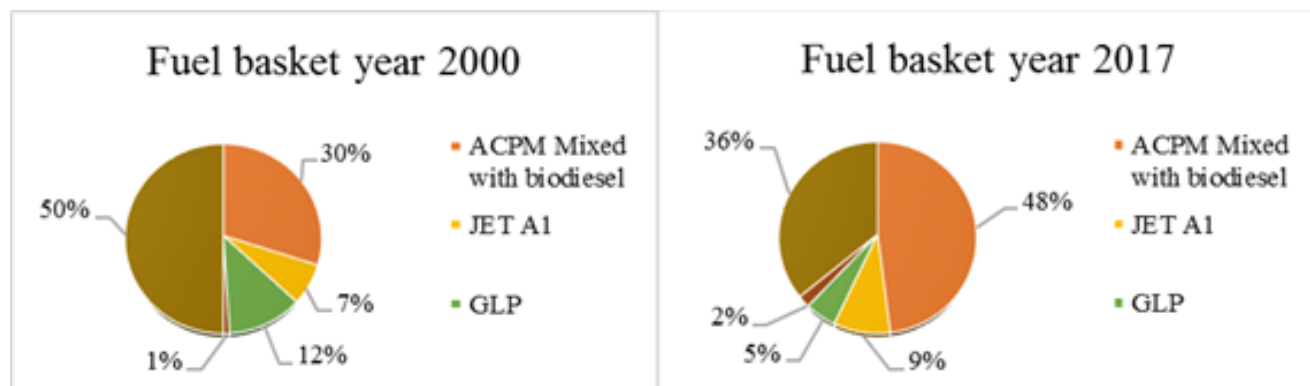


Figure 13: Evolution of fuel basket [20].



For these sectors showed in Table 2, 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. LPG has numerous advantages: 96 % lower emissions of nitrous oxides (NO_x) and 99 % lower particles emissions than diesel, 14 % lower CO₂ emissions and 50 % lower operating costs than gasoline and 5 % lower NO_x emissions and 4.5 % lower CO₂ emissions than LNG. Furthermore, the availability of fuel at any point of the geography, reducing by up to 200 % the costs of investment in sale points [25] is another significant advantage. The Mines and Energy Ministries, Social Protection and Environment, Housing and Territorial Development by resolution 2604 of 24 December 2009 determined a fundamental criterion for clean fuels. In terms of the content of their components, it is taking into account the following as clean fuel: LPG, diesel fuel up to 50 ppm sulphur, mixtures of diesel with biodiesel, gasoline and mixtures of gasoline with fuel alcohol or denatured anhydrous ethanol.

two variables: the international price of propane and butane, and the source of production of LPG. The selling price to the end user would thus be affected by the variation in international prices and variability in the composition (mixes) of the product delivered for consumption. Consequently, LPG has not yet become competitive within the alternative fuels market. This was supported by the Confecámaras report, which indicated the share of each sector within the national economy: 38.7%, accommodation, 15.6 % food services and 9.9 % manufacturing, which could represent consumption of LPG. However, this sector only manages to reflect 0.4 % growth, a situation very different from that in 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]. Thus, LPG has not yet managed to become a competitive fuel, because low levels of growth do not allow coverage or cover the current and projected demand.

Table 2: Size of the sector market share in percentages [24].

Sector	Market share
Commercial	50.78%
Industrial	35.92%
Official	1.84%
Residential	11.46%

The Energy and Gas Regulation Commission (CREG) has considered defining the price of the product through an auction mechanism, considering

National dynamics has indicated that the sector has not generated its own intelligence. The LPG market is still awaiting regulatory modifications to improve its competitiveness compared with other energy sources such as natural gas, as only one of the seven offshore blocks for exploration in the Caribbean Sea offered by Ecopetrol was granted. The gas reserves of 6.8 cubic meters would have allowed the country to meet current and expected demand in the medium term. Together with the existing contractual structure, regulations restricting exports, and price regulations, further exploratory activity is not encouraged [1]. A series of factors affect the supply of LPG: oil production and prices, demand and prices of petroleum derivatives, demand for natural gas, projects of expansion of refining capacity, natural gas processing, the consumption and prices of LPG, and

the low growth in the production of LPG refineries. As a result, a near stagnation of LPG production has occurred from 2009 until 2016, with an average of production of 5.67×10^8 kg of LPG, as shown in Figure 14.

