

FARO90



Ethanol Blending in Gasoline - Ecuador

Ethanol Blending in Latin America

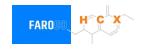
There are important fuel quality and environmental impact of vehicle emission challanges in the Region.

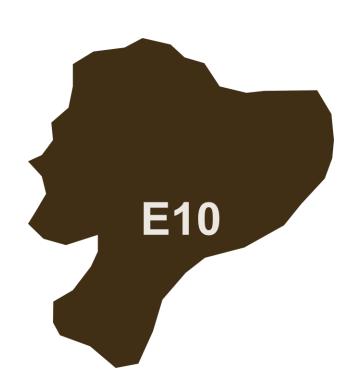
- The use of ethanol improves gasoline quality and creates flexibility in gasoline production.
- Ethanol use is a cost-effective way to increase gasoline octane and to replace more expensive gasoline components.
- Ethanol contributes to transport decarbonization and air quality improvement.
- There are 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 Gasoline - Ecuador



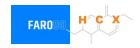


In 2022, gasoline consumption in Ecuador reached 1,200 millon galons (4,500 million liters). A new decree was stablished to implement new grades of gasoline: four grades with 5 different types: Gasoline Extra (RON 85), Gasoline Ecopais E10 (RON 85), Gasoline Ecoplus (RON 89), Gasoline Súper (RON 92) and Gasoline Súper Premium (RON 95). Gasoline Supere Premium (RON 95) will gradually substitute gasoline Super (RON 92). Gasoline Ecoplus (RON 89) was recently introuduced in the market. Ecuador has local production and imports naphtas (unfinished gasolines) to supply national demand.

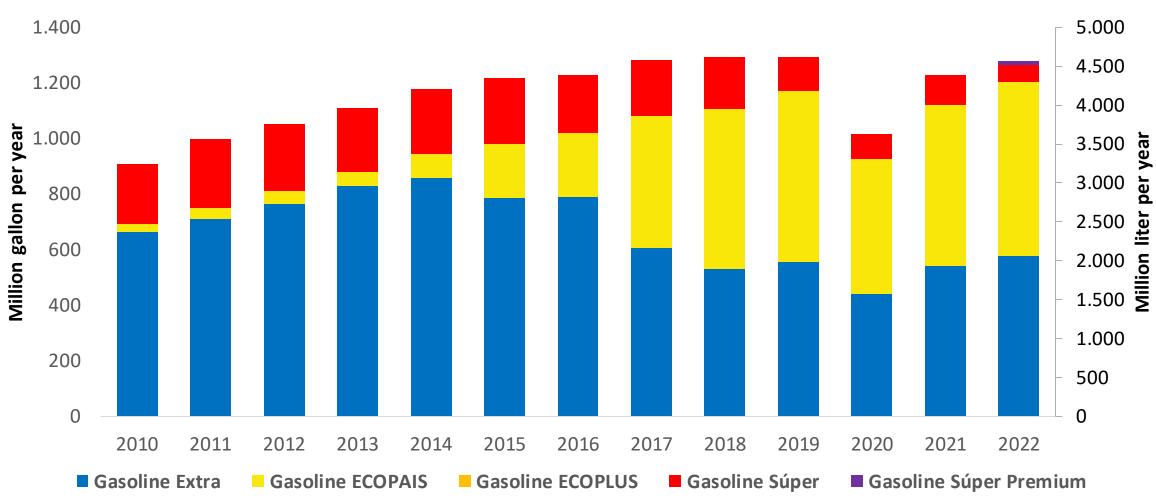
There is no specific mandate for ethanol blending, however there is a permit to blend it with gasoline. Therefore, E5 ECOPAIS and E8 ECOPLUS are observed in the market since 2009. Ethanol is produced ,consumed and exported to neighbouring countries for fuel and industrial use.

