AREAS ADVERTISEMENT 2022

Geological Habitat prospectivity socio-environmental and economic sustainability and wet gas (LPG) in Colombia as energy transition fuel

June 3, 2022

Geological Habitat, Prospectivity, Socio-Environmental and Economic Sustainability of Wet Gas (LPG) in Colombia as an Energy Transition Fuel

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Problem Statement

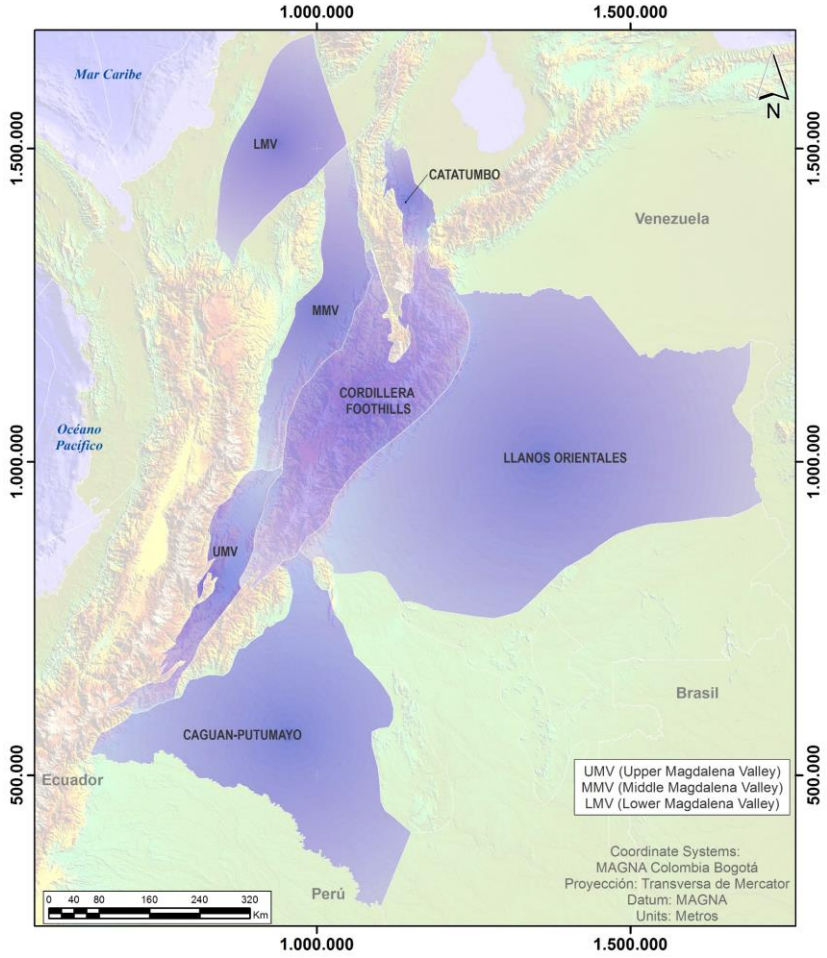
- Colombia has incorporated LPG in its energy basket.
- This is a fossil fuel considered as an energy transition fuel. This represent 2% of the total energy used in the country. This fuel is very important for the residential consumption, especially more than three million households belonging to social strata 1 and 2.
- Currently, the country has lost self-sufficiency in the supply of LPG due to different factors:
  1) Absence of gas discoveries with high volumes of wet gas during last decade
  2) Lack of infrastructure oriented to the separation of wet gas in oil fields
  3) Instabilities and decrease in the supply of Ecopetrol (main producer of wet gas in Colombia)

Research questions

1. What are the main factors controlling the socio-environmental and economic sustainability of the LPG business in Colombia?
2. What is the geological habitat that controls the wet gas accumulations already discovered in the country?
3. What is the geological and petroleum systems model that controls the accumulation of wet gas in the Cusiana, Cupiagua area where the largest wet gas production is found?
4. Which are the most prospective areas for LPG exploration in the basins with commercial hydrocarbon production?
5. What is the volume of wet gas prospective resources to be discovered?

Basins to be analysed and methodology used

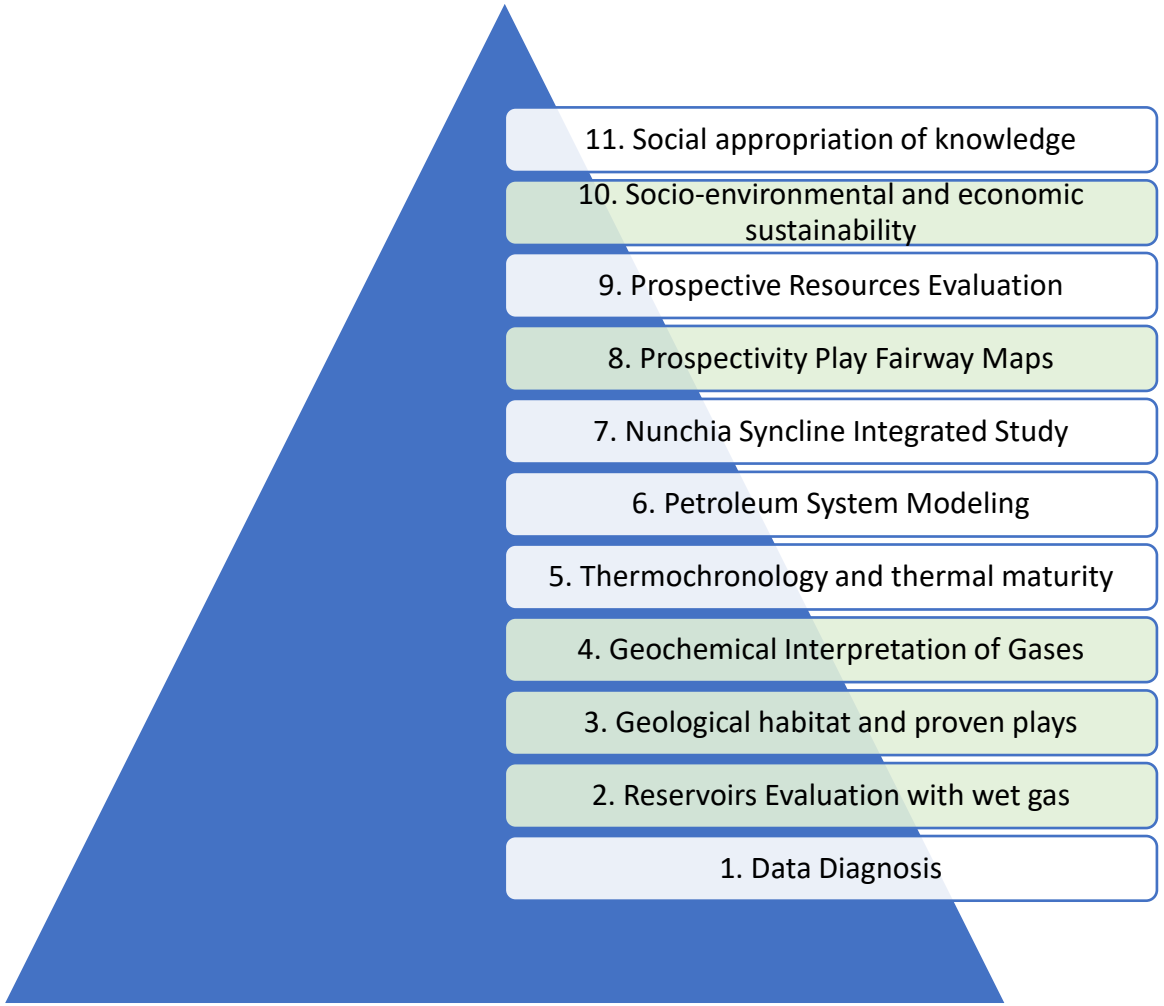
Basins With Hydrocarbons Commercial Production



Location Map
Evaluated Basins

Conventions

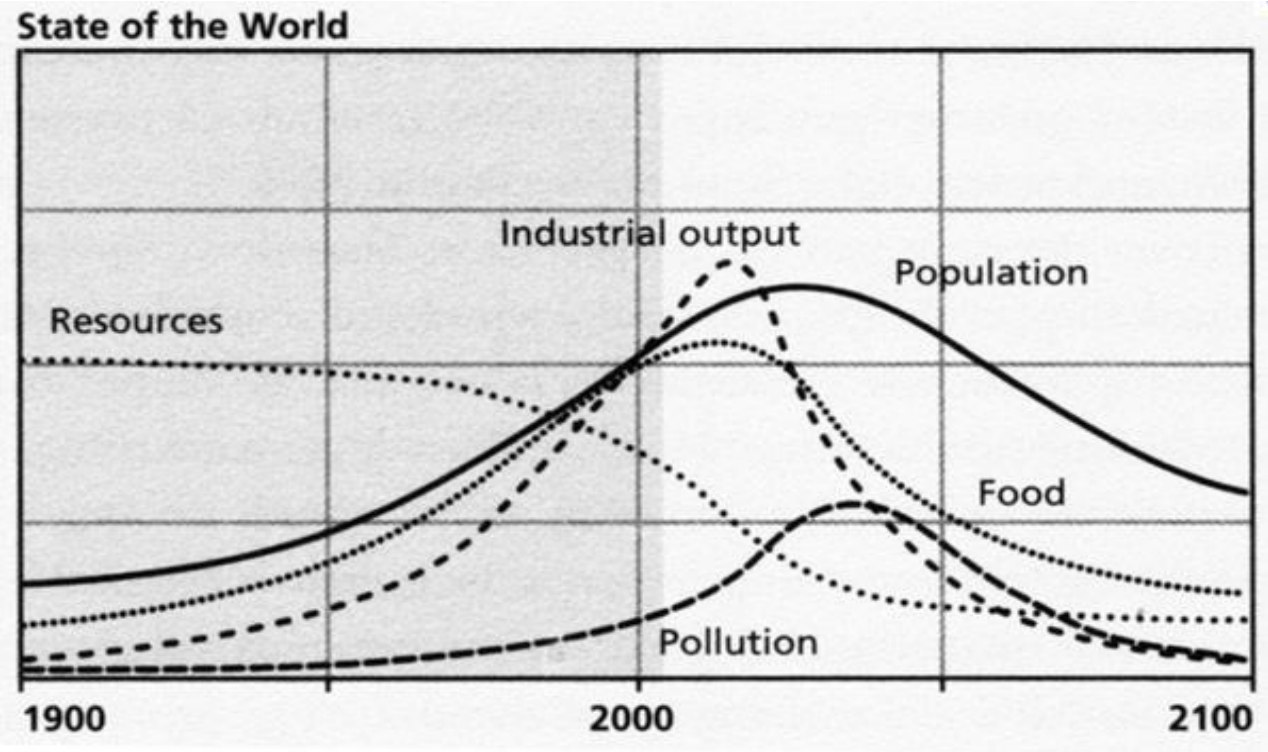
Basins



Current Talk

Sustainability: ¿What are we talking about?

- The limits to growth (1972)
- Modeling economic growth in a finite resource planet.



Meadows, D. H., & Randers, J. (2013)

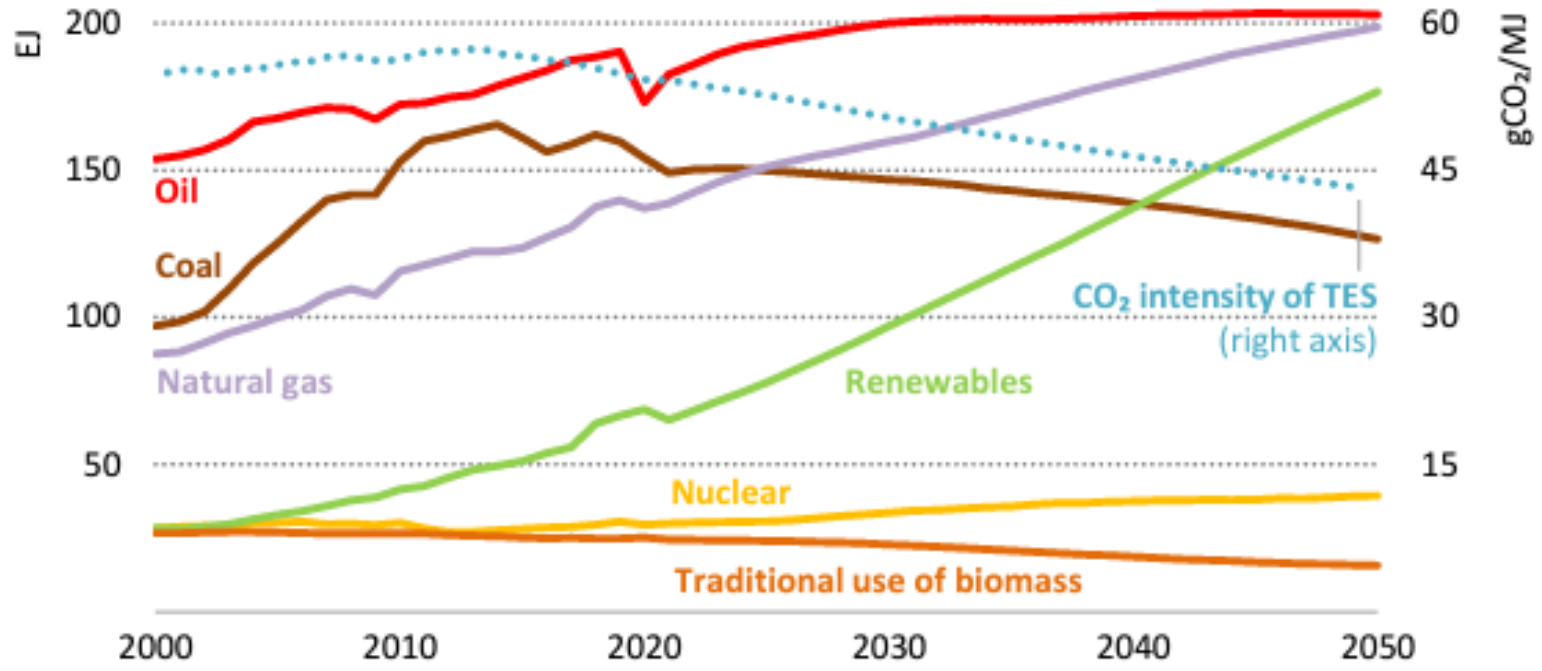
The Brundtland definition of sustainable development: "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs“ (1987)

Criteria for sustainability measure

- 1. Reduction of GHG emissions
- 2. Reduction of pollutants in earth and water surfaces
- 3. Reduction of the depletion of natural resources
- 4. Progress towards OSD
- 5. Security and sovereignty

Sustainable Energy: The scenarios for the middle term

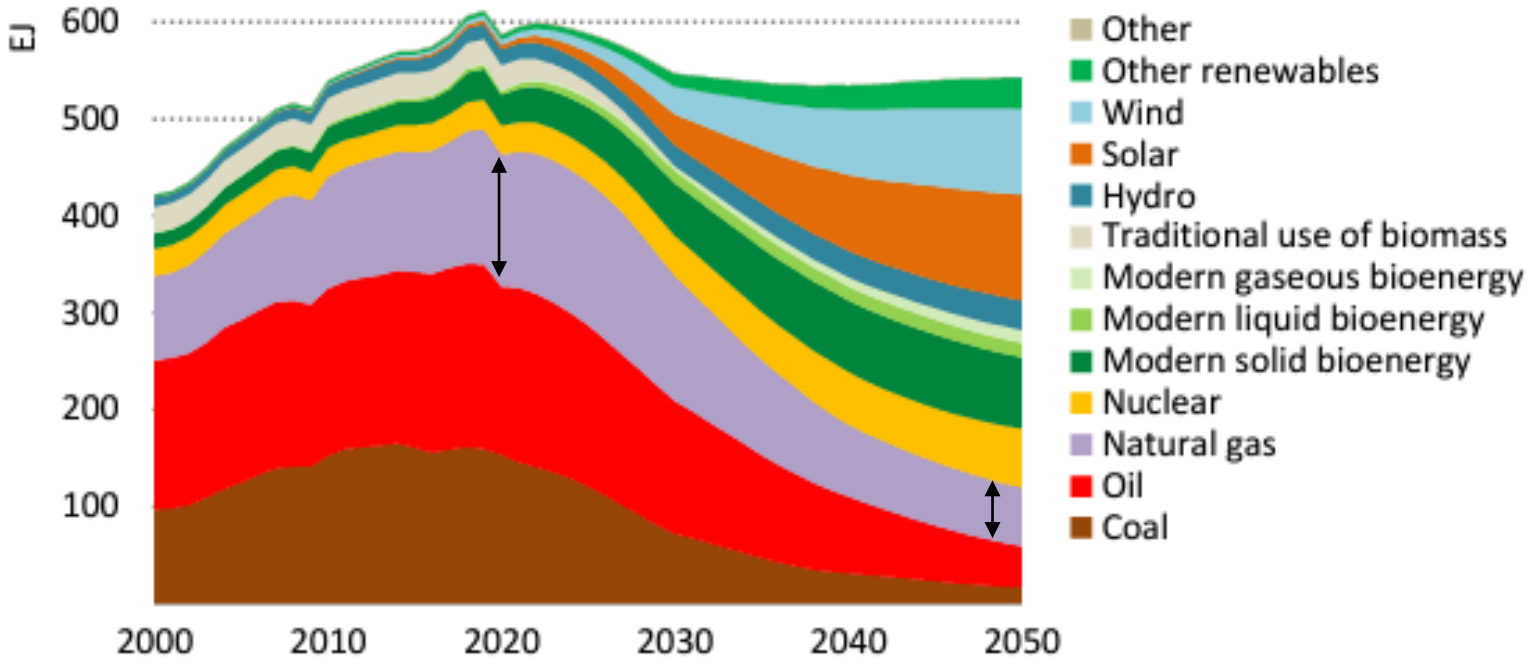
(IEA STEPS SCENARIO) TOTAL ENERGY SUPPLY and CO2 intensity