Figure 14: Annual Colombian LPG production (kg), 2008–2016 [24].

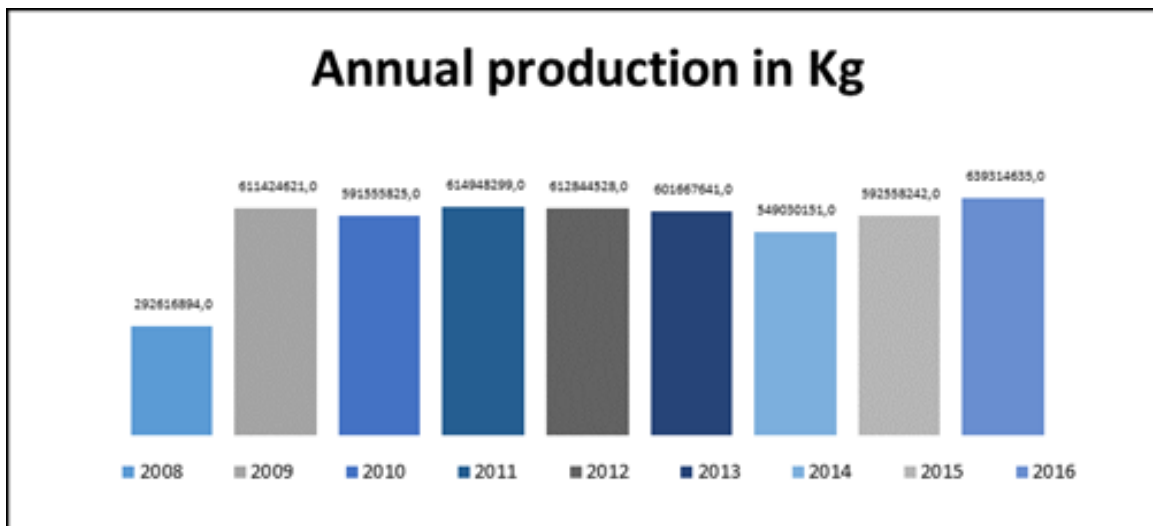


Table 3: Global annual LPG production [1].

Annual LPG production (thousand metric tonnes)										
Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	6.000	5.900	5.250	5.250	5.900	5.800	5.250	5.300	5.288	5.288
Ghana	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
Kenya	20	15	20	20	10	5	-	-	-	-
Peru	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
Turkey	900	800	800	850	900	900	900	1.000	1.100	1.100
United States	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

4. International vs. national scenario

It is necessary to analyse the Colombian national scenario in the context of the international LPG market quantitatively in terms of production, consumption, share and number of vehicles converted to LPG. In an international context, Colombian LPG production has remained relatively stagnant along with other nations (with the exception of the United States), but the Colombian production, at less than 2,900 metric tonnes, is well below international scenarios.

The production of LPG was not adequate to meet the demand, as highlighted in the mismatch between

Figures 15 and 16 and that between Tables 3 and 4. The production compared with countries like Brazil, India and the United States is quite low (54%, 77% and 65%, respectively). The LPG consumption per sector is broken down in Table 5. The low share of LPG in the international and Colombian industrial and commercial sectors is highlighted in Figure 17 and Table 6 below shows that India and Indonesia highlight the importance that they give to the fuel in the domestic context, whereas in Colombia, it is relegated to agriculture, transport, chemical and commercial sectors. Peru surpasses us in terms of its use in the transport and industrial sectors through years 2008 to 2017.

Figure 15: Global annual LPG production [1].