Source: EP PETROECUADOR, 2023

Gasoline Demand in Ecuador

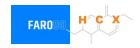




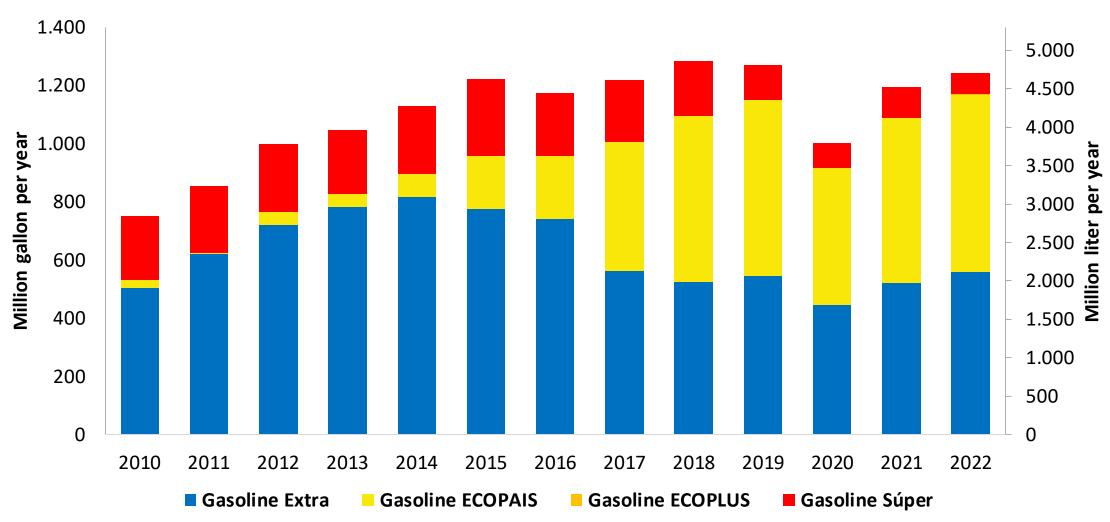


Source: EP PETROECUADOR, 2023

Gasoline Production in Ecuador





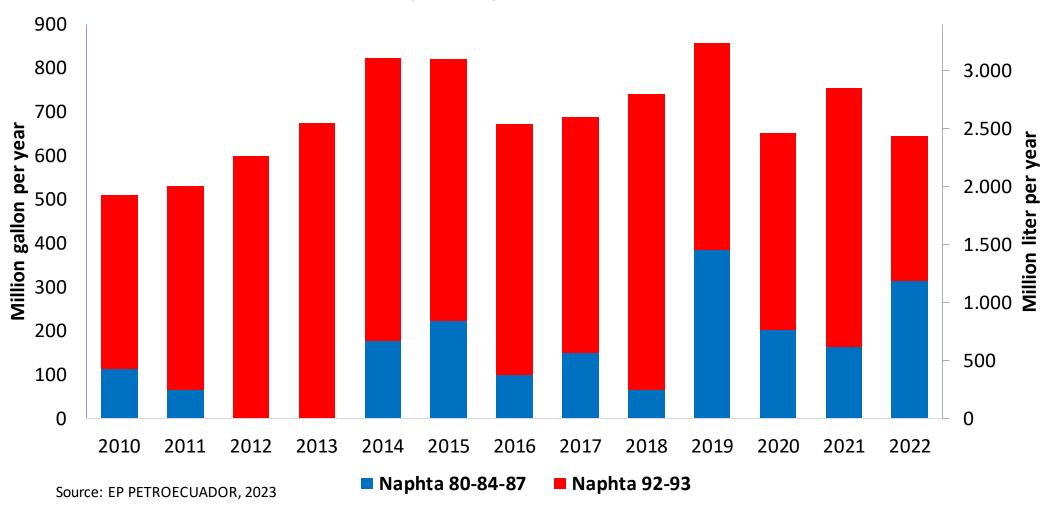


Source: EP PETROECUADOR, 2023

Gasoline Imports in Ecuador



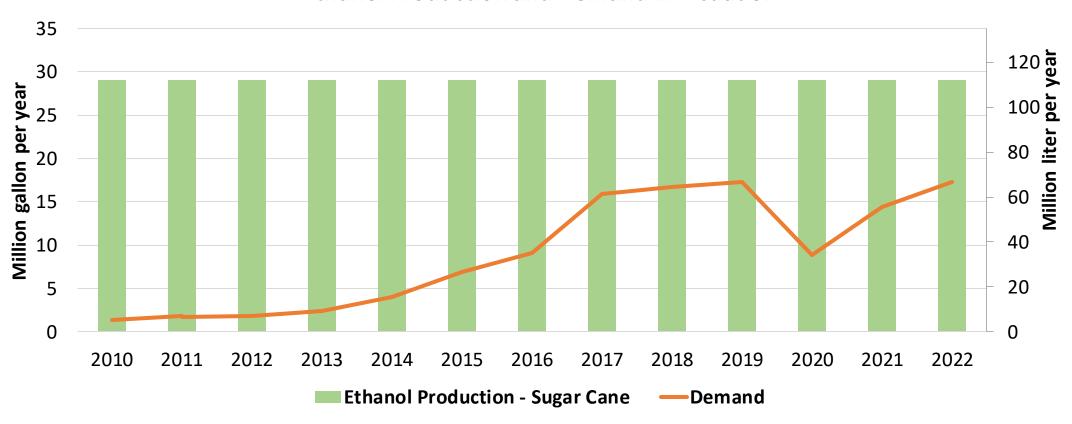




Ethanol Balance in Ecuador



Ethanol Production and Demand in Ecuador



Source: EP PETROECUADOR, 2023; CEDRSSA, 2020



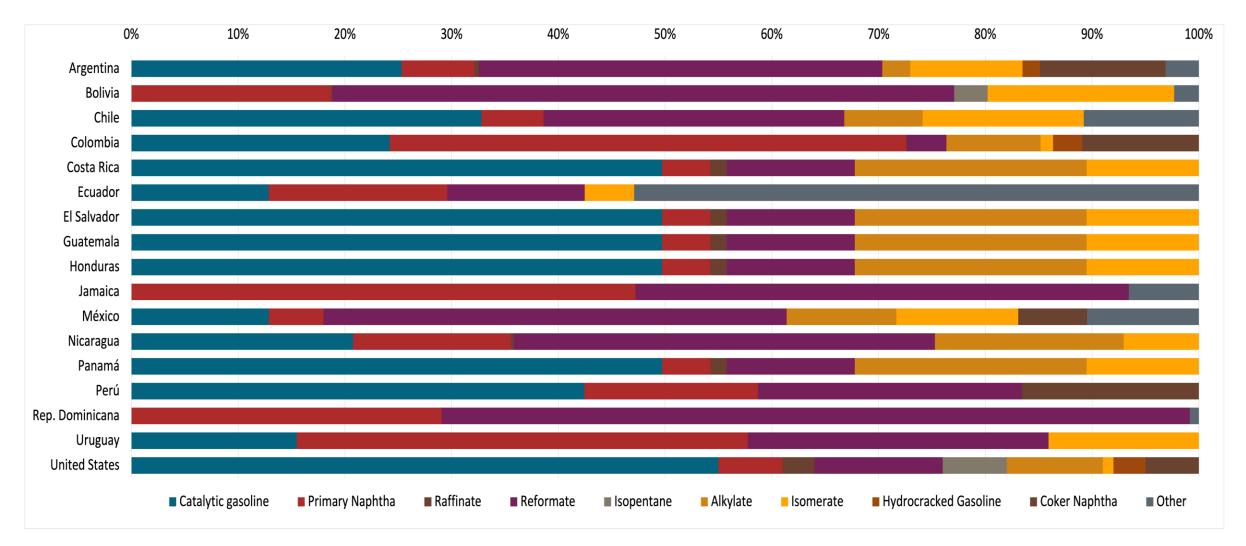


Name		NTE INEN	EN 228:2012 + A1:2017 (Euro 6 enabling)						
Implementation Date		2017							
Applicability	Whole country	Whole country	Whole country	Whole country	All countries				
Selected Grade	RON 85	RON 89	RON 92	RON 93	RON 95 E5	RON 95 E10	RON 98 E5	RON 98 E10	
