



FARO90

Ethanol Blending in Gasoline - Colombia

Ethanol Blending in Latin America

There are important fuel quality and environmental impact of vehicle emission challanges in the Region.

- The use of ethanol improves gasoline quality and creates flexibility in gasoline production.
- Ethanol use is a cost-effective way to increase gasoline octane and to replace more expensive gasoline components.
- Ethanol contributes to transport decarbonization and air quality improvement.
- There are opportunities across Latin America to increase the ethanol blend level and implement new policies on the use of gasoline-ethanol blends.

Sixteen countries with potential and additional use of ethanol were studied: 1) gasoline market profiles; 2) Optimization of gasoline blends with ethanol and 3) Environmental impact of gasolines blended with ethanol.



Ethanol Blending in Ethanol - Colombia





In 2022, gasoline consumption in Colombia was 1,800 million gallons (6,800 million liters). Market share was 3% for Extra gasoline E10 (RON 97 – AKI 94) and 97% for Regular gasoline (regular) E10 (RON 89 – AKI 84). Local production supplies 65% of total demand. United States is the mainly source of gasoline imports.

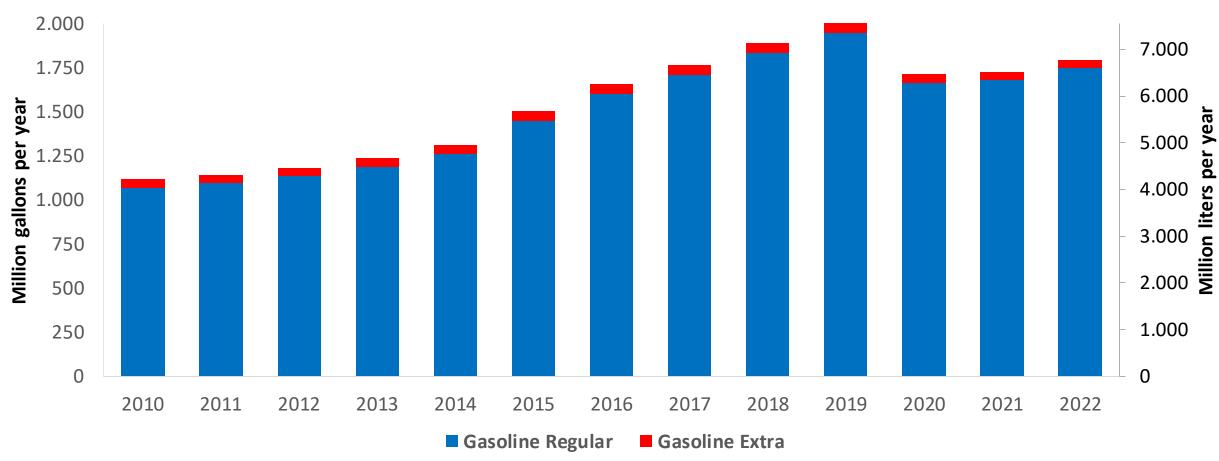
Resolution 40391 of 2023 authorizes the blending of up to 7% ethanol in the country, but allows up to 10% in accordance with Decree 675 of 2015. E10 is the predominant grade in the country except on the border with Venezuela. The ethanol supply comes from imports from the United States and from local production.