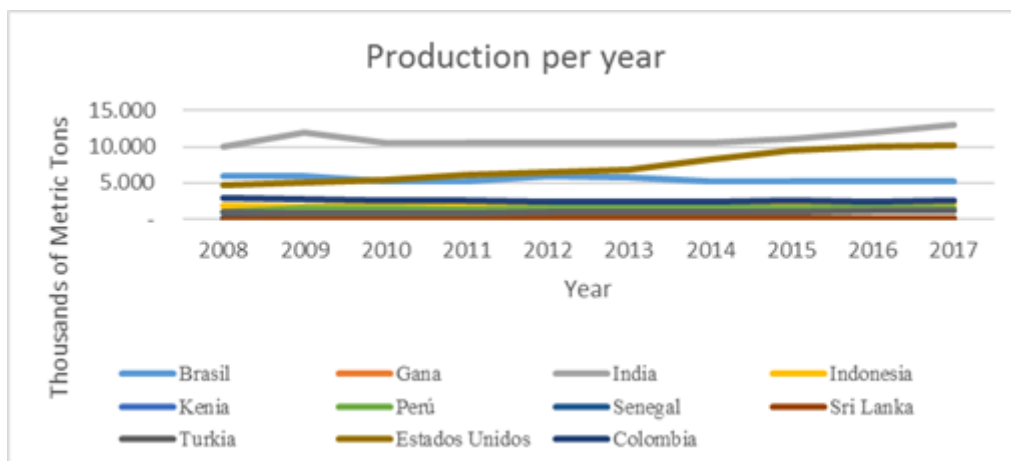


Table 4: Global annual LPG consumption [1].

Annual consumption (thousand metric tonnes)										
Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Brazil	6.250	6.500	6.500	7.000	7.000	7.250	7.500	7.250	7.500	7.250
Ghana	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
Kenya	70	90	90	100	110	120	130	150	180	200
Peru	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
Turkey	3.900	3.900	3.900	3.990	3.999	4.000	4.050	4.200	4.100	4.100
United States	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

Figure 16: Global annual LPG consumption [1].

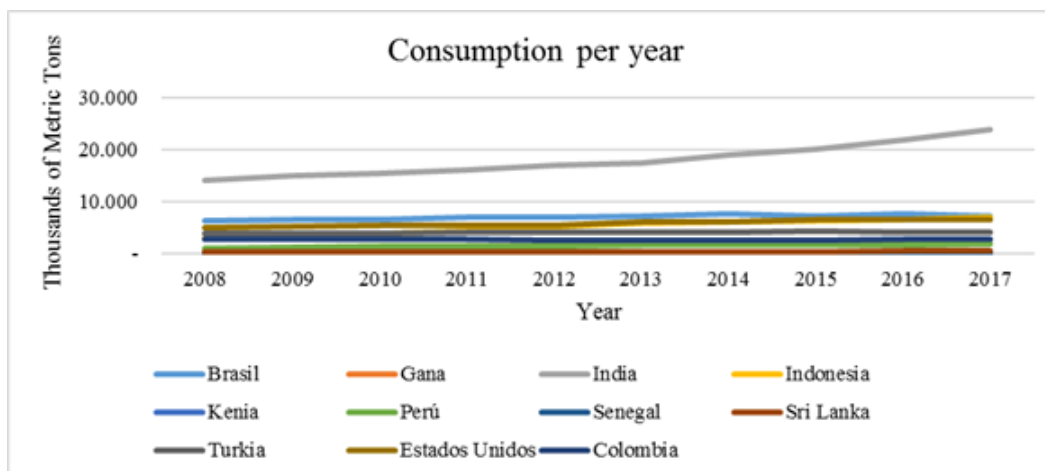
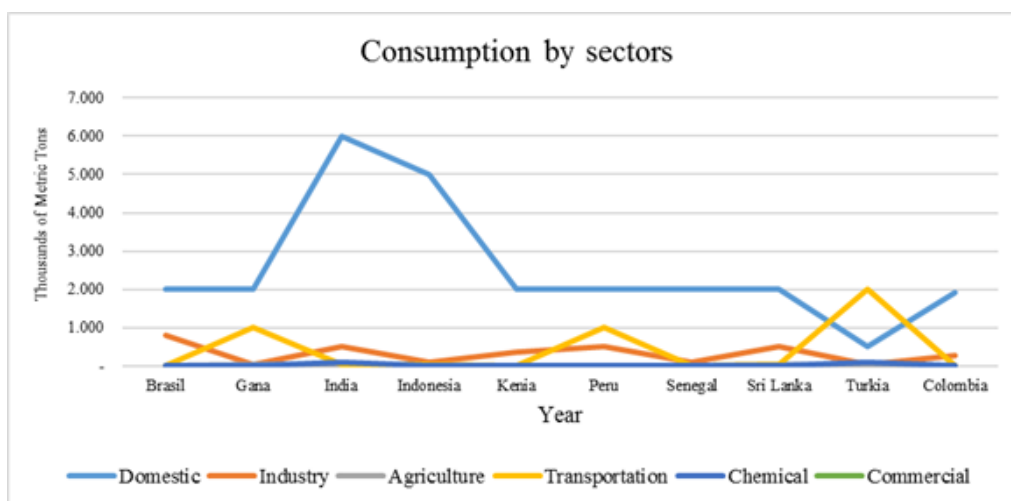