(IEA,2021)

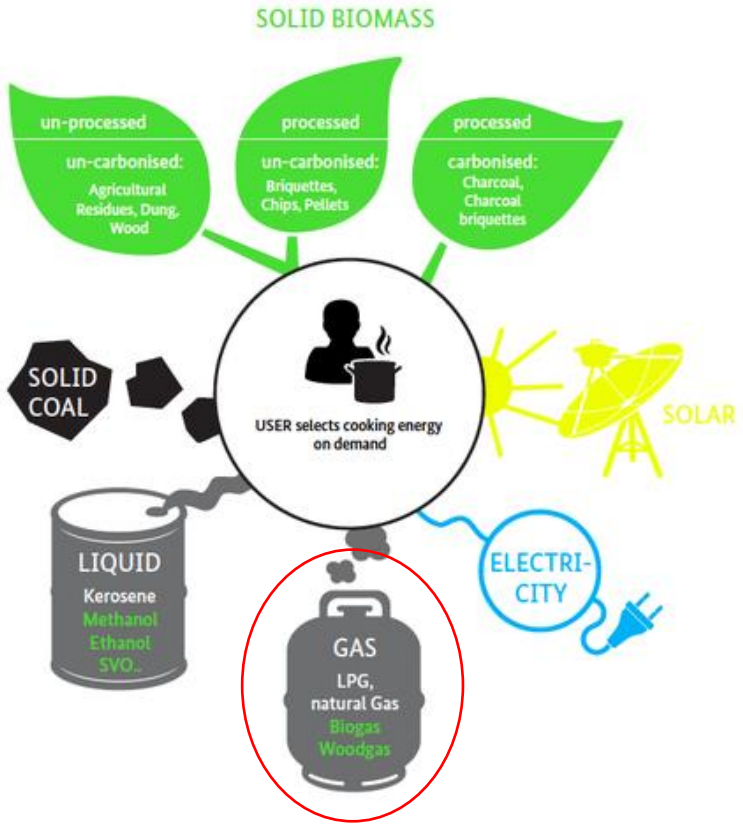
Sustainable Energy: The scenarios for the middle term

IEA (NET ZERO SCENARIO) TOTAL WORLD ENERGY SUPPLY



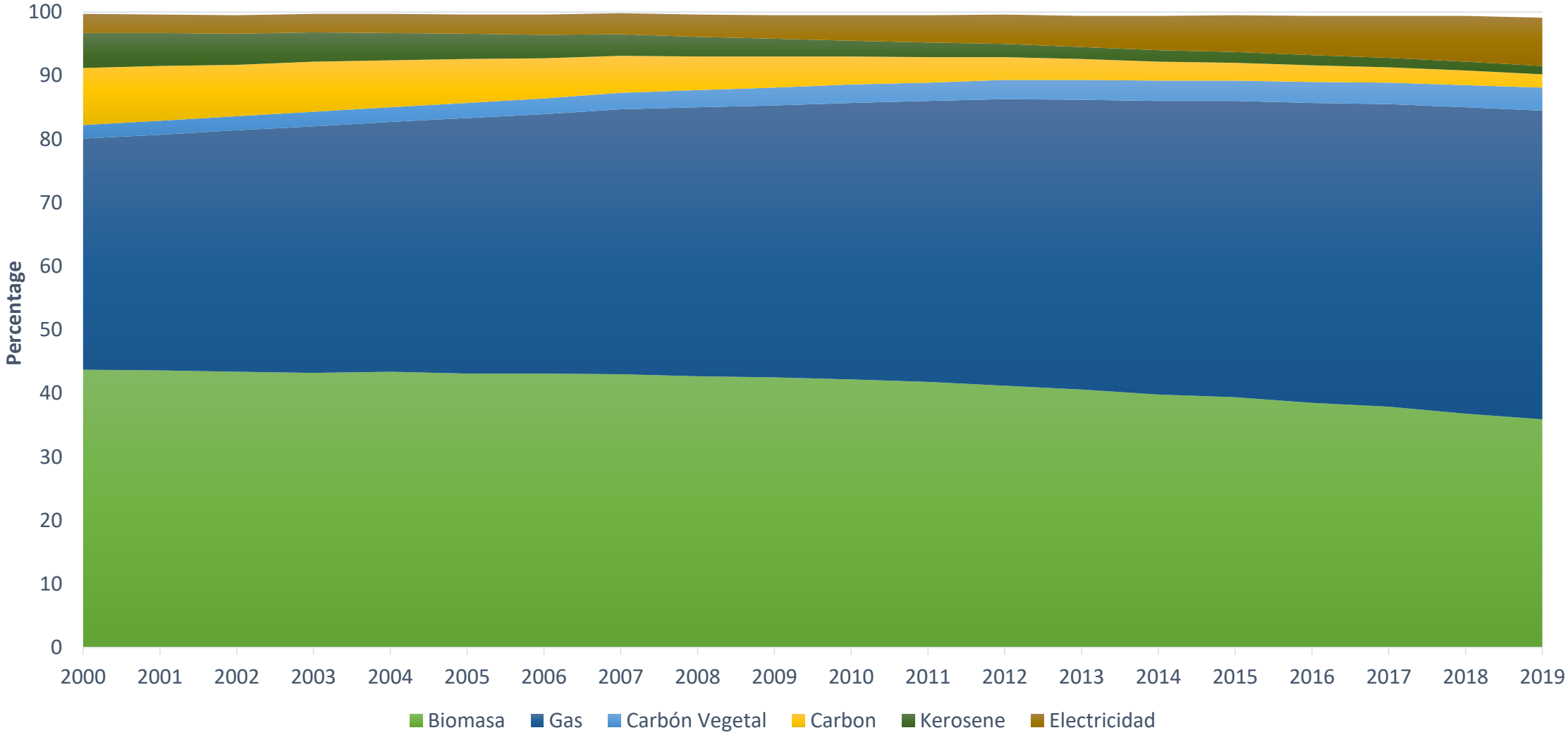
(IEA,2021)

LPG: ¿Sustainable transition fuel?



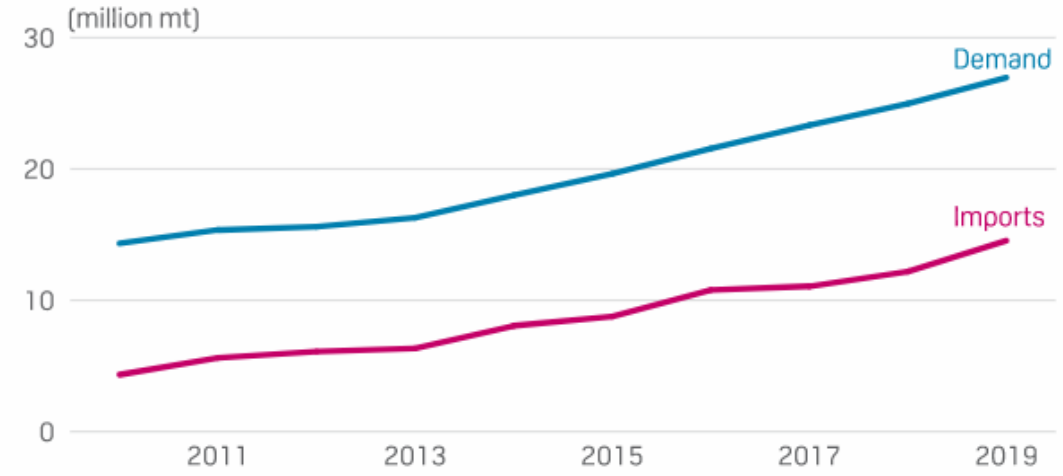
- 1. Cooking Fuel for low-income Households as replacement for traditional Biomass.
- 2. Transportation fuel as replacement for petrol (diesel).
- 3. Replacement for coal in industrial energy uses.
- 4. Heating for rural houses

COOKING FUEL WORLD SUPPLY



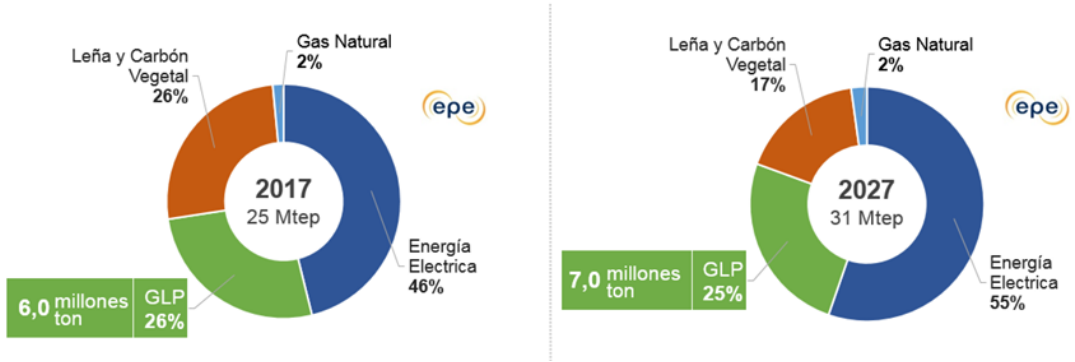
Data from (WHO,2021)