Source: ACP, 2023

Gasoline Demand in Colombia





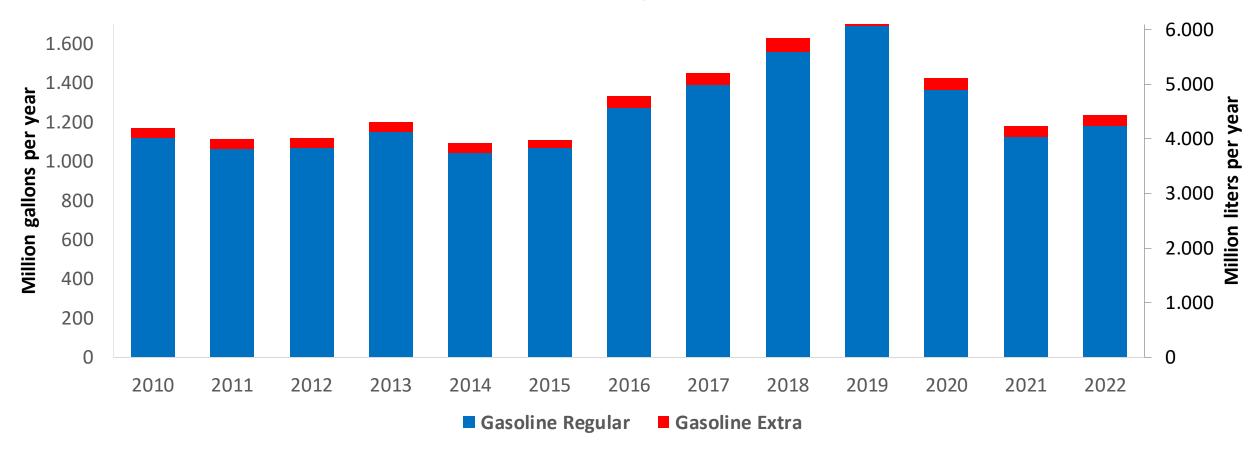


Source: ACP, 2023

Gasoline Production in Colombia



Gasoline Production by Grade in Colombia

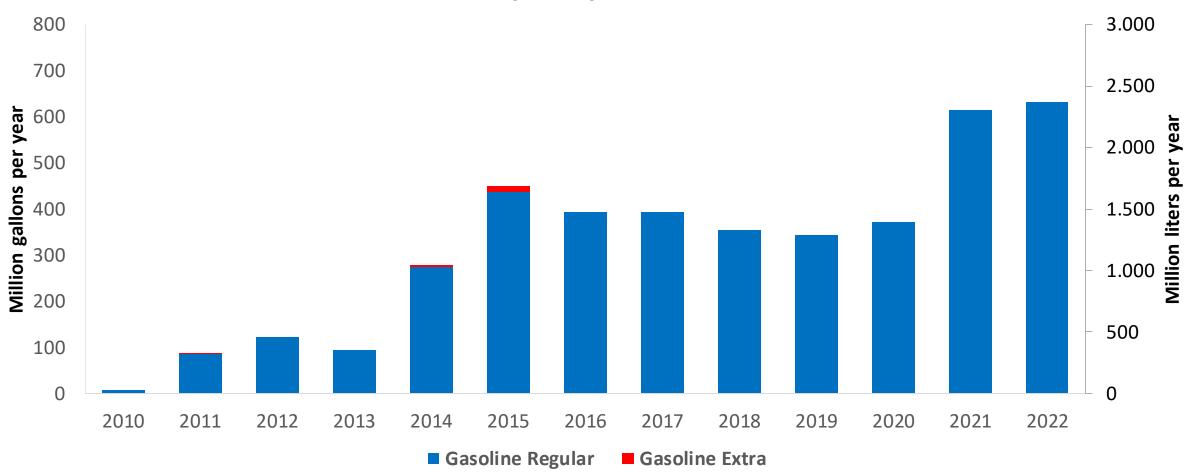


Fuente: ACP, 2023

Gasoline Imports in Colombia



Gasoline Imports by Grade in Colombia

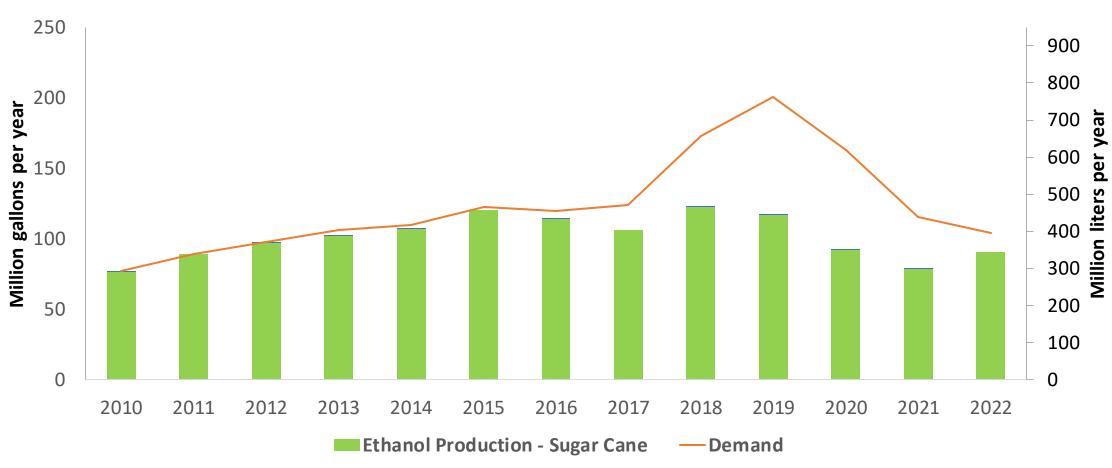


Fuente: ACP, 2023

Ethanol Balance in Colombia







Source: Asocaña - Balance Azucarero Colombiano, 2020; EIA, 2023



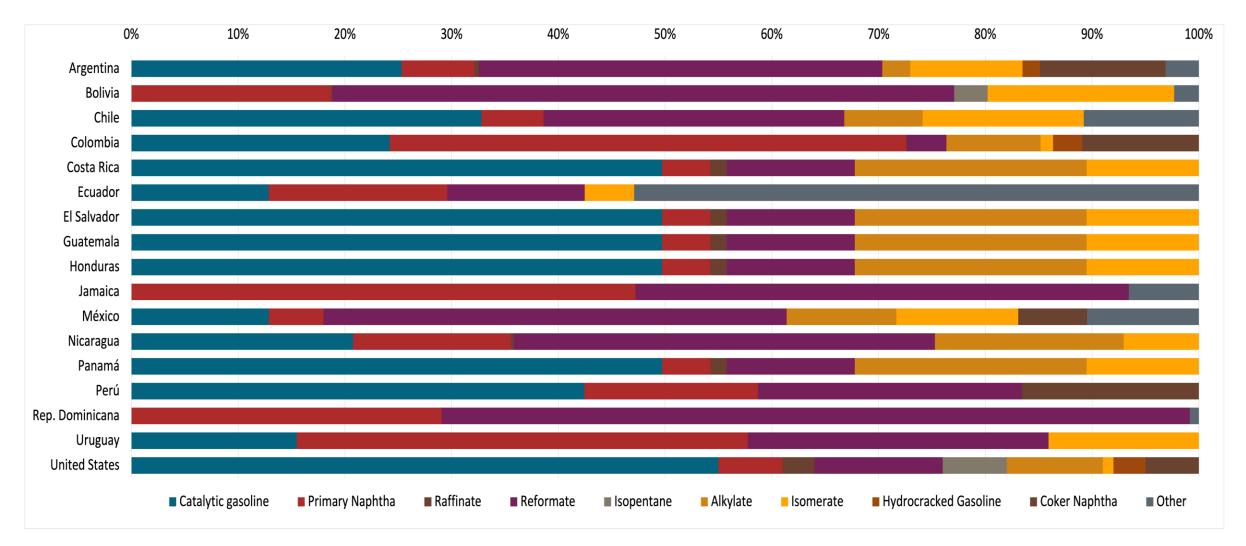
Gasoline Quality in Colombia

Name		EN 228:2012 + A1:2017 (Euro 6 enabling)							
Implementation Date	2021					2017			
Applicability	Whole country	Whole country	Whole country	Whole country	All countries				
Selected Grade	Gasoline Regular	Gasoline Extra	Gasoline Regular E10	Gasoline Extra E10	RON 95 E5	RON 95 E10	RON 98 E5	RON 98 E10	
Benzene Content	< 1,0 %V/v	< 2,0 %V/v	< 0,9 %v/v	< 1,8 %v/v	< 1 %v/v	< 1 %v/v	< 1 %v/v	< 1 %v/v	
Aromatics	< 28 %V/V	< 35 %V/v	< 25 %V/V	< 31,5 %v/v	< 35 %v/v	< 35 %v/v	< 35 %v/v	< 35 %v/v	