Table 5: LPG consumption by sector between 2008 and 2017 [1].

LPG consumption by sector (thousand metric tonnes)						
Country	Domestic	Industry	Agriculture	Transportation	Chemical	Commercial
Brazil	2.000	800	-	-	-	
Ghana	2.000	50	50	1.000	-	
India	6.000	500	50	50	100	
Indonesia	5.000	100	-	50	-	
Kenya	2.000	360	-	-	-	
Peru	2.000	500	-	1.000	-	
Senegal	2.000	100	-	-	-	
Sri Lanka	2.000	500	50	30	-	
Turkey	500	50	-	2.000	100	
Colombia	1.910	273	-	-	-	546

Figure 17: LPG consumption (in metric tonnes) by sector between 2008 and 2017 [1].**Table 6:** Vehicular LPG consumption [1].

Consumption of LPG as a vehicular fuel (thousand metric tonnes)																	
Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
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
Czechia	65	70	68	68	85	85	75	78	77	77	76	75	74	70	75	90	95
France	220	210	180	160	150	140	130	120	110	105	110	125	110	101	90	80	70
Germany	-	-	9	12	15	25	100	150	310	410	505	501	510	500	470	420	400
Greece	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
Italy	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
United States	710	750	740	720	740	752	770	680	600	590	310	305	410	510	480	525	620
Colombia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 18: Consumption of LPG as a vehicular fuel in thousand metric tonnes [1].

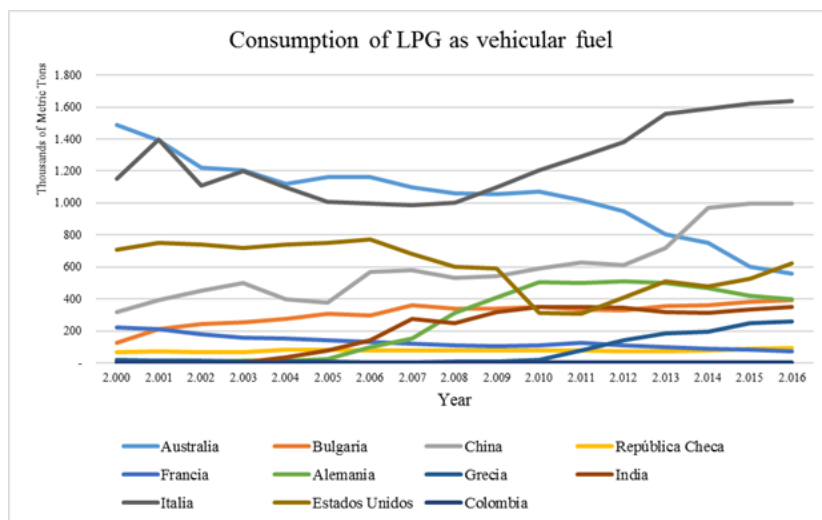
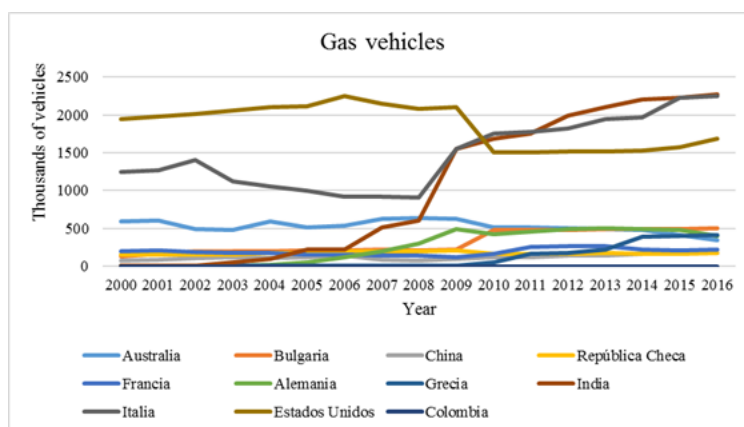