INDIA'S LPG CONSUMPTION AND IMPORT GROWTH TREND



Source: Petroleum Planning and Analysis Cell

Brazil Residencial Energy Matrix



ENERGY POLICY AND SUSTAINABILITY

OBJETIVOS DE DESARROLLO SOSTENIBLE

7 ENERGÍA ASEQUIBLE Y NO CONTAMINANTE

Plan Nacional de Desarrollo 2018 - 2022

Pacto por Colombia pacto por la equidad

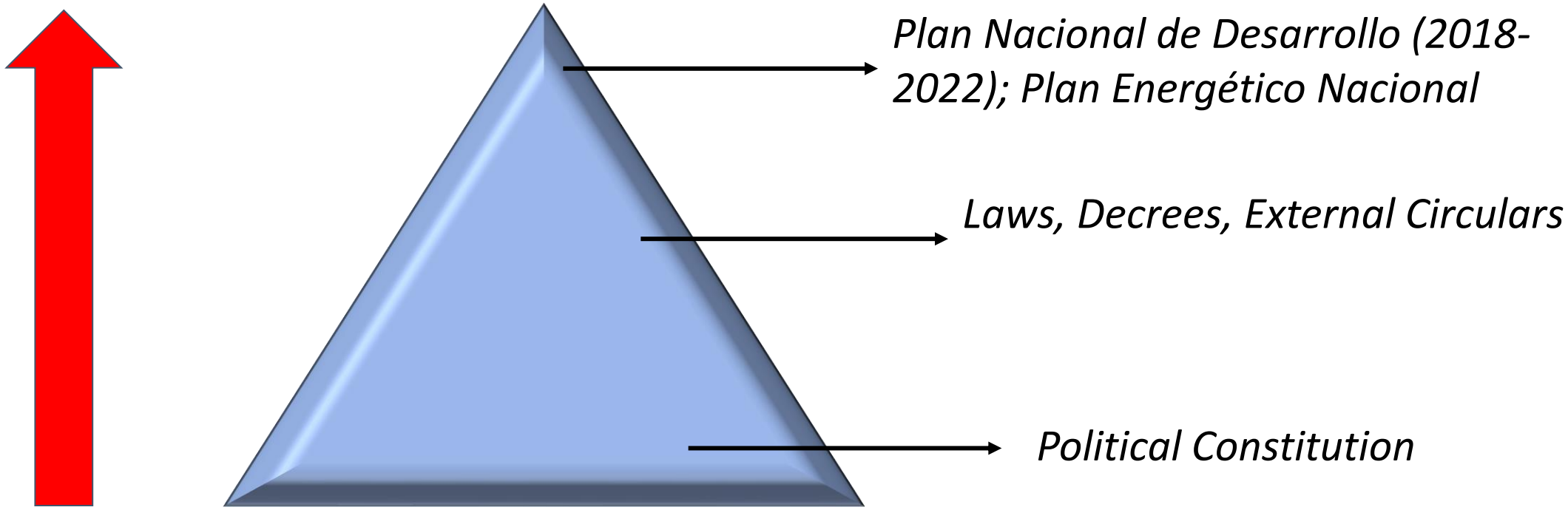
CMNUCC

Emission Reduction
Energy Access
Energy Efficiency

LPG

Reduction Scenarios 20%/30% GEI

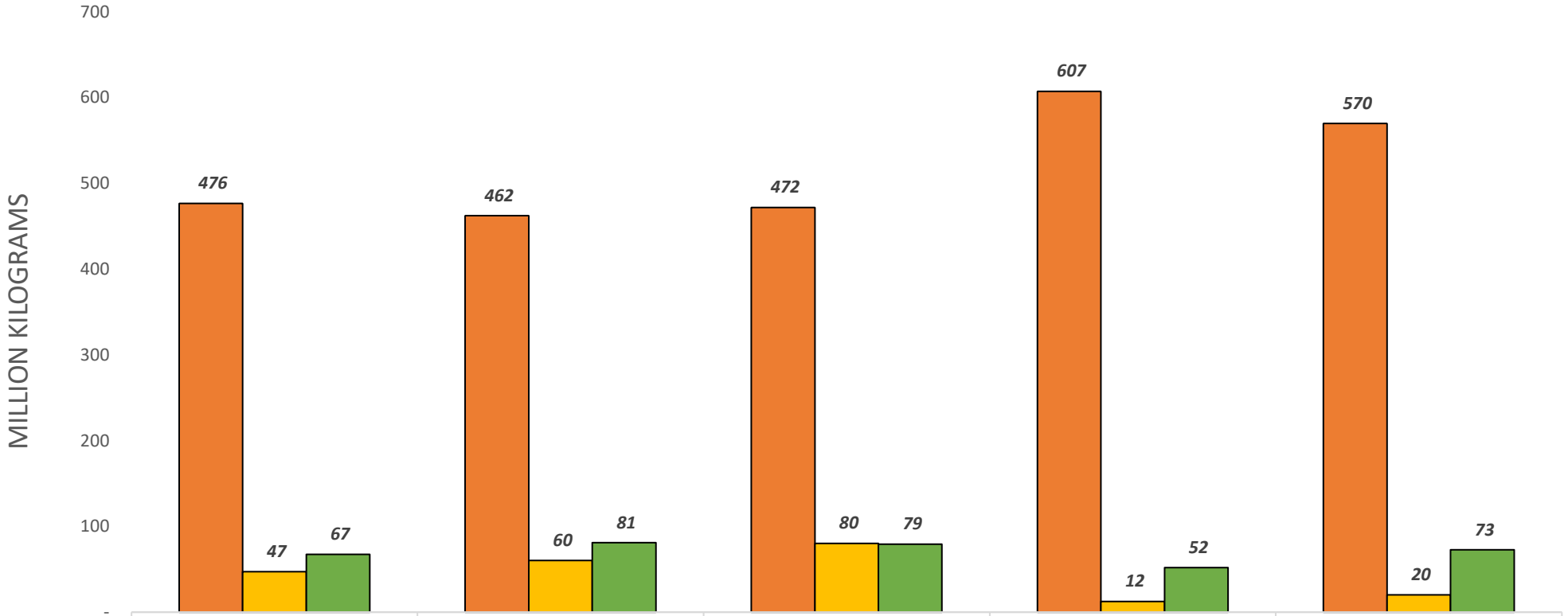
LPG IN COLOMBIA: REGULATION



LPG IN COLOMBIA: REGULATION HIGHLIGTHS

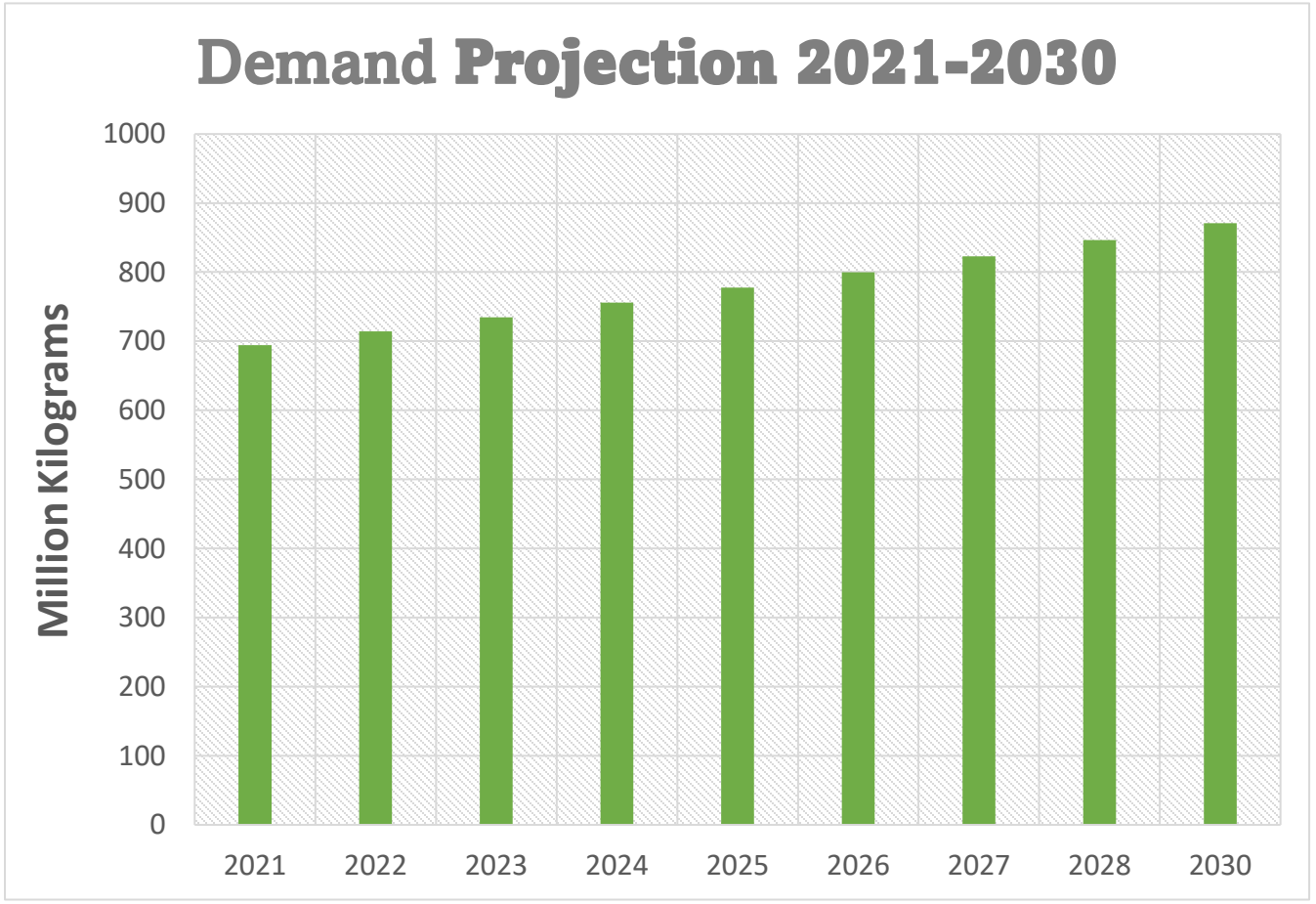
- 1. LPG is a public domiciliary service regulated by Ley 142 de 1994.
- 2. Price regulation because of dominant position of Ecopetrol.
- 3. The distribution, transport and commercialization of LPG its subject to a regulated competition.
- 4.Since 2017 there is a regulation for AUTOGLP and NAUTIGLP, for using LPG as a fuel for cars and boats in the country.

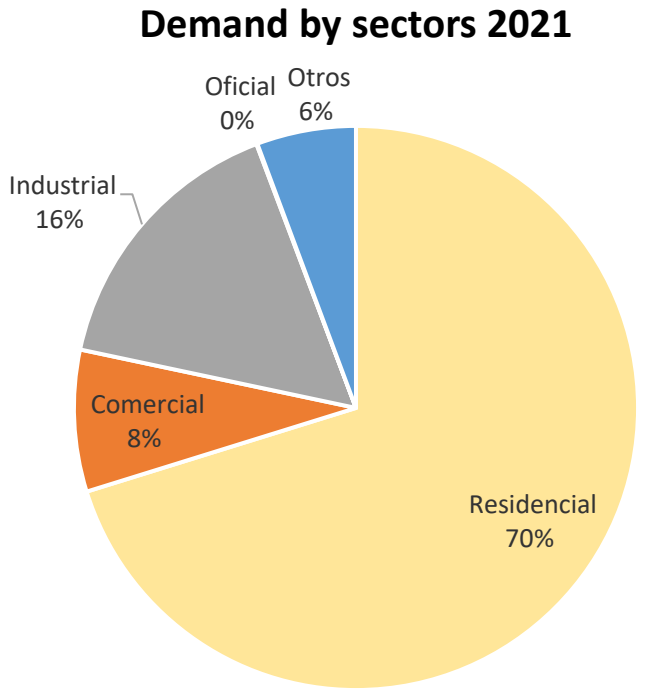
GLP SUPPLY (COLOMBIA 2017-2021)



	2017	2018	2019	2020	2021
Ecopetrol	476.350.091	462.145.046	471.754.467	607.127.893	569.694.873
Import	47.193.483	60.261.507	80.104.496	12.361.449	20.182.166
Other producers	67.380.359	80.886.000	79.307.403	52.033.125	72.575.622

Data from (GASNOVA,2022)





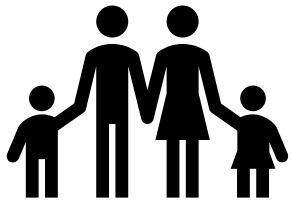
Data from (GASNOVA,2022)

LPG IN COLOMBIA: SOME FINAL CONSIDERATIONS

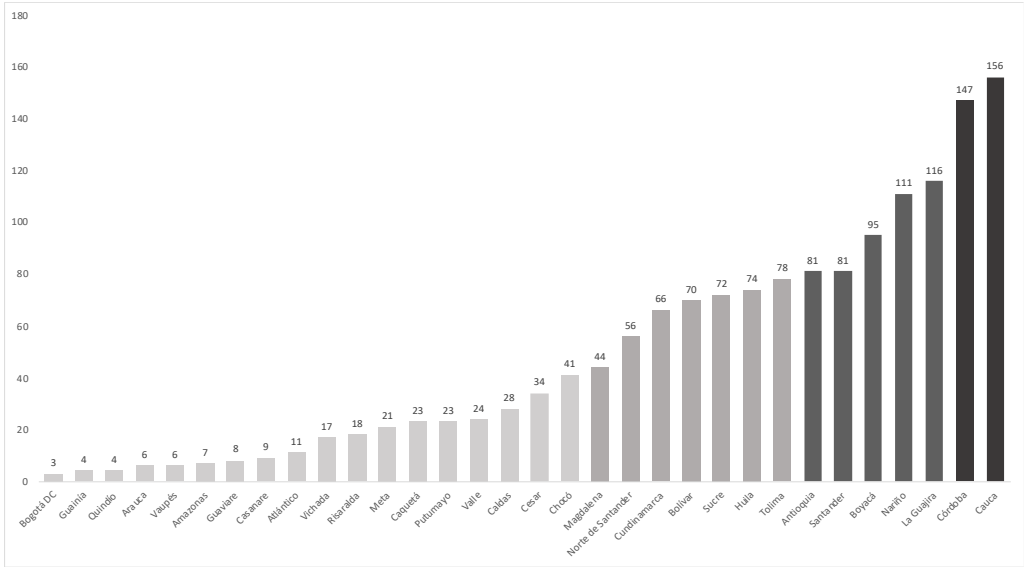
- 1. 6.5 million people use LPG as their main fuel for cooking in Colombia, the security of the supply is crucial.
- 2. The demand is expected to grow, and with new incentives from reduction of GHE emissions it is possible that the growth will be even bigger than the expected.
- 3. The programs for replacing biomass for secure and cleaner fuels for cooking will also rise the demand for LPG in the country.
- 4. How are we going to guarantee the supply?

SOCIO-ENVIRONMENTAL SENSITIVITY ANALYSIS

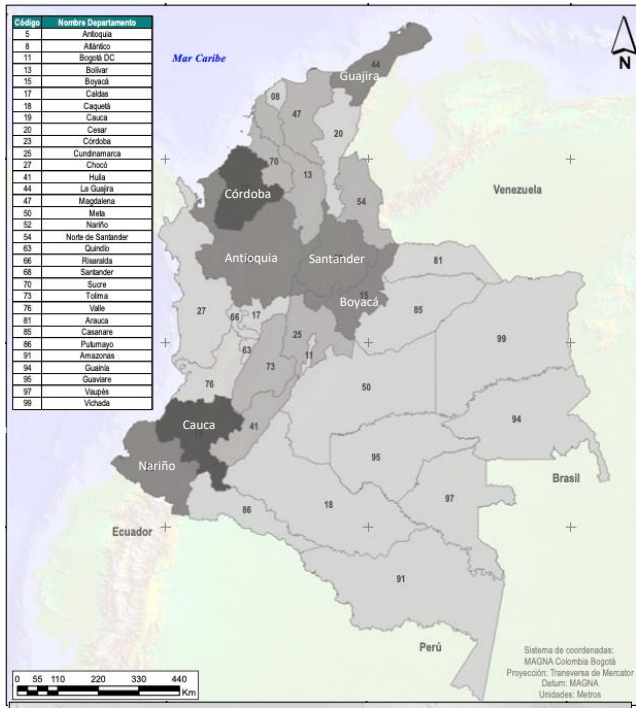
1.664.000 Households



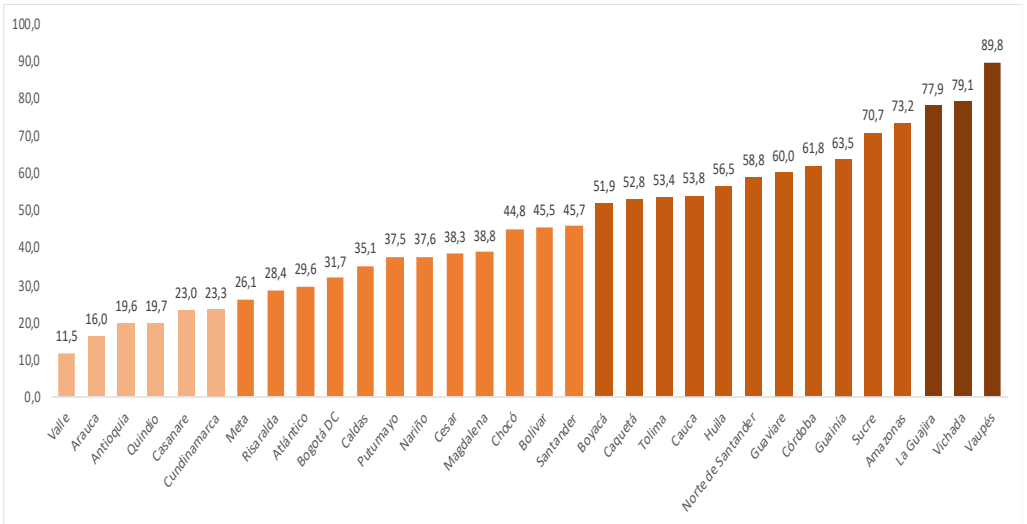
of rural households that cook with firewood (thousands)



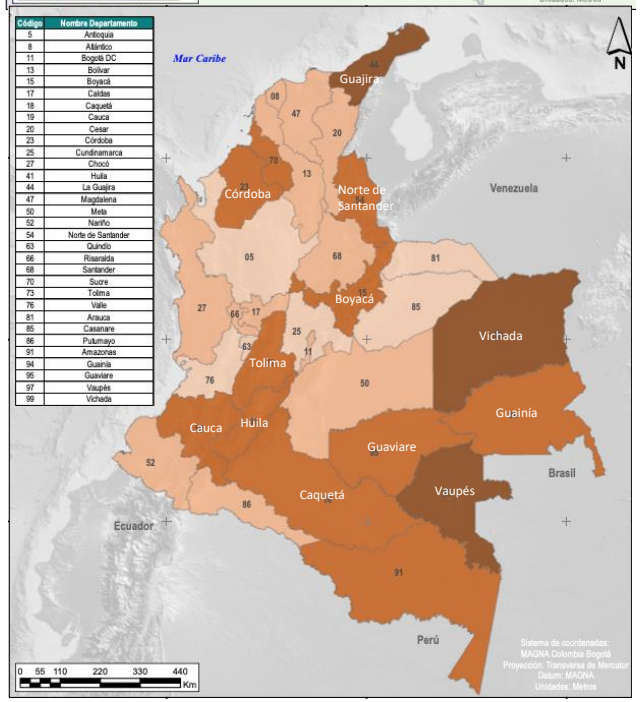
Fuente: Elaboración Propia con base en ENCV (2018)



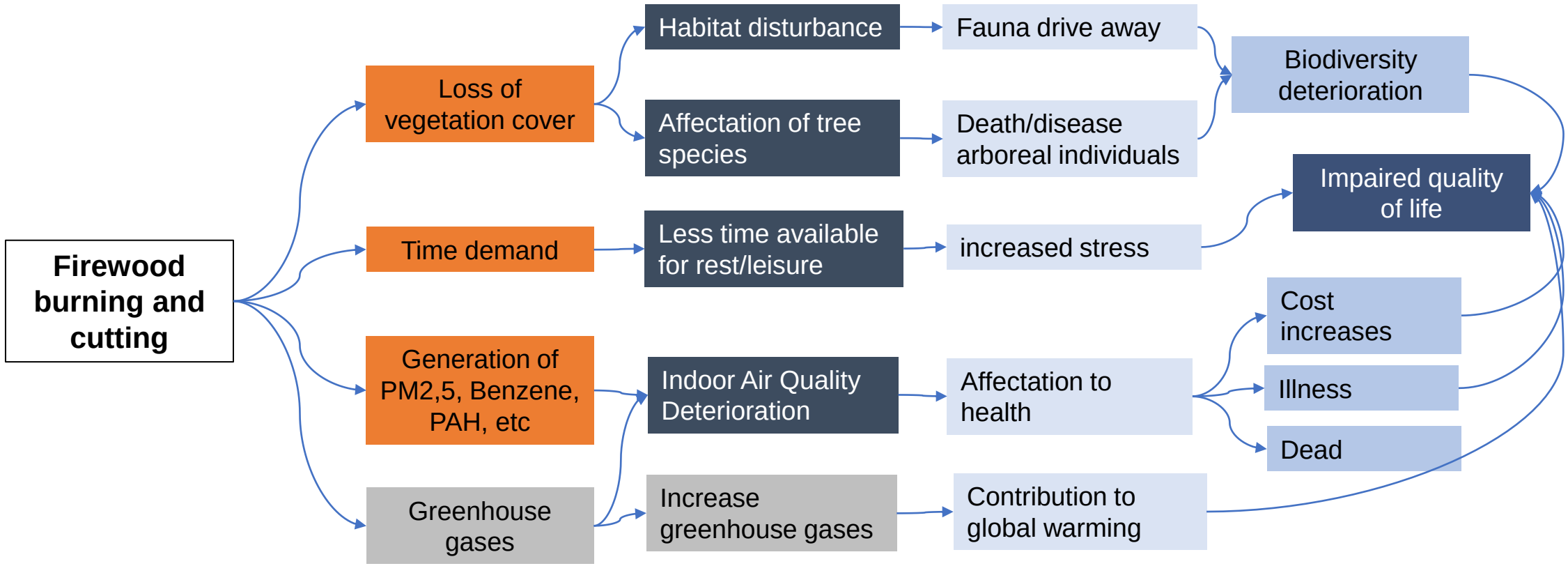
% of rural households that cook with firewood



Fuente: Elaboración Propia con base en ENCV (2018)



Socio-environmental impacts of firewood burning

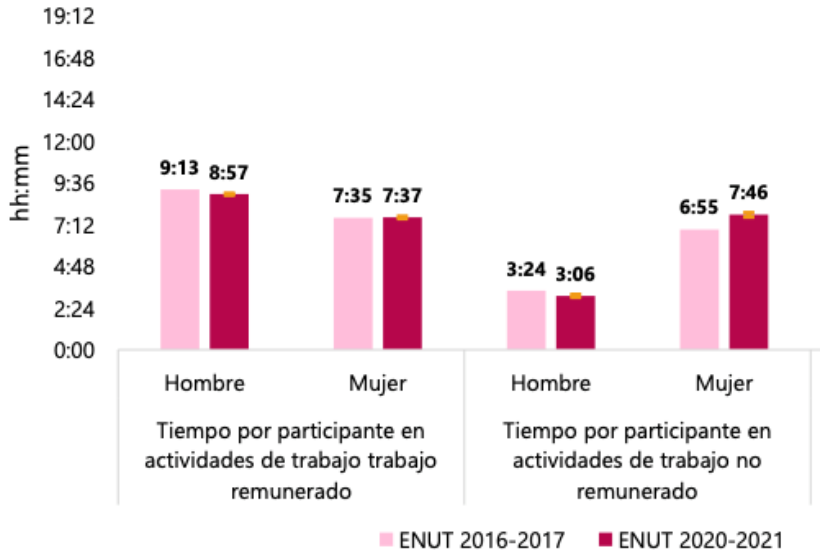


Socio-environmental impacts of firewood burning

6.123.000 ton/year

Loss of vegetation cover

Average diary time per participant in paid and unpaid work



Fuente: DANE, ENUT.