Olefins	-	-	-	-	< 18 %v/v	< 18 %v/v	< 18 %v/v	< 18 %v/v	
Lead Content	< 0,013 g/l	< 0,013 g/l	< 0,013 g/l	< 0,013 g/l	< 5 mg/l	< 5 mg/l	< 5 mg/l	< 5 mg/l	
Manganese	-	-	-	-	< 2,0 mg/l	< 2,0 mg/l	< 2,0 mg/l	< 2,0 mg/l	
RON	> 84	> 93	> 89	> 97	> 95	> 95	> 98	> 98	
MON	-	-	-	-	> 85	> 88	> 85	> 88	
AKI	> 81	> 91	> 84	> 94					
Sulfur Content	< 50 mg/kg	< 50 mg/kg	< 50 mg/kg	< 50 mg/kg	< 10 mg/kg	< 10 mg/kg	< 10 mg/kg	< 10 mg/kg	
Oxygen Content			< 3,7 %m/m	< 3,7 %m/m	<2,7 % m/m	<3,7 % m/m	<2,7 % m/m	<3,7 % m/m	
Ethanol (EtOH)	<> 9,5 - 10,5 %v/v	<> 9,5 - 10,5 %√v	<> 9,5 - 10,5 %√v	<> 9,5 - 10,5 %v/v	<5 %v/v	<10 %v/v	<5 %v/v	<10 %v/v	
RVP 37.8°C (Summer)	<> 65 kPa	<> 65 kPa	<> 65 kPa	<> 65 kPa	<> 60 - 70 kPa *Depends on the country, RVP is regulated in the EU Fuel Quality Directive				
RVP 37.8 °C(Winter)									
RVP 37.8°C (Transition)									
MTBE					-	-	-	-	
Ehters 5 or more C Atoms	-	-	-	-	Based on oxygen content	<22 %V/V	Based on oxygen content	<22 %\/v	

Source: Ministerio de Energía y Minas, 2021

Gasoline Component Blending in Latin America