Benzene Content	< 1 %v/v	< 2 %V/v	<2 %v/v	<1,3 %v/v	< 1 %v/v	< 1 %v/v	< 1 %v/v	< 1 %v/v	
Aromatics	< 30 %v/v	< 35 %v/v	< 35 %V/v	< 35 %√v	< 35 %v/v	< 35 %v/v	< 35 %v/v	< 35 %v/v	
Olefins	< 18 %√v	< 25 %v/v	< 25 %V/V	< 25 %V/v	< 18 %v/v	< 18 %v/v	< 18 %v/v	< 18 %v/v	
Lead Content	< 0 mg/l	< 0 mg/l	< 0 mg/l	< 0 mg/l	< 5 mg/l	< 5 mg/l	< 5 mg/l	< 5 mg/l	
Manganese	0 mg/l	0 mg/l	0 mg/l	0 mg/l	< 2,0 mg/l	< 2,0 mg/l	< 2,0 mg/l	< 2,0 mg/l	
RON	85	89	92	95	> 95	> 95	> 98	> 98	
MON					> 85	> 88	> 85	> 88	
AKI									
Sulfur Content	650 mg/kg	650 mg/kg	450 mg/kg	<300 mg/kg	< 10 mg/kg	< 10 mg/kg	< 10 mg/kg	< 10 mg/kg	
Oxygen Content	< 2,7 %m/m	< 2,7 %m/m	< 2,7 %m/m	< 2,7 %m/m	<2,7 % m/m	<3,7 % m/m	<2,7 % m/m	<3,7 % m/m	