Increased demand for time for unpaid work

Socio-environmental impacts of firewood burning

Health

WHO, 2022

- 3.8 million deaths every year as a result of household exposure to smoke
- Increase risk for: heart disease, stroke, chronic obstructive pulmonary disease, cancer and pneumonia.

Colombia

- 1,000 people die from intramural contamination due to cooking food with firewood and charcoal (MADS, 2015).
- 50% of pneumonia deaths in children under 5 years are related to household air pollution (UPME, 2019)

LPG

Cleaner: doesn´t produce smoke, PM2.5, PAH, Sulfur…

Faster and more efficient

Less greenhouse emissions…

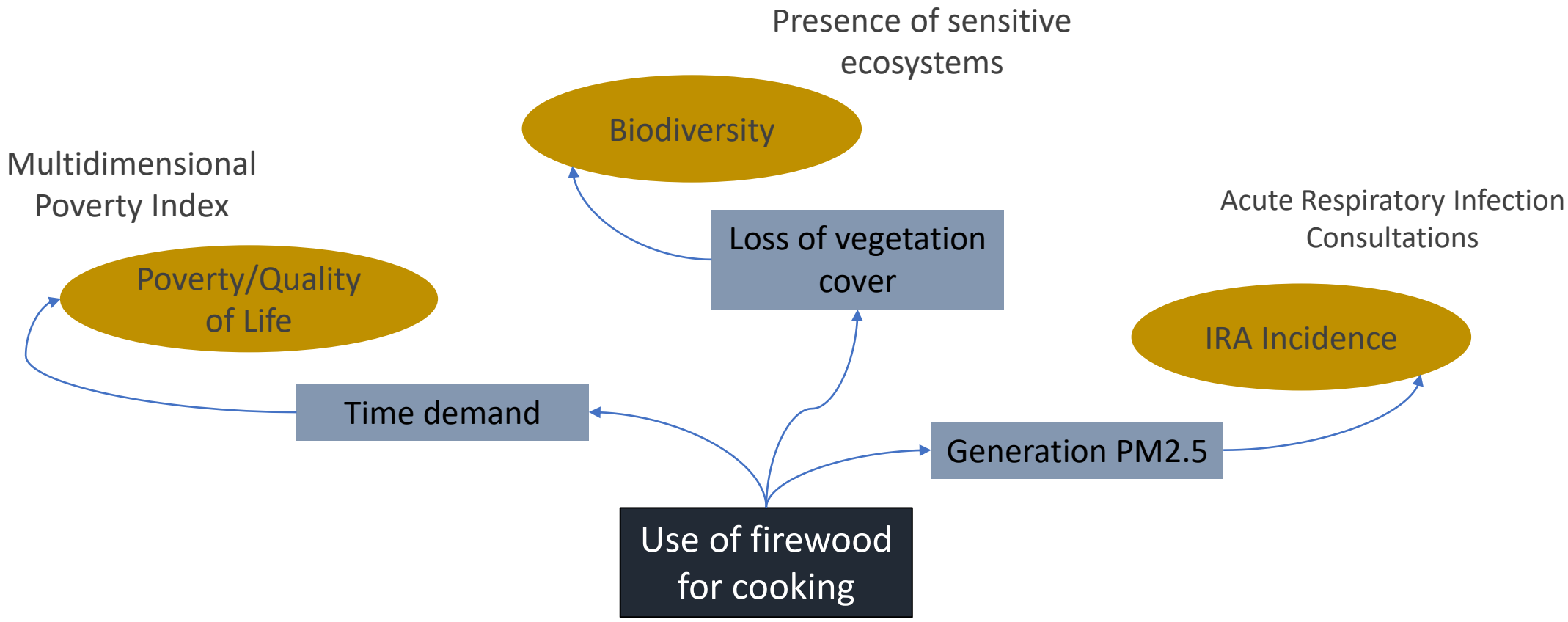
Does not degrade the forest

SOCIO-ENVIRONMENTAL SENSITIVITY ANALYSIS

Objective

Analyze the socio-environmental sensitivity of each of the areas of possible impact in a proposal to replace firewood with LPG in the residential sector as a way to prioritize territorially

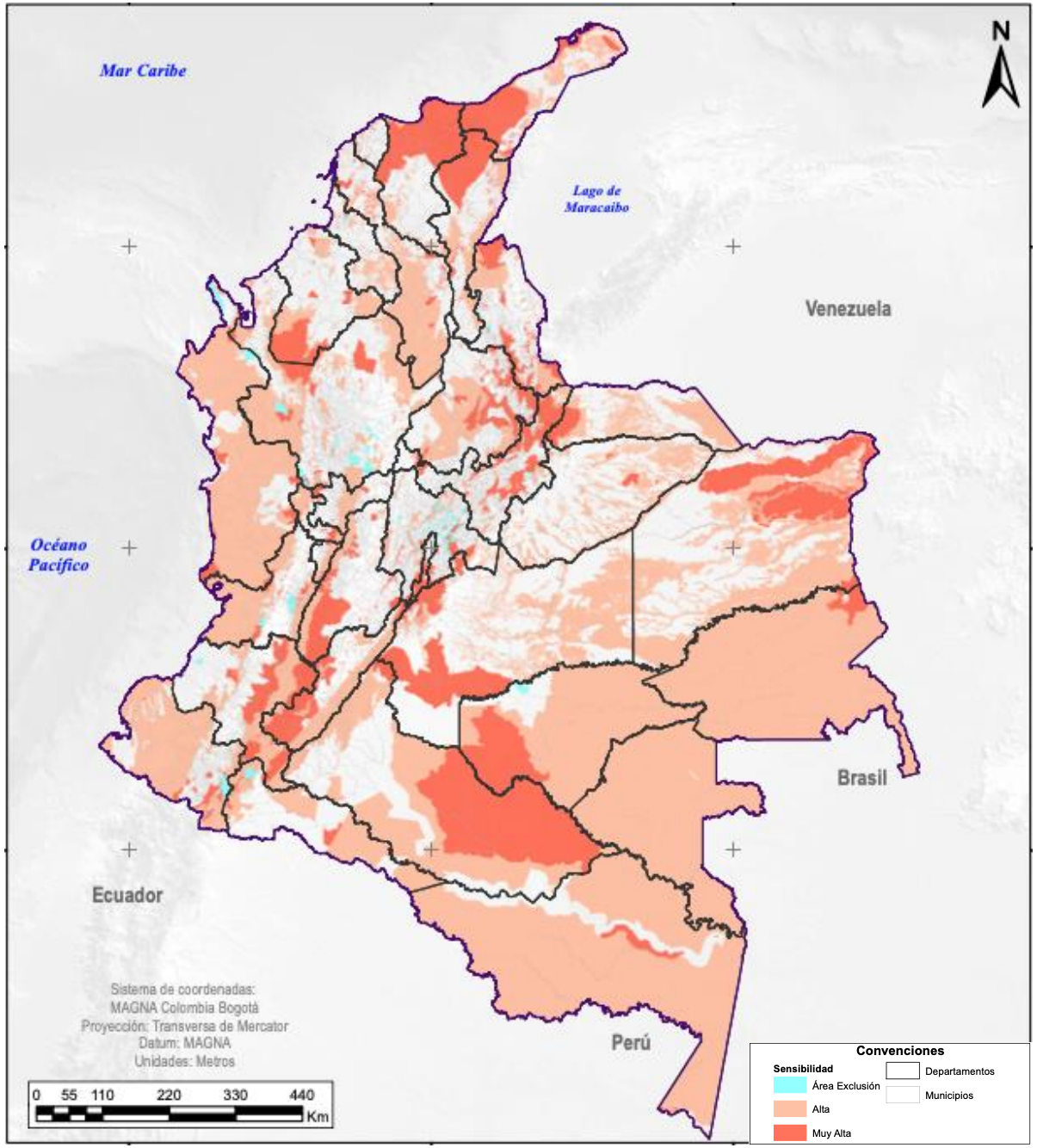
Main Socio-Environmental Impacts / Territorial Factors



Loss of vegetation cover

Impact on Biodiversity

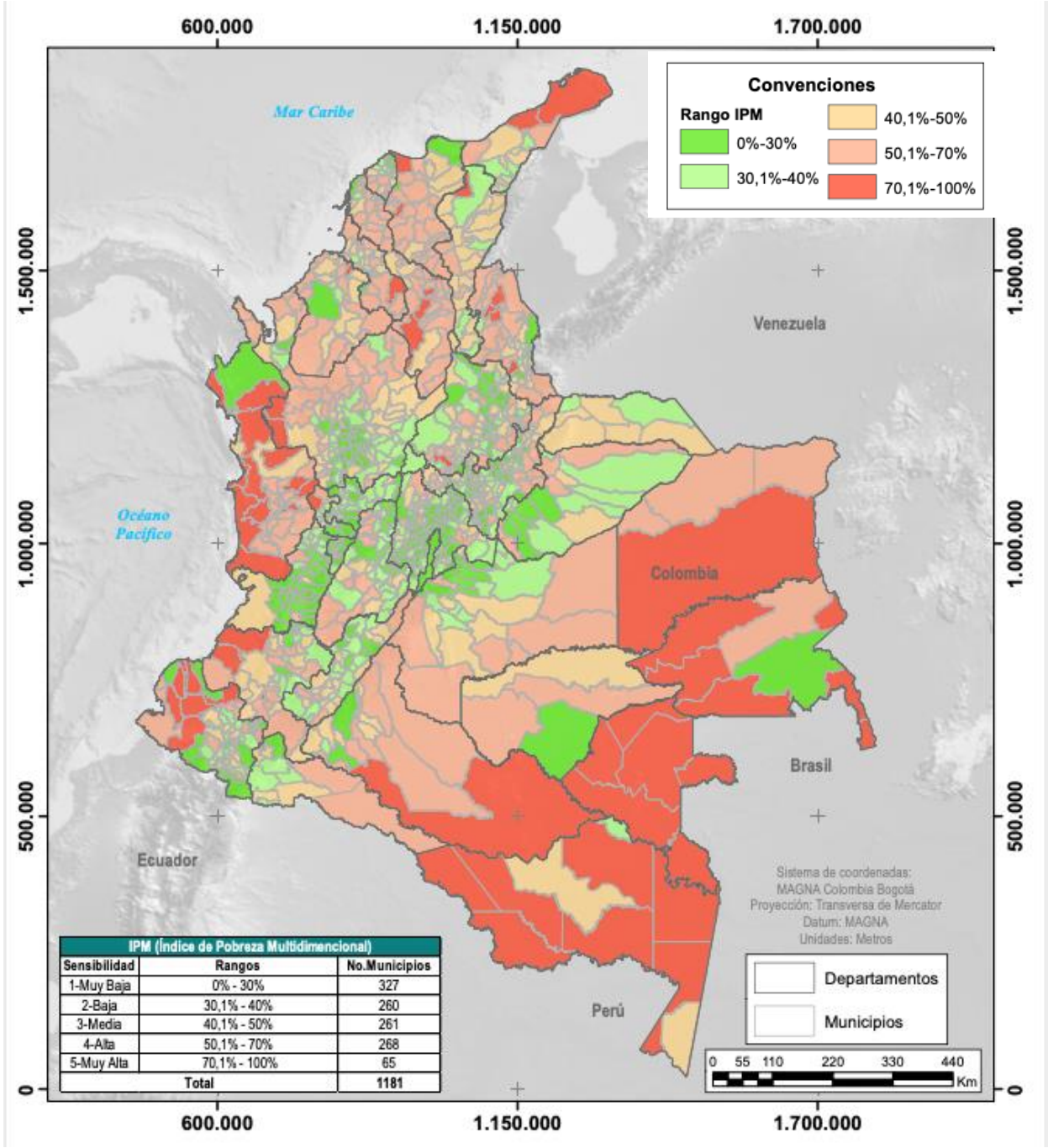
Presence of sensitive ecosystems



Time demand

Poverty/Quality of Life

Multidimensional Poverty Index

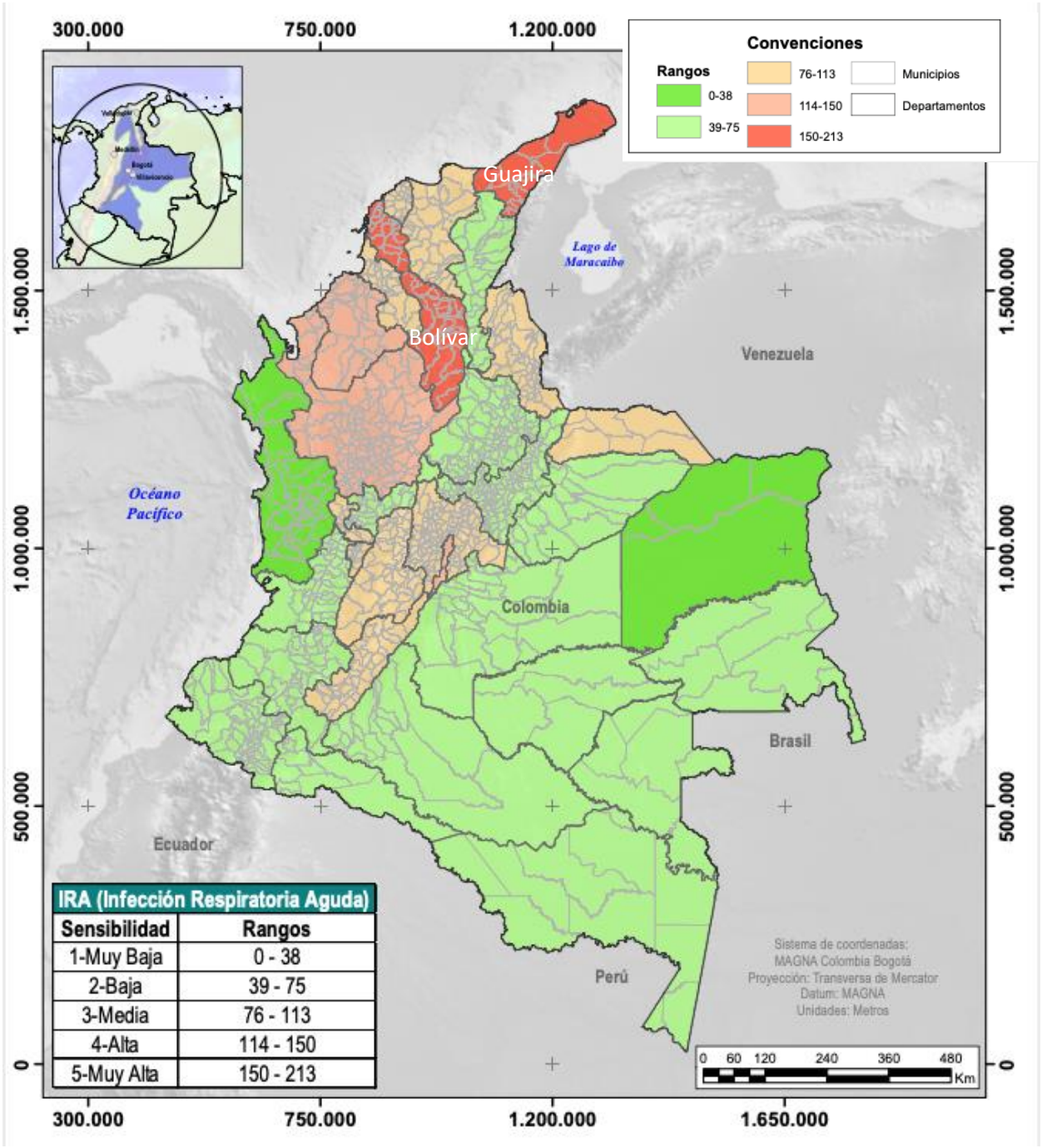


IPM (Índice de Pobreza Multidimencional)		
Sensibilidad	Rangos	No.Municipios
1-Muy Baja	0% - 30%	327
2-Baja	30,1% - 40%	260
3-Media	40,1% - 50%	261
4-Alta	50,1% - 70%	268
5-Muy Alta	70,1% - 100%	65
Total		1181