Gasoline is a blend of a base gasoline and other components. This blending is usually done at blending terminals as only 30% of the world's finished gasoline is distributed directly from refineries. Each component provides different properties to the final blend, for example, isomerates, alkylates and butanes increase the octane. The components commonly used in Latin America are:



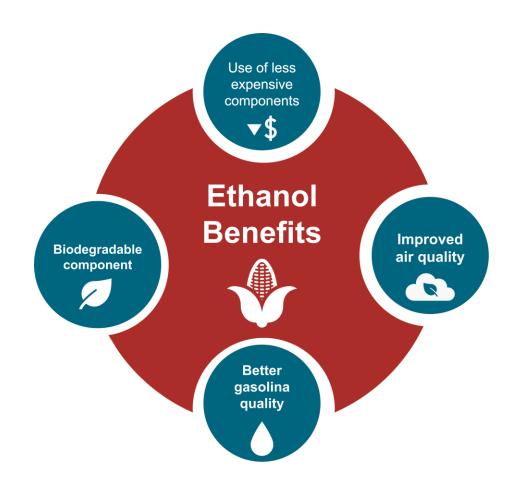
Gasoline Blending Optimization

In some parts of the world, ethanol is added to gasoline as a blending component. The advantages of ethanol include that it is a renewable fuel made of biomass; that it is an octane booster that helps to dilute sulfur; and that it allows the fulfillment of environmental objectives. To determine the optimal components to be blended with ethanol, a **blending model** was used. This model selects the components to add in the gasoline/ethanol blend based on:

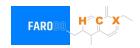
- Components prices,
- Properties each component affects,
- Quality parameters by country, and
- Component availability by country.