Table 7: Vehicles converted for LPG use [1].

VEHICLES CONVERTED FOR LPG USE																	
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
Czechia	155	152	150	150	170	170	195	195	195	210	165	165	165	175	168	168	175
France	200	210	185	175	175	155	150	140	140	115	165	255	260	265	220	210	215
Germany	5	7	8	10	20	55	115	200	300	490	425	455	495	500	490	485	400
Greece	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
Italy	1250	1270	1400	1125	1050	995	920	915	910	1550	1750	1775	1820	1950	1965	2225	2250
United States	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

Figure 19: Vehicles converted for LPG use consumption in thousand metric tonnes [1].



The use LPG as a vehicular fuel is summarised in Figure 18 and Table 6, further indicating the missed opportunity of the Colombian LPG market; there are no figures showing how many vehicles of the private automotive fleet or public use this this fuel. Figure 19 presents the number of vehicles converted for LPG usage according to the WLPGA Global Statistical Review report for the year 2018.

5. Conclusions

This work presents an analysis of the international and Colombian economic status of the LPG market. In Colombia, it is necessary to make visible the economic, social and environmental benefit of using LPG, and to establish plans and policies that guarantee greater fuel supply and demand, supplying unexplored markets and those not covered by other energy sources.

The demand for LPG arises from residential, industrial, agricultural, transport and commercial sectors. In Colombia, LPG demand 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, out of 27 departments that are supplied with this fuel in the country. This represents a coverage of 83 %, without evidence of a coverage of 100 % of the municipalities of the national territory, with the precedent that in Colombia, 17000barrels of propane gas are consumed every day, not covering other productive sectors of the country that are using liquid fuels with higher levels of contamination.

There is clearness about the energy needs of Colombia, and a report done by the Inter- American Development Bank (IDB), which states that they will grow by 110.3% by the year 2040, in which will require an unprecedented amount of infrastructure to support this demand. However, without leaving aside the fact that the current energy crisis in the country reflects the challenges that must be faced to support the demand in coming years. At the same time, IDB indicates the need of a plan including a significant amount of new energy infrastructure capable of meeting future needs.

If LPG is considered only as a public utility service, it cannot be guaranteed. Additionally, It can be evidenced from the fact that Ecopetrol uses huge quantities of fuel as a diluent for heavy crude oils or for internal electricity generation using the LPG it produces, and does not release the fuel for distribution in households. Increased national supply to avoid shortage problems in Colombia is desirable.

A comparison of the national and international LPG production and consumption shows that the LPG sector within Colombia has a low market share compared with countries such as Brazil, the United States, India and Indonesia. The contribution of the sector to the country's economy is low and not competitive, despite having favourable environmental characteristics. Energy is being made available to the domestic, industrial and commercial sectors without considering the agricultural, chemical and transport sectors. Accordingly, urgent intervention is required to make this fuel competitive within the basket of liquid fuels, so that it provides an alternative energy source and is established using a public policy sector structure to supply a market and satisfy social and economic needs.

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