Generation of PM 2.5

IRA Incidence

Acute Respiratory Infection Consultations

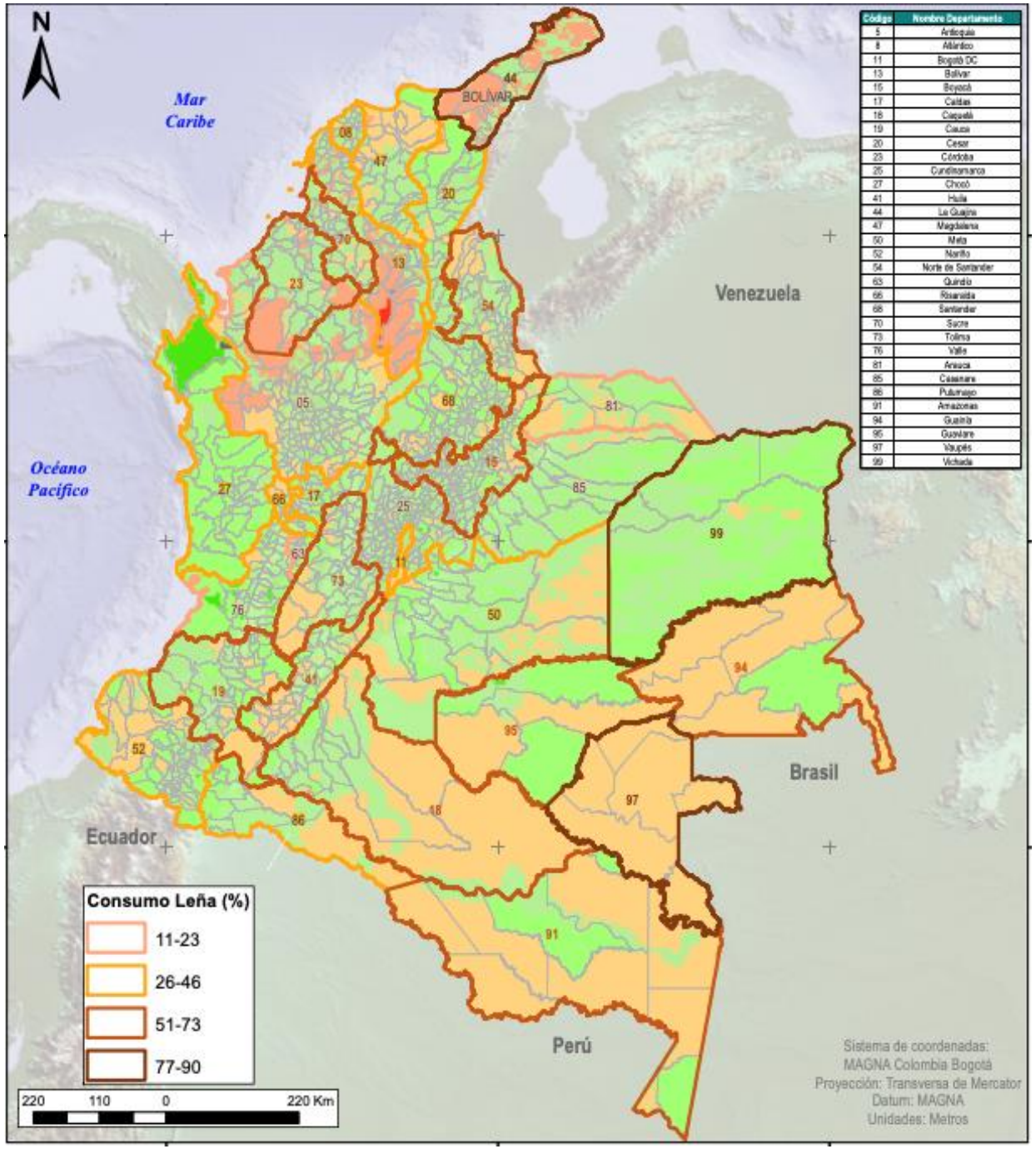


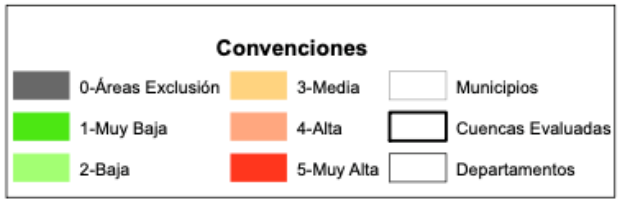
Integrated Sensitivity Indicator

Equation of socio-environmental sensitivity integrated to the combustion of firewood

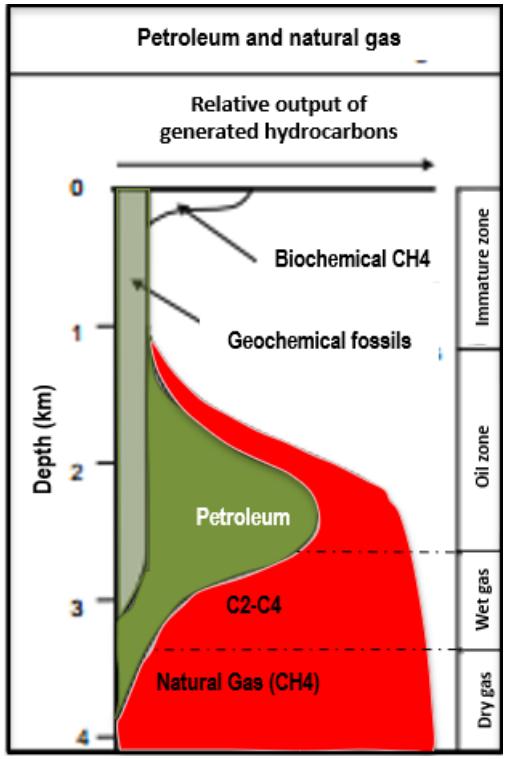
STCL= (IPM*3 + IRA*5 + ES*2)/10

STCL: territorial sensitivity to wood combustion
MPI: Multidimensional Poverty Index
IRA: Acute respiratory diseases
ES: Presence of Sensitive Ecosystems





Introduction



Composition Of A Production Gas

Hydrocarbons

- % CH4 gas (molar) (dry base) 47,82% → Gas Natural
- %C2H6 gas (molar) (dry base) 3.22% → Plastics industry
- %C3H8 (molar) (dry base) 2.46%
- %C4's (molar) (dry base) 2.85%

Wet or Rich Gases -LPG - Propane and Butane

- %C5's (molar) (dry base) 13.61% → Liquid -Polystyrene Industry
- %C6's (molar) (dry base) 2.18%
- %C7's (molar) (dry base) 0.38%
- %C8's (molar) (dry base) 0.09%
- %C9's (molar) (dry base) 0.01%
- %C10's (molar) (dry base) 0.01%

Liquids -Nafta-Gasoline

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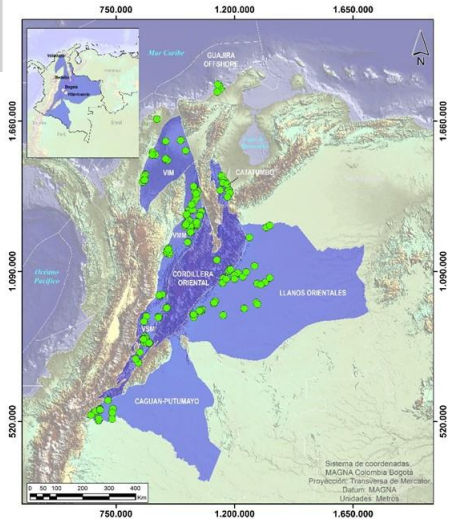
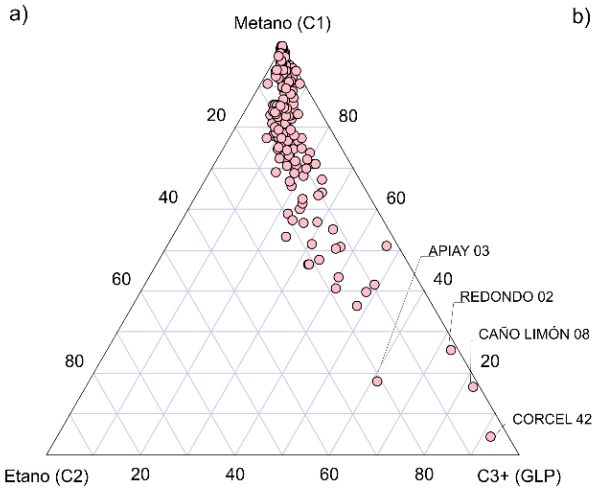
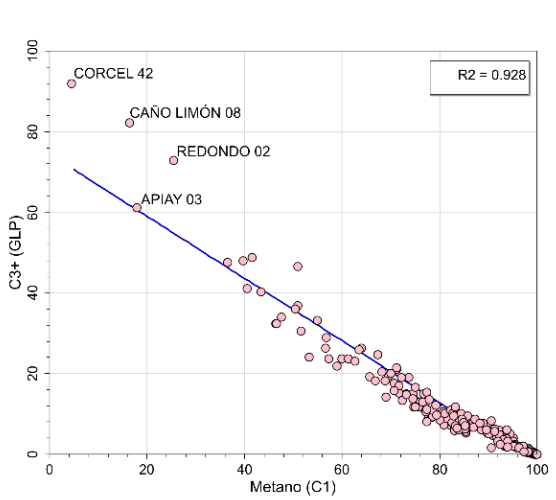
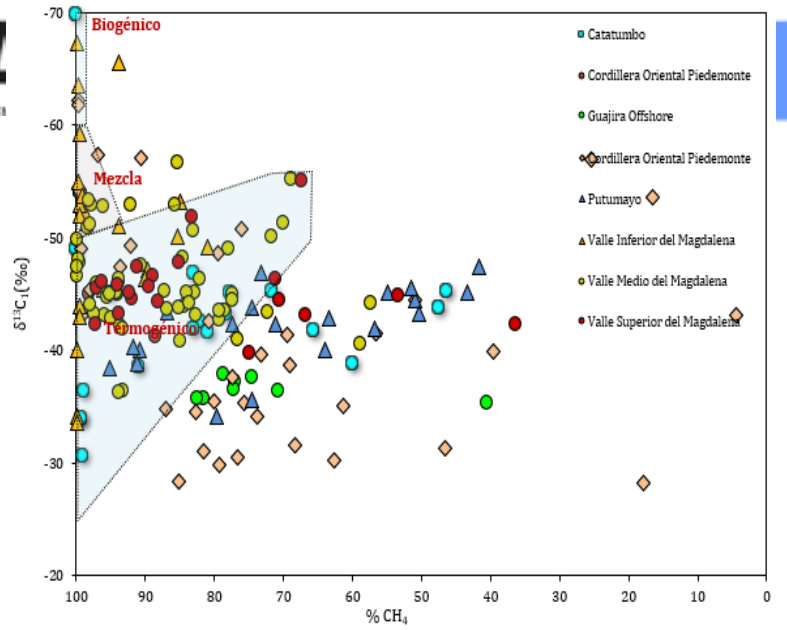
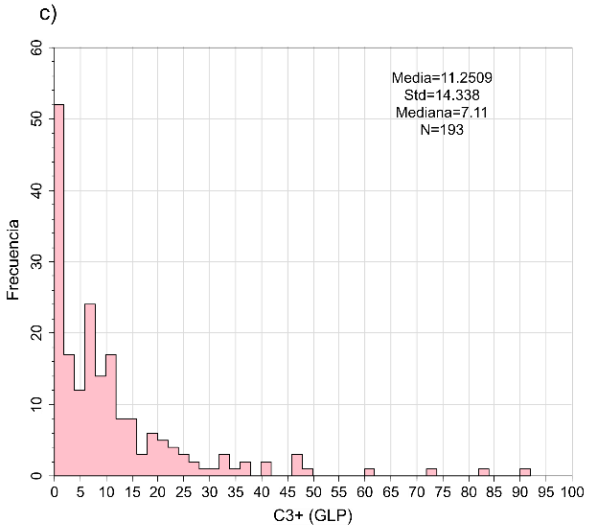
Colombia Gas Geochemistry

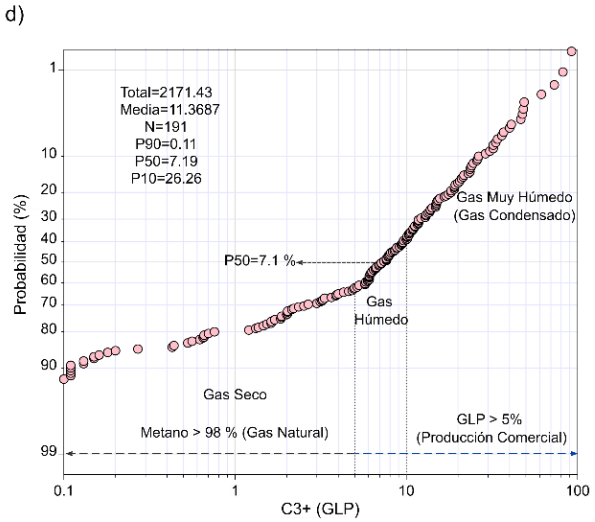


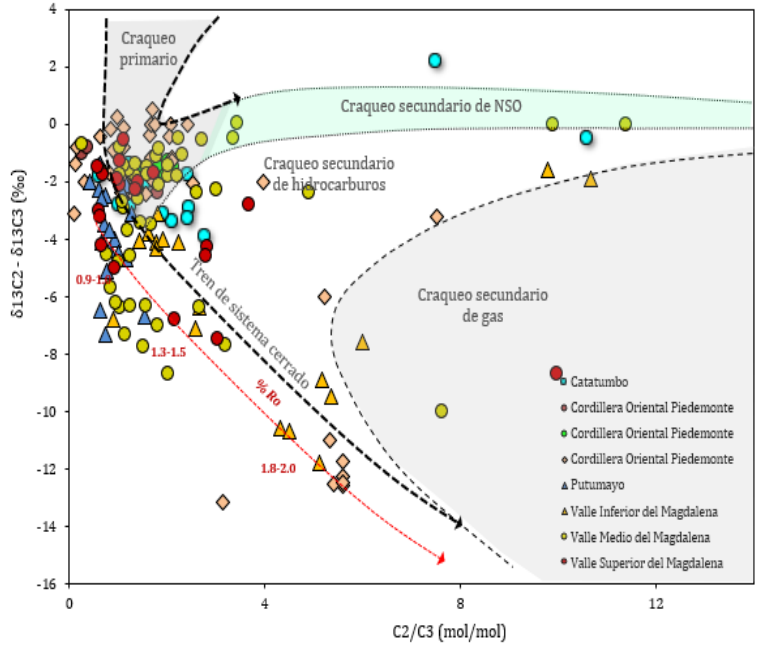












- 193 samples
- LPG range = 1-92%
- Pmean = 1.9 %
- 65% of the analyzed wells have more than 5% LPG
- LPG Probability P50 = 7.1 %

The evidence indicates that LPG contents higher than 4% can already be profitable

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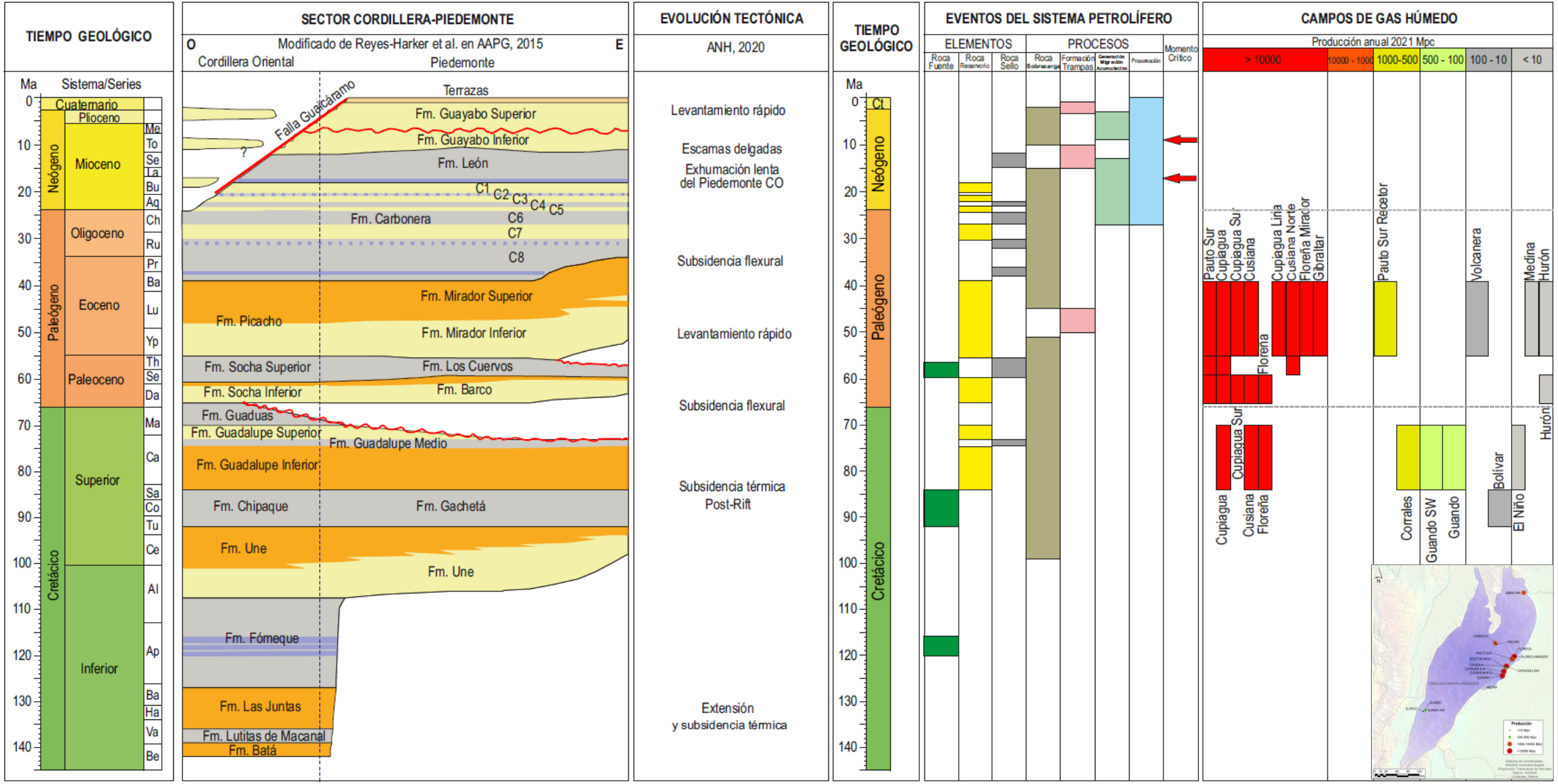
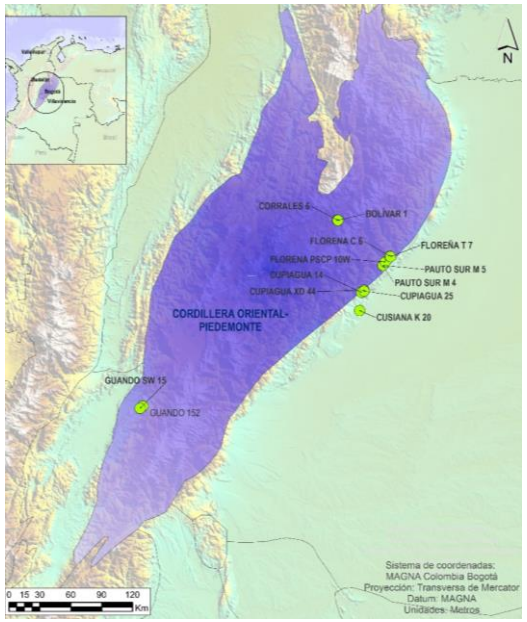
LPG Geological Habitat Chart – CO-Foothills