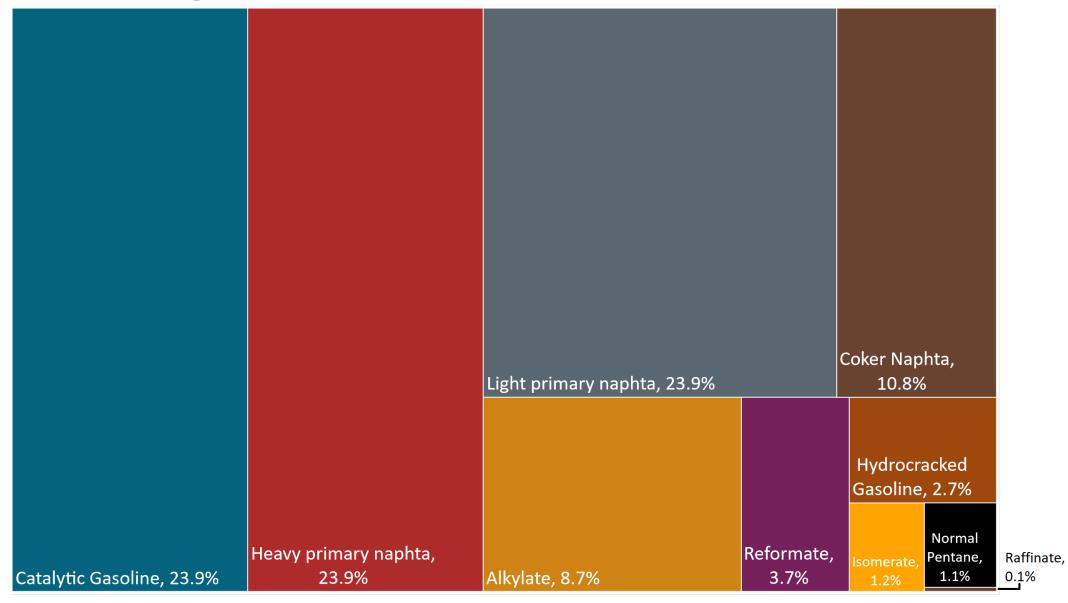
Through iterations, the model obtains the %v/v of the components to be blended with 10%, 15%, 20%, 25% and 30% of ethanol, in such a way that the final blend complies with the required properties of a finished gasoline by country.

The blending model uses gasoline component spot average prices January 2022 – February 2023 and provides fuel prices that do not include country distribution costs, local taxes and subsidies and import or gas station margins.