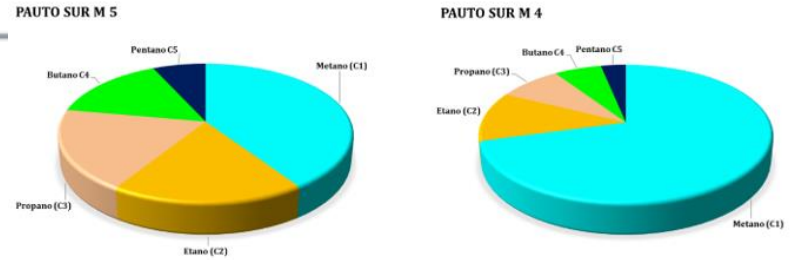
ANH | El futuro es de todos | Minenergía

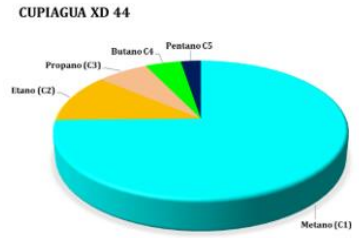


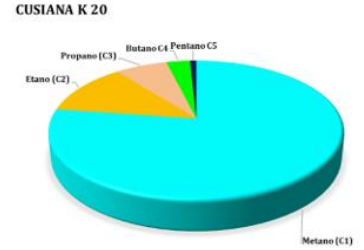
Cordillera & Foothills / Gas Geochemistry

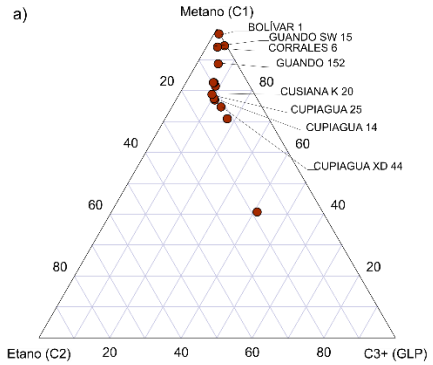


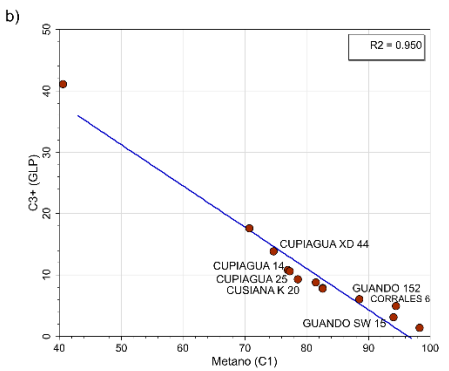
- LPG range = 1 - 41%
- Pmean = 11 %
- 82% of the analyzed wells have more than 5% LPG
- LPG Probability P50 = 8.8 %

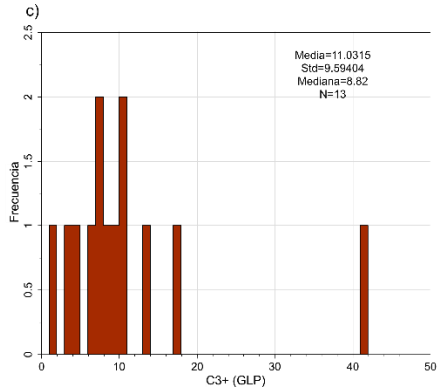


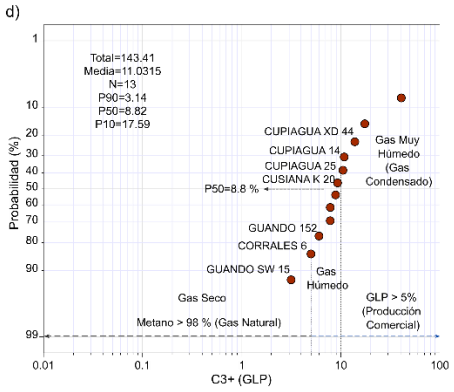












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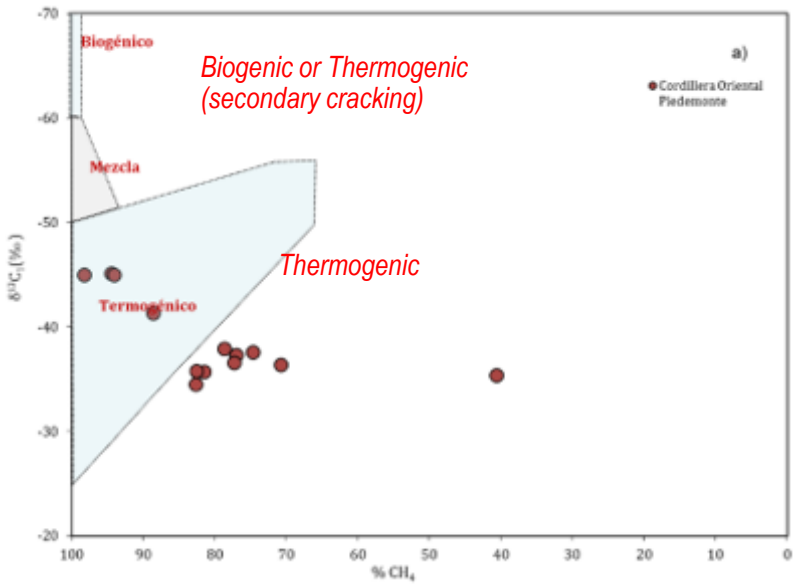
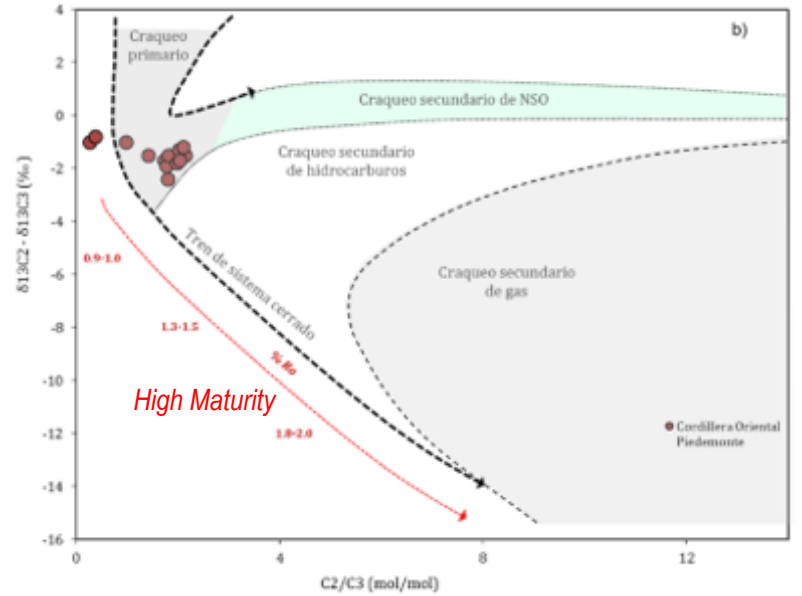
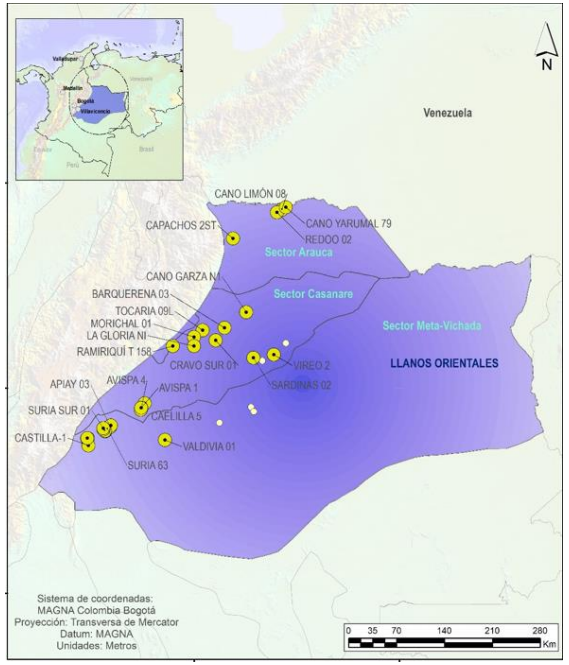
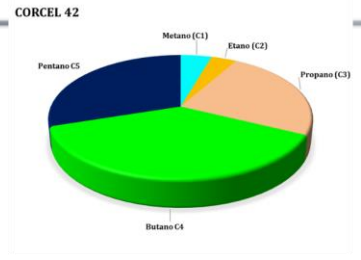


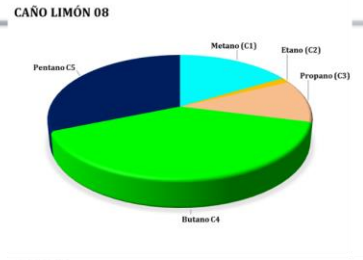


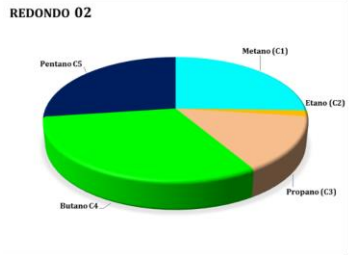
Llanos Orientales

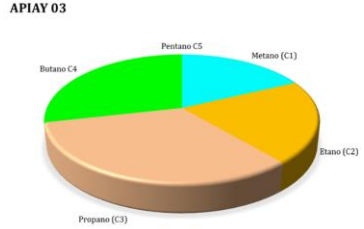


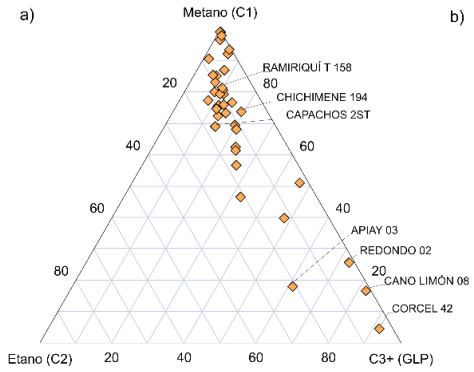
- LPG range = 1 - 92%
- Pmean = 20 %
- 85% of the analyzed wells have more than 5% LPG
- LPG Probability P50 = 11.8 %