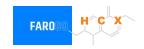


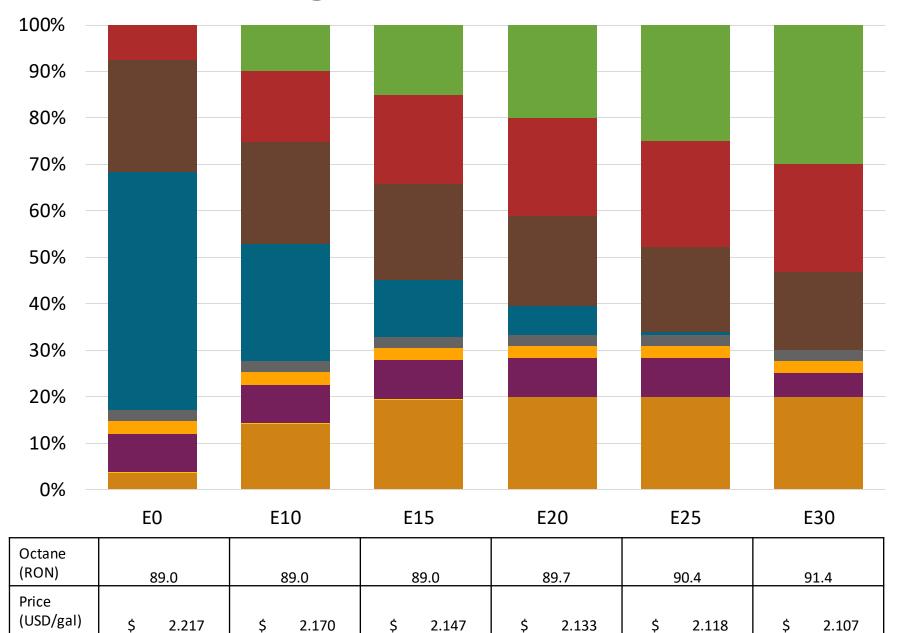
Available Blending Components





Colombia – G. Regular – Constant Octane

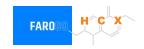


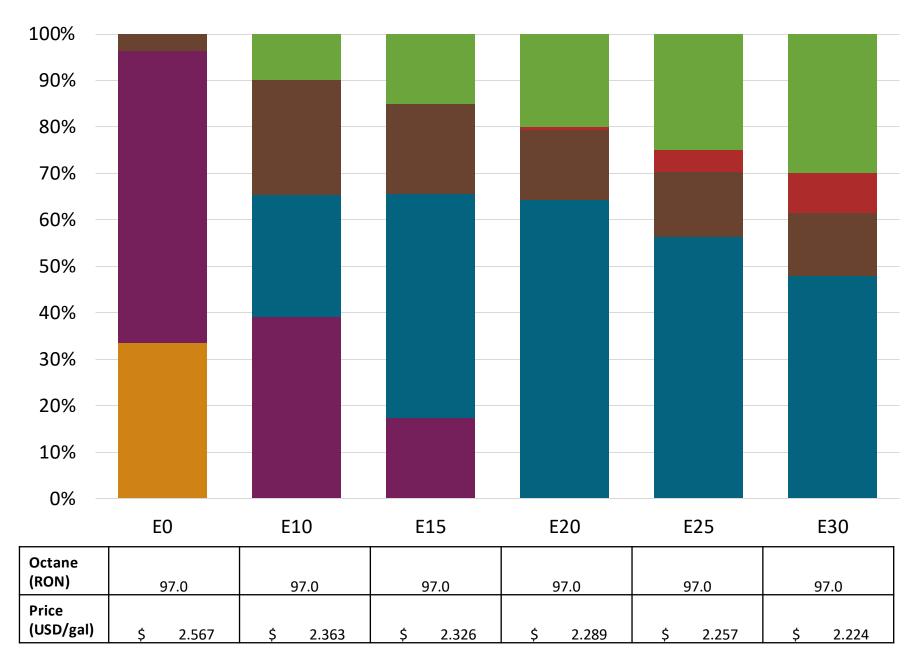


Ethanol
Alkylate
Raffinate
Reformate
Isomerate
Normal pentane
Catalytic Gasoline
Coker Naphtha
Light Primary Naphtha
Heavy Primary Naphtha
Hydrocracked Gasoline

Prices are average Jan 22 – Feb 23. They do not include local distribution costs, import or gas station margins, taxes and subsidies.

Colombia - G. Extra - Constant Octane



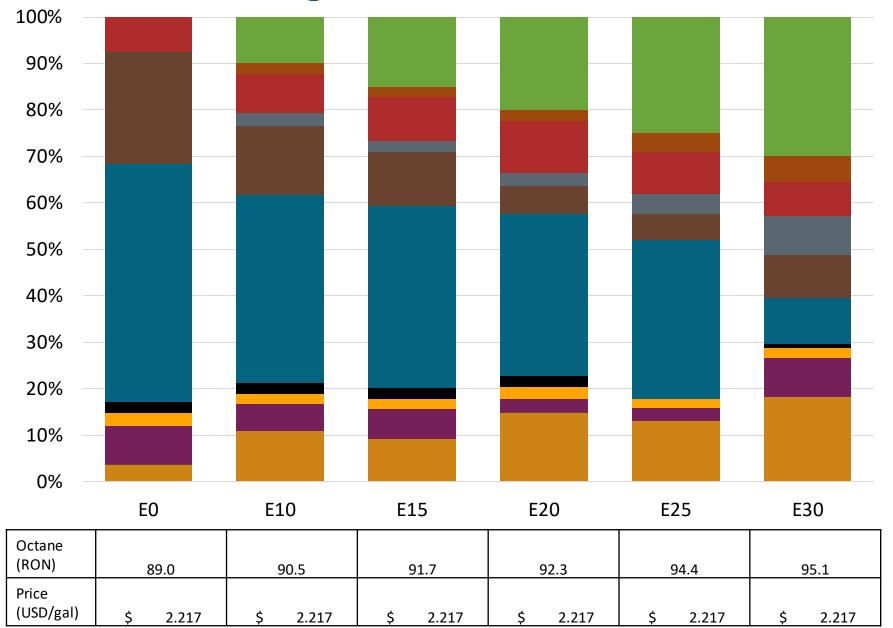


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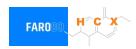