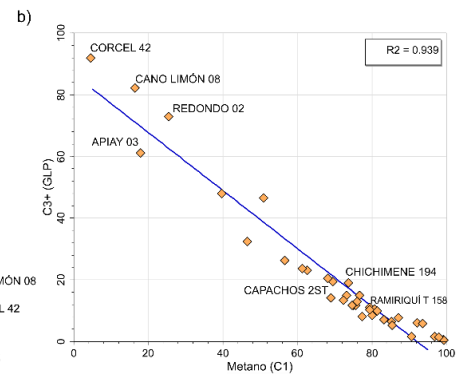


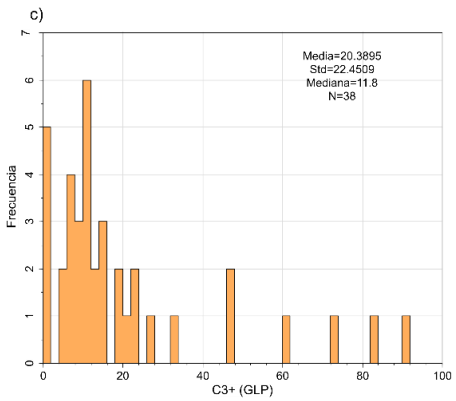


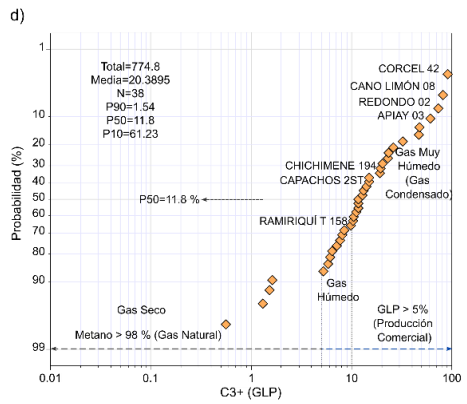


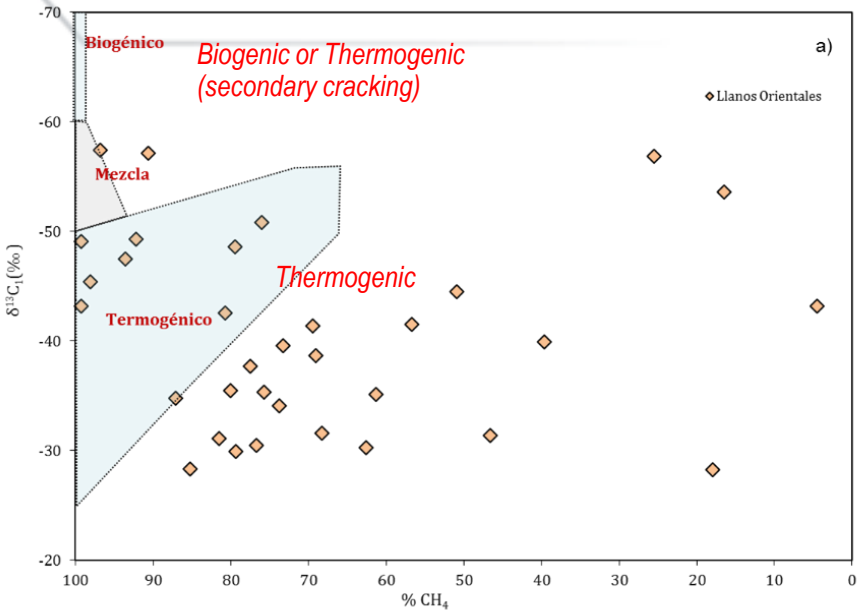


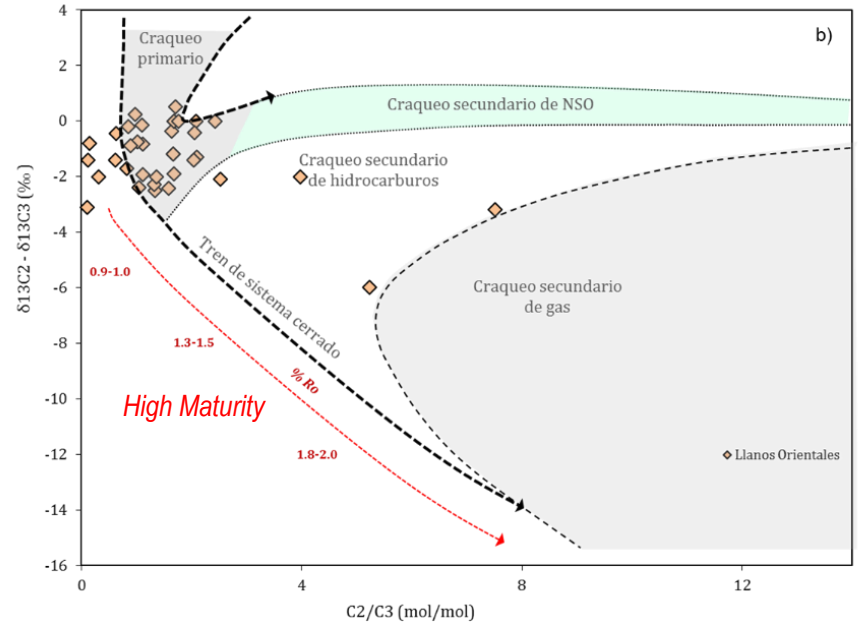




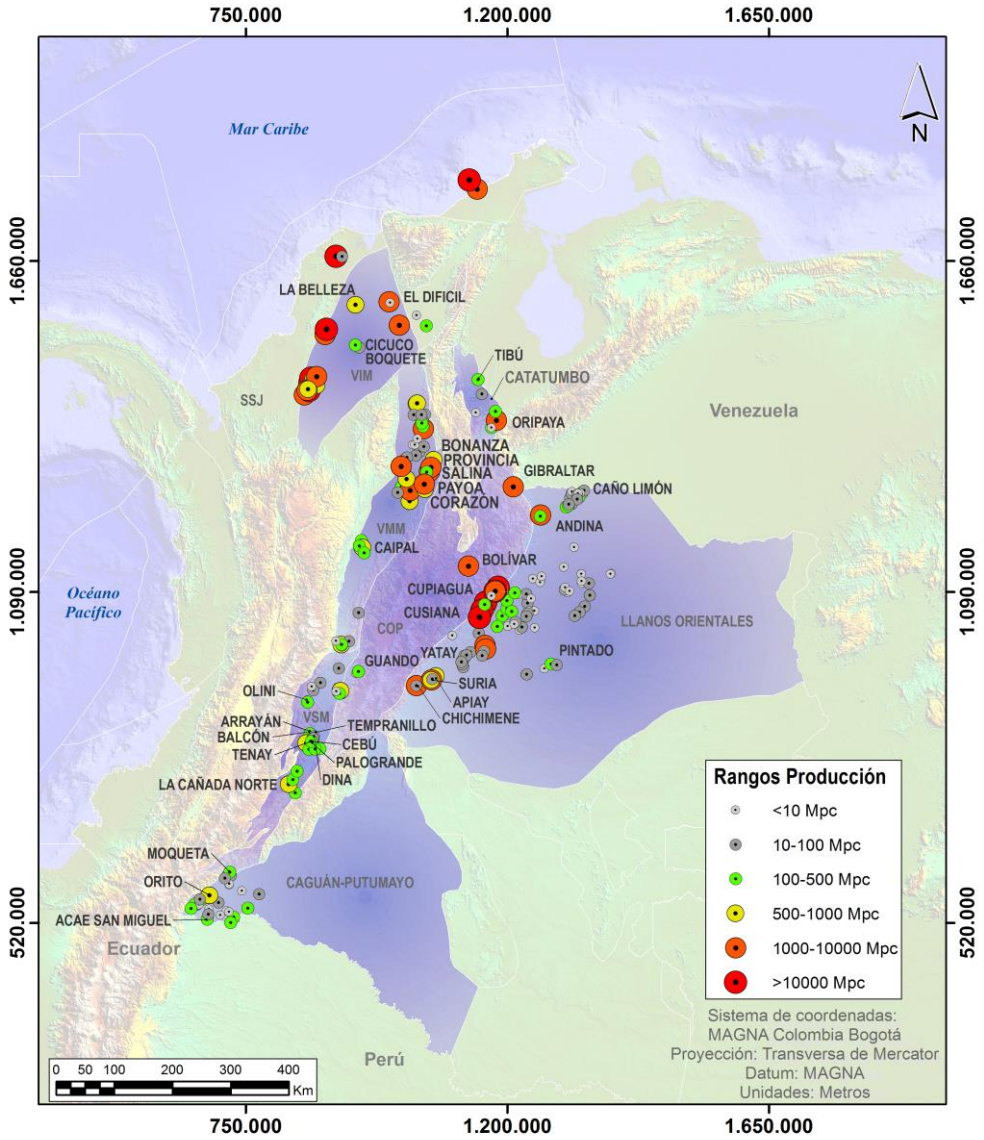






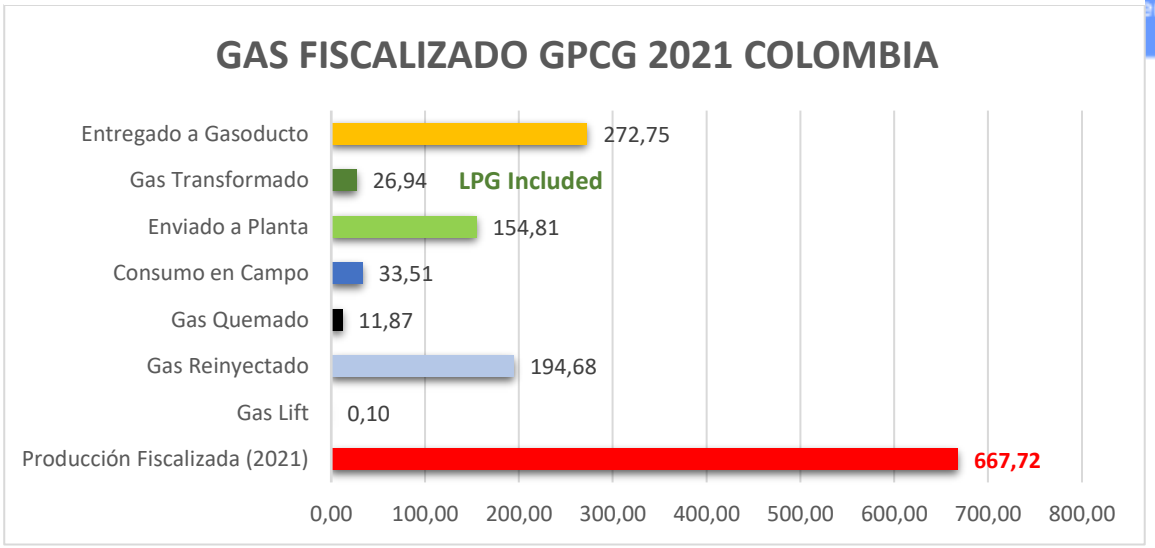


Current Scenario Of Gas In Colombia



In 2021, 279 fields had a certified production of Gas in the country, with a total production of **667 GCFG**

Gas Certified GCFG (2021)



Gas Certified GCFG excluding Foothills

AREAS ADVERTISEMENT 2022

Current scenario of Wet Gas and LPG in Colombia

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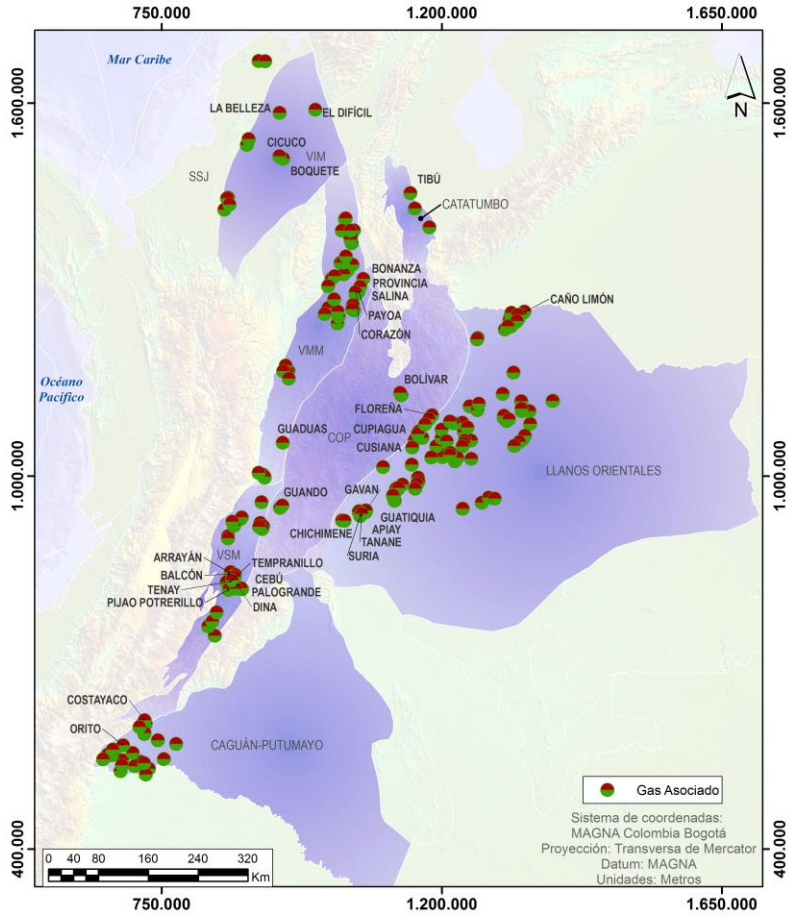
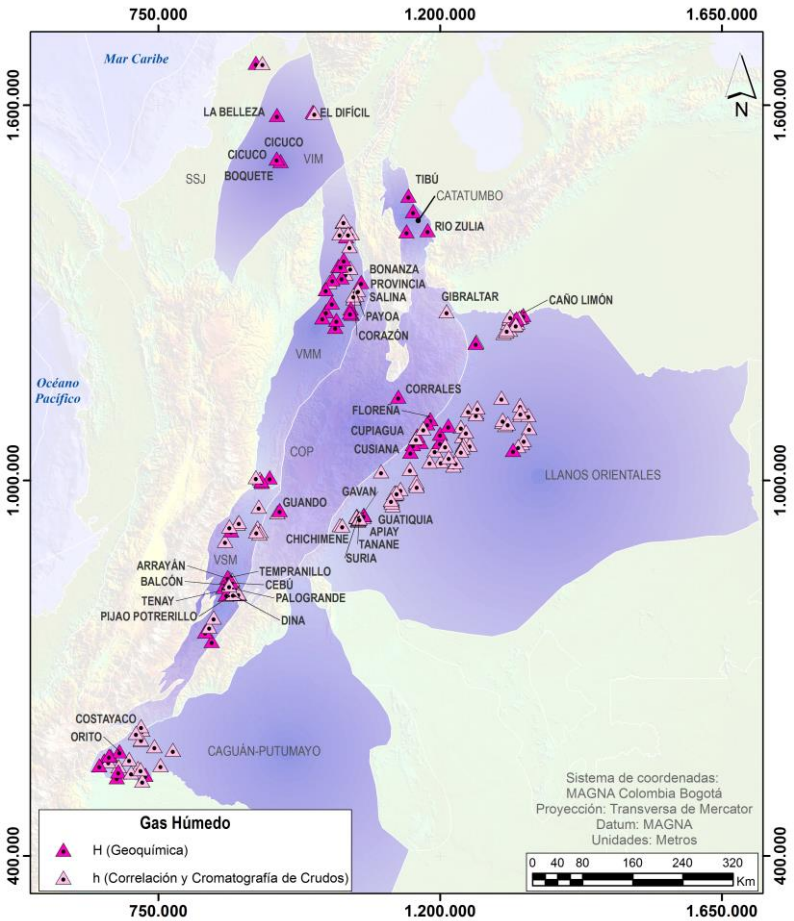


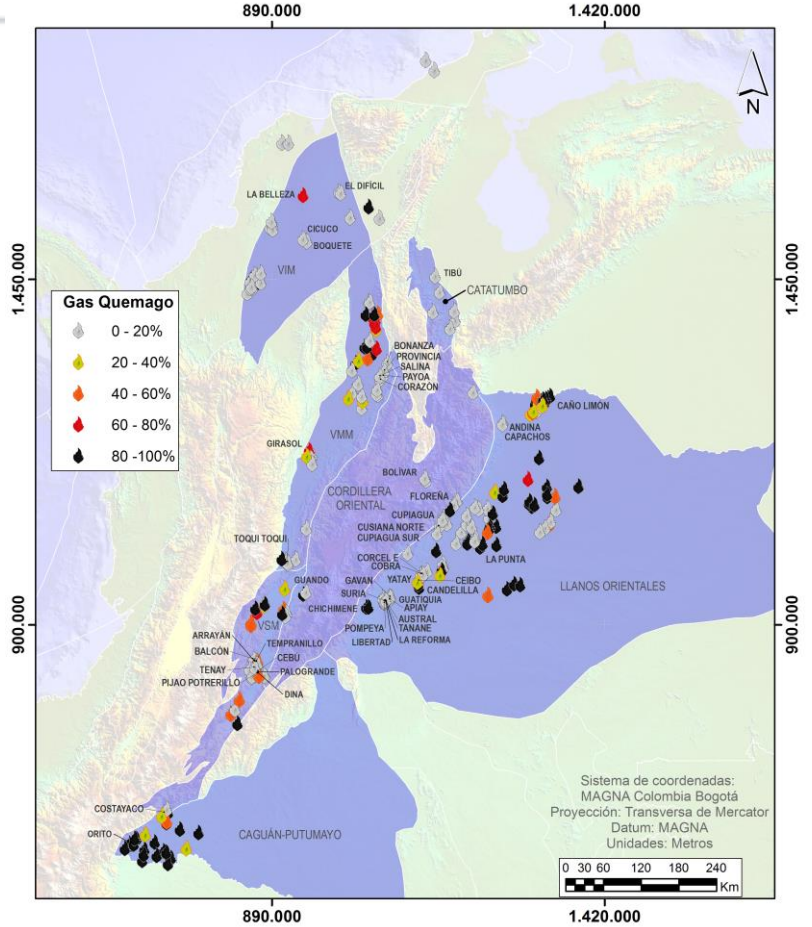
Associated Gas

250 fields produced gas associated with the production of oil, which corresponds to 89% of the gas producing fields.



Wet Gas

215 fields (86%) in this study are defined as producers of wet gas, with more than 5% wet gas.



Burned Gas

11,9 GCFG is burned in teas (11,9 GPCG).
Basins such as Llanos (25%), UMB(25%) and the Putumayo (54%) urgently need to transform gas

AREAS ADVERTISEMENT 2022

Cordillera- Foothills

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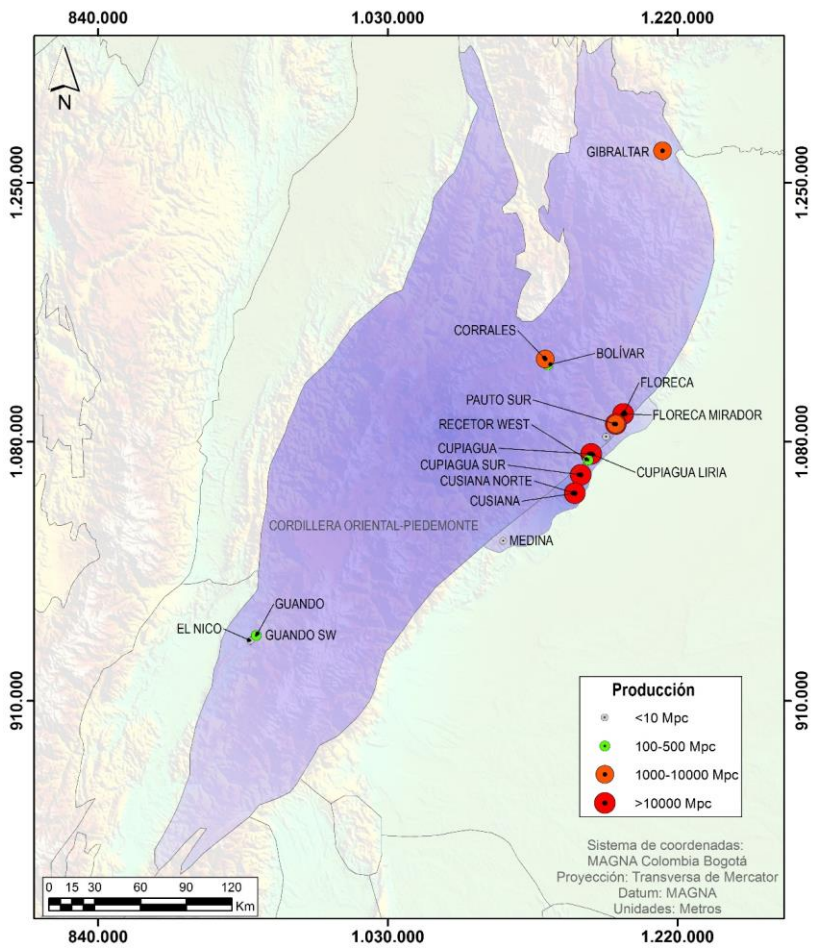
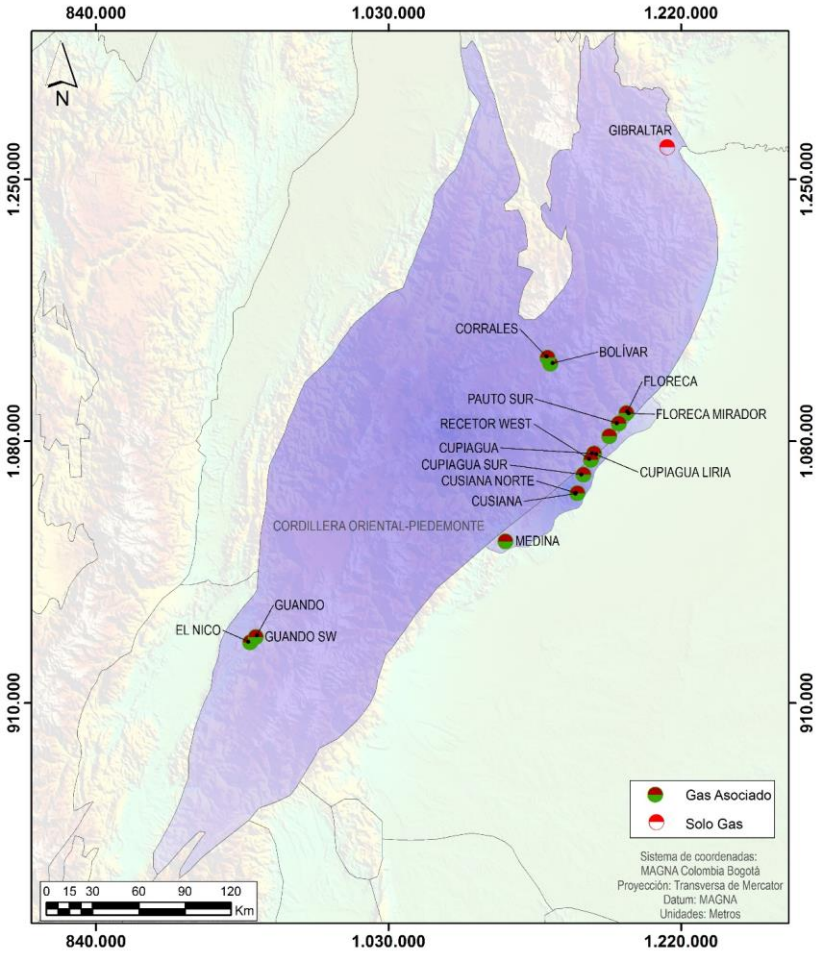