Colombia – G. Regular – Octane Increment

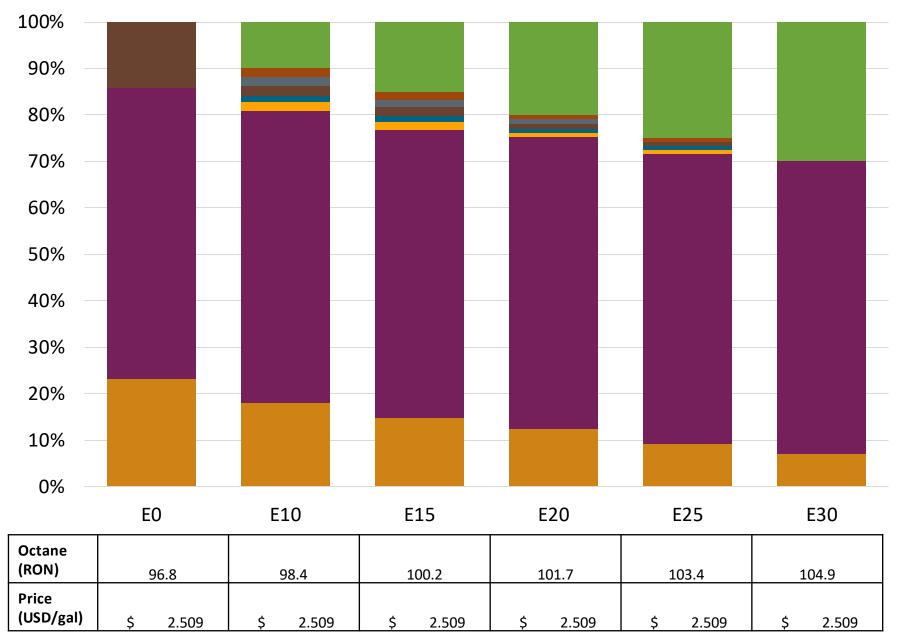


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Colombia – G. Extra – Octane Increment



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Source: Faro90

subsidies.

Vehicle Emission Impact for Ethanol Gasoline Blending

The model used in this analysis takes as a reference the **International Vehicle Emissions Model (IVE).**

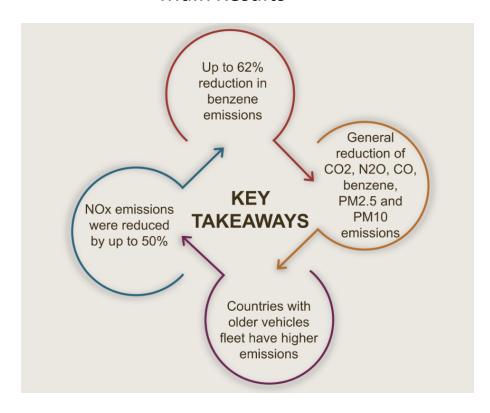
The model uses the Base Emission Rates from IVE model, as well as its Adjustment Factors based on:

- Vehicle technology (cars, trucks, buses, motorcycles),
- Vehicle fleet average age,
- Average traveled distance per vehicle by country, as well as
- Geographical and climatic conditions (altitude, humidity, temperature).

Emissions of criteria pollutants, toxic pollutants, and greenhouse gases (GHG) were calculated and calibrated with emission inventories, using real gasoline quality data. The reduction rates for gasoline/ethanol blends were obtained from various sources (IPCC, US Grains, among others).

Emission estimations for different pollutants for gasoline and gasoline/ethanol blends (10%, 15%, 20%, 25% and 30% ethanol) were determined using the IVE Model. A comparison between the results and the European (Euro 6) requirements is made. Results are also compared with real emissions of the United States vehicle fleet*.

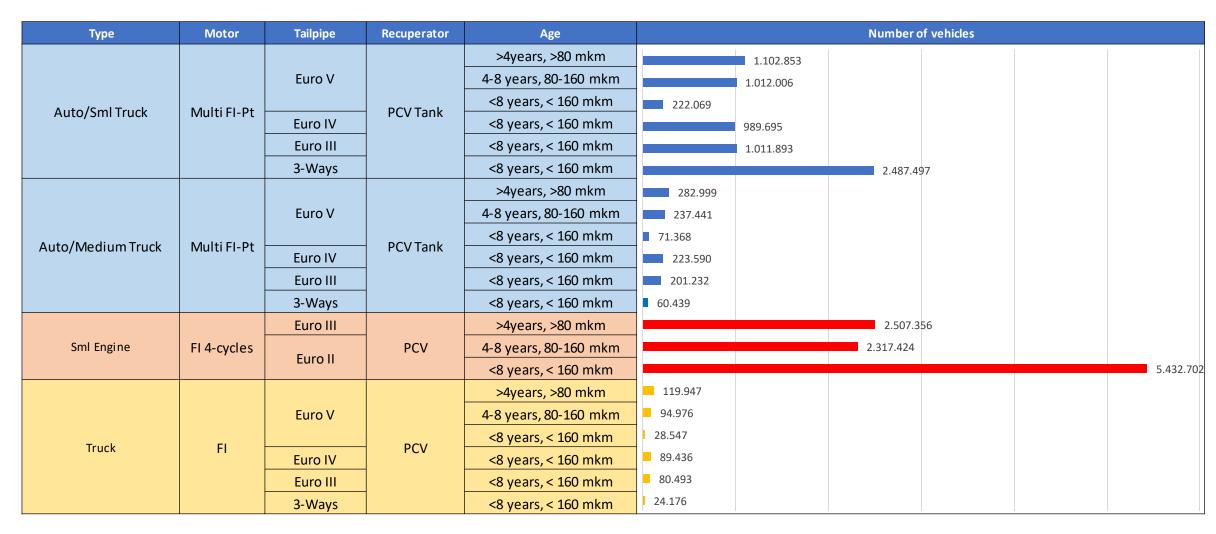
Main Results



^{*}Source: Bureau of transportation statistics.

Gasoline Vehicle Fleet - Colombia





Vehicular Fleet: **14,259,624** Average Age: **12.8 years** Motorcyles Fleet: **72%**

Source: RUNT, Andemos, 2023, Faro90

Colombia – Vehicular Emissions



Emissions	E0 g/km	E10 g/km	E15 g/km	E20 g/km	E25 g/km	E30 g/km	E10 - E0	E20 - E0	E30 - E0	Euro 6	TIER USA
СО	22.65	20.77	20.16	19.62	19.23	18.69	-8%	-13%	-17%	1	3.5
VOC	2.09	1.94	1.90	1.86	1.83	1.79	-7%	-11%	-15%	95	255
VOCevap	0.62	0.62	0.63	0.64	0.66	0.67	0%	4%	7%	0.1	0.273
NOx	0.97	0.68	0.64	0.60	0.56	0.52	-30%	-38%	-46%	0.06	0.203
SOx	0.01	0.01	0.01	0.01	0.01	0.01	-15%	-28%	-41%		
NH3	0.06	0.06	0.06	0.06	0.06	0.06	-2%	0%	1%		
Butadiene	0.01	0.01	0.01	0.01	0.01	0.01	-8%	-12%	-16%		
Acetaldehyde	0.02	0.04	0.06	0.08	0.09	0.11	68%	249%	372%		
Formaldehyde	0.09	0.11	0.12	0.13	0.14	0.16	13%	39%	68%		
Benzene	0.10	0.10	0.09	0.09	0.09	0.09	-9%	-11%	-18%		
CO2	348.07	330.67	324.02	320.73	317.66	311.80	-5%	-8%	-10%		
N2O	0.02	0.02	0.02	0.02	0.02	0.02	-1%	2%	4%		
CH4	0.46	0.46	0.47	0.48	0.49	0.50	0%	4%	7%		
PM 2.5	0.03	0.02	0.02	0.02	0.01	0.01	-22%	-43%	-65%		
PM10	0.05	0.04	0.04	0.03	0.03	0.02	-22%	-43%	-65%	0.005	0.007
тнс	0.70	0.71	0.76	0.79	0.82	0.86	3%	14%	23%		