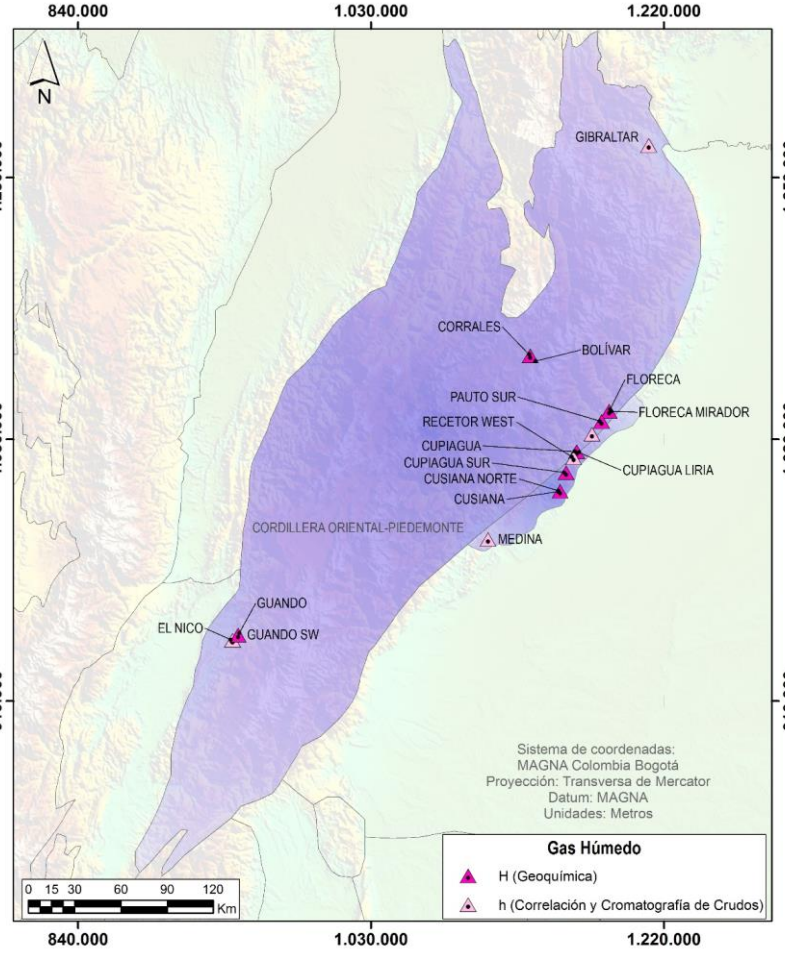
Certified Gas

There are 18 gas producing fields and they have the highest cumulative gas production in 2021 with 470.8 GPCG (71%)
Pauto sur is the largest gas producer in Colombia



Associated Gas

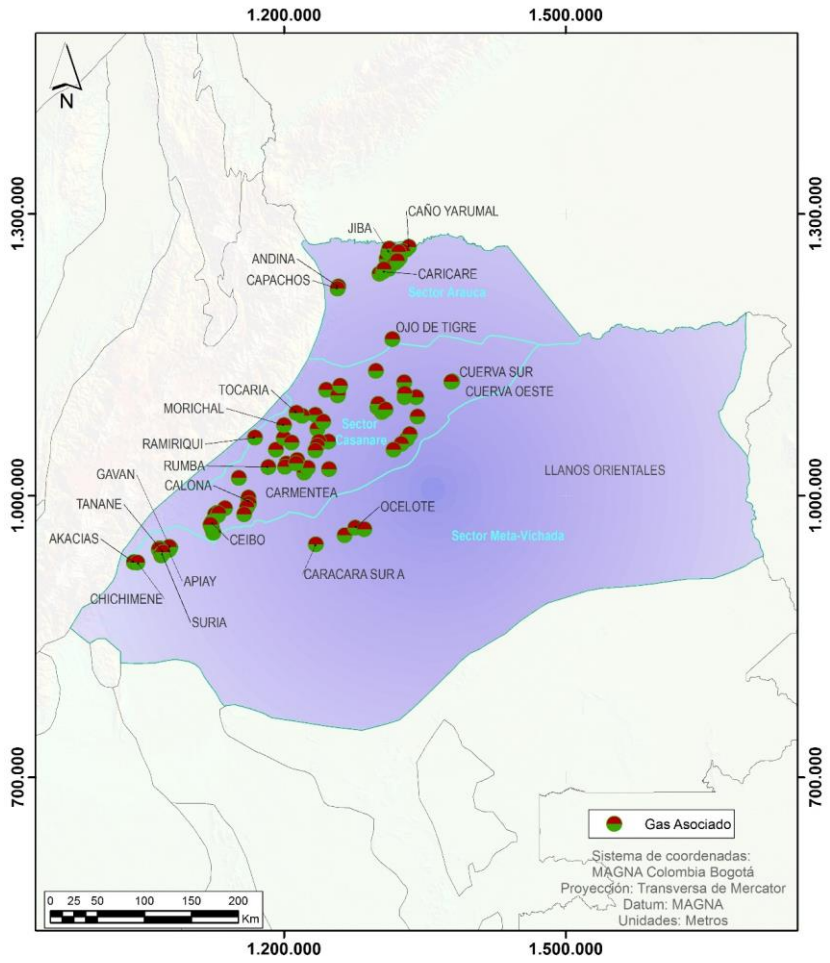
All fields produce Associated Gas except for Campo Gibraltar which produces only gas



Wet Gas

Most ot the gas production correspond to wet gas
The most important fields currently for LPG production in Colombia are Cusiana and Cupiagua fields.

Llanos Basin



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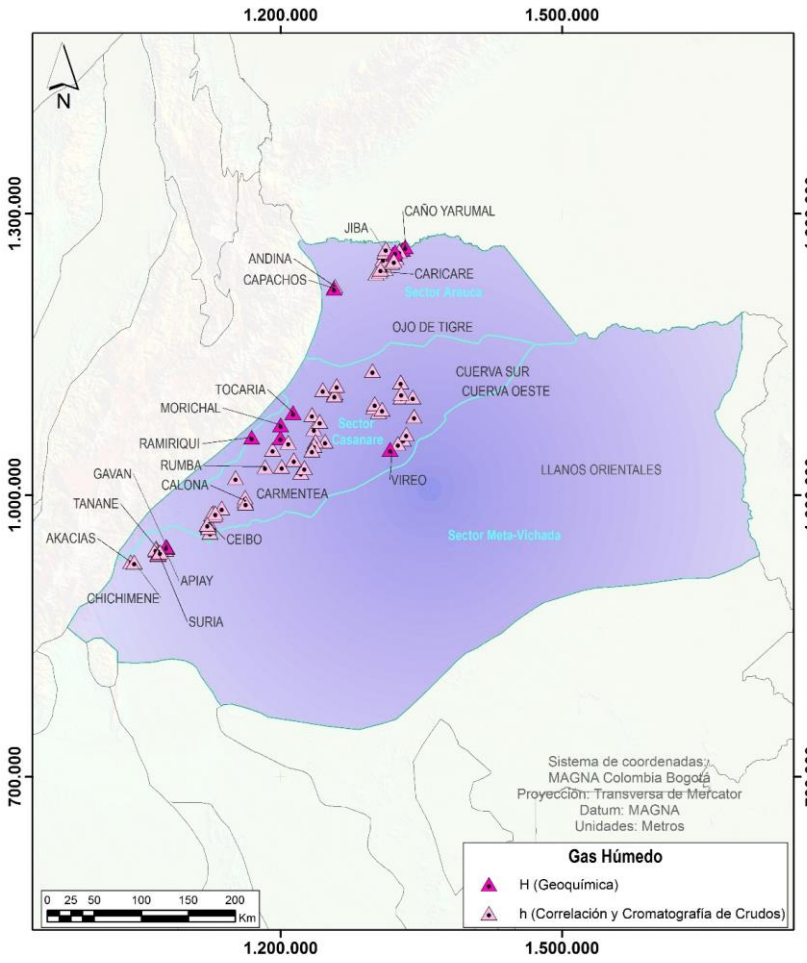

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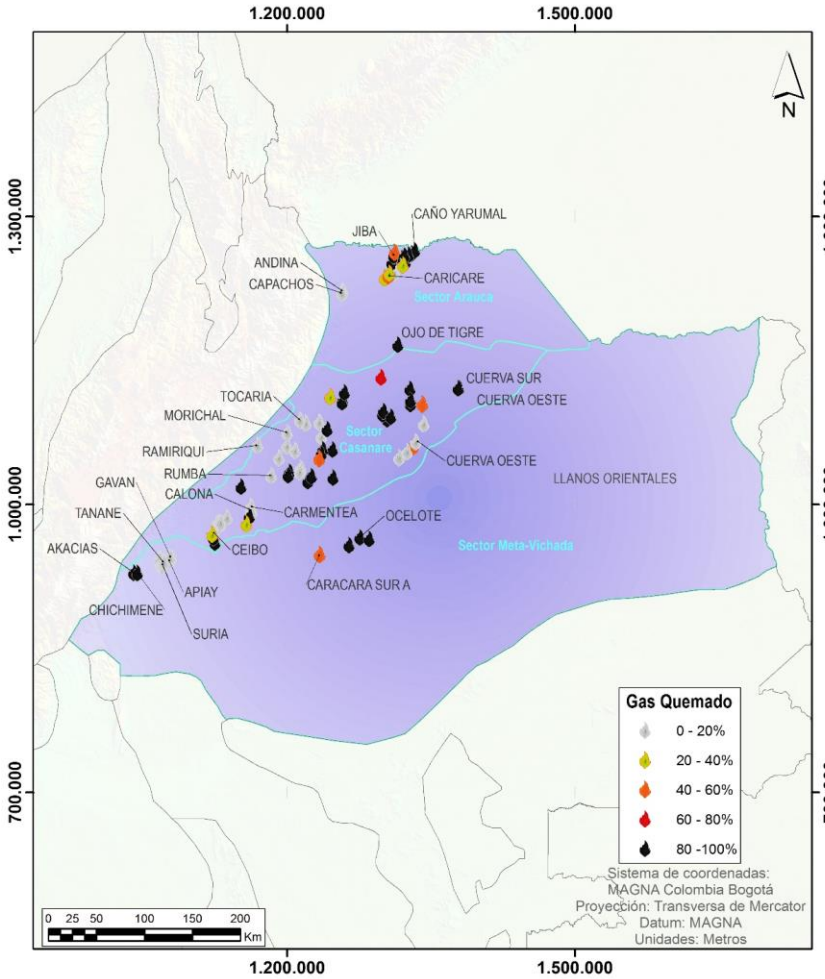


Burned Gas

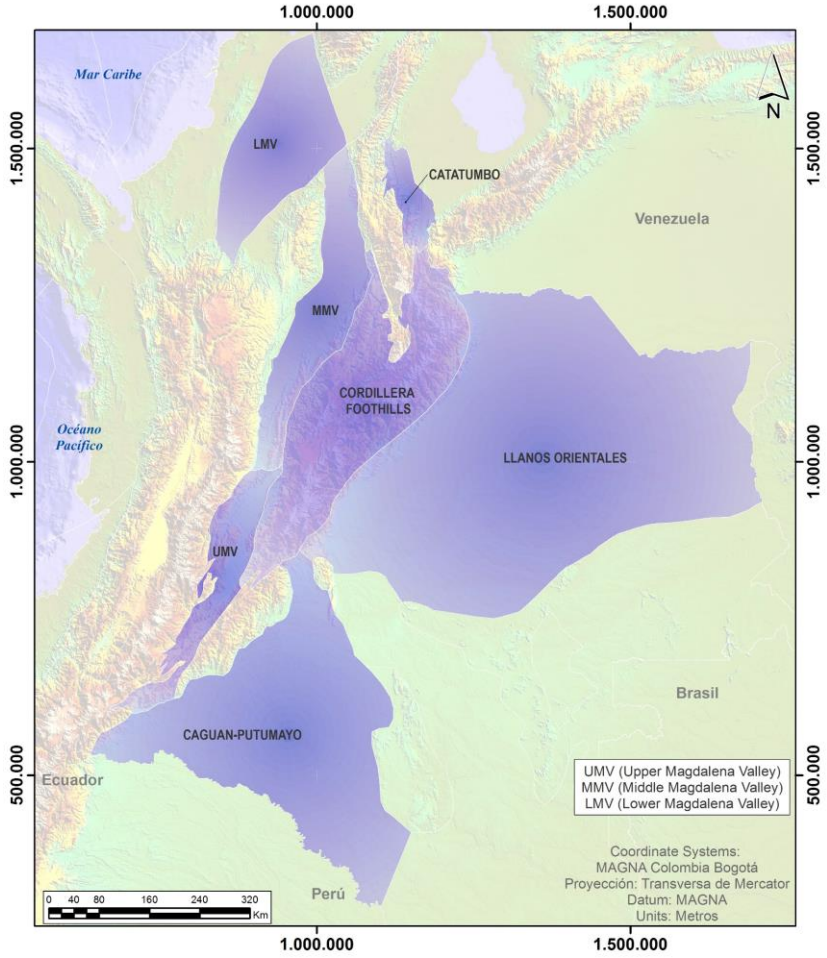
Most of the associated gas is used for the fields operations. Gas produced in Chichimene and Caño Limon fields (wet gases), are burned almost entirely

Preliminary Conclusions

- The gas associated with the production of crude oil in Colombia shows that in 80% of cases it corresponds to wet or rich gas that could be used to transform it and obtain natural gas and LPG.
- Most of this gas corresponds to primary cracking typical of the late oil window.
- All the basin with hydrocarbons commercial production has options for LPG projects. Llanos Orientales, UMV and Putumayo are the basins with the highest content of LPG:
- The fields of the Cordillera Foothils: Pauto Sur, Floreña, Recetor, Cusiana and Cupiagua are the most important accumulations of LPG in the country; the production and transformation of production gas into LPG will depend on a large percentage of the internal supply.
- The accumulations of gas recently discovered in the Lower Magdalena Valley are mainly gas with a dry tendency and are very important for the supply of natural gas
- Given the need to finish burning gas, the transformation of associated wet gas to generate products such as LPG, must be implemented especially in areas that today consume LPG and/or have high consumption of firewood.

Basins To Evaluated And Methodology

Basins With Hydrocarbons Commercial Production



Location Map
Evaluated Basins

Conventions

Basins

- 11. Social appropriation of knowledge
- 10. Socio-environmental and economic sustainability
- 9. Prospective Resources Evaluation
- 8. Prospectivity Play Fairway Maps
- 7. Nunchia Syncline Integrated Study
- 6. Petroleum Systems Modeling.
- 5. Thermochronology and thermal maturity
- 4. Geochemical Interpretation of Gases
- 3. Geological habitat and proven plays
- 2. Reservoirs Evaluation with wet gas
- 1. Data Diagnosis

Current Talk