Ethanol (EtOH)					<5 %v/v	<10 %v/v	<5 %v/v	<10 %v/v	
RVP 37.8°C (Summer)	<60 kPa	<60 kPa	<60 kPa	<62 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	Based on oxygen content	<22 %\/v	

Source: Servicio Ecuatoriano de Normalización, 2023

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:



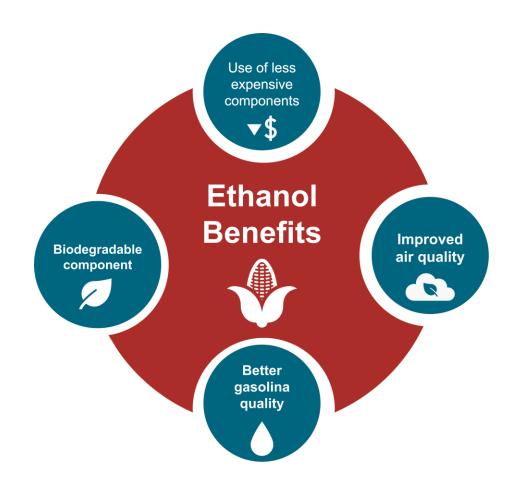
Gasoline Blending Optimization

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.

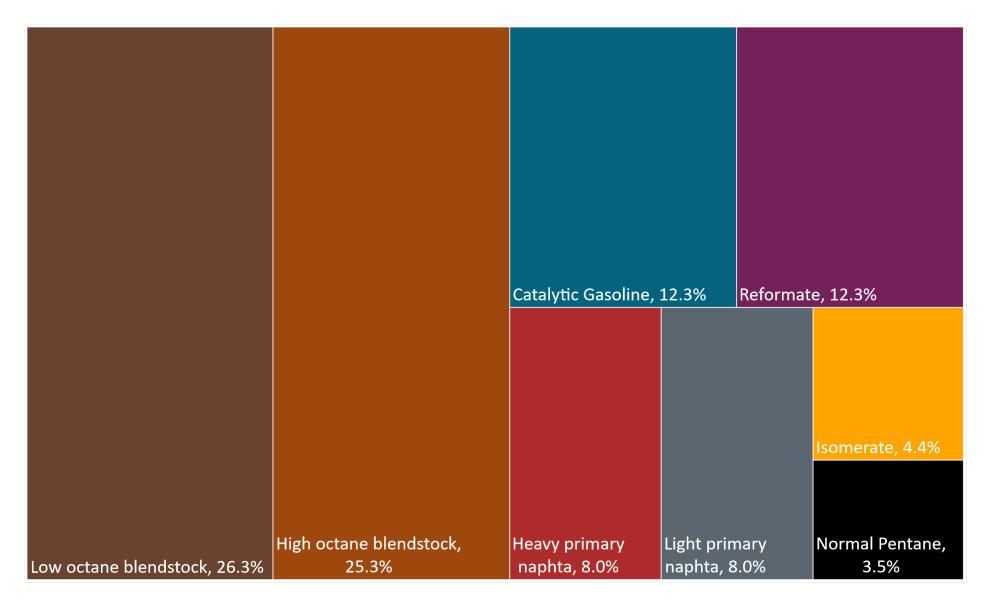
Through iterations, the model obtains the %v/v of the components to be blended with 10%, 15%, 20%, 25% and 30% of ethanol, in such a way that the final blend complies with the required properties of a finished gasoline by country.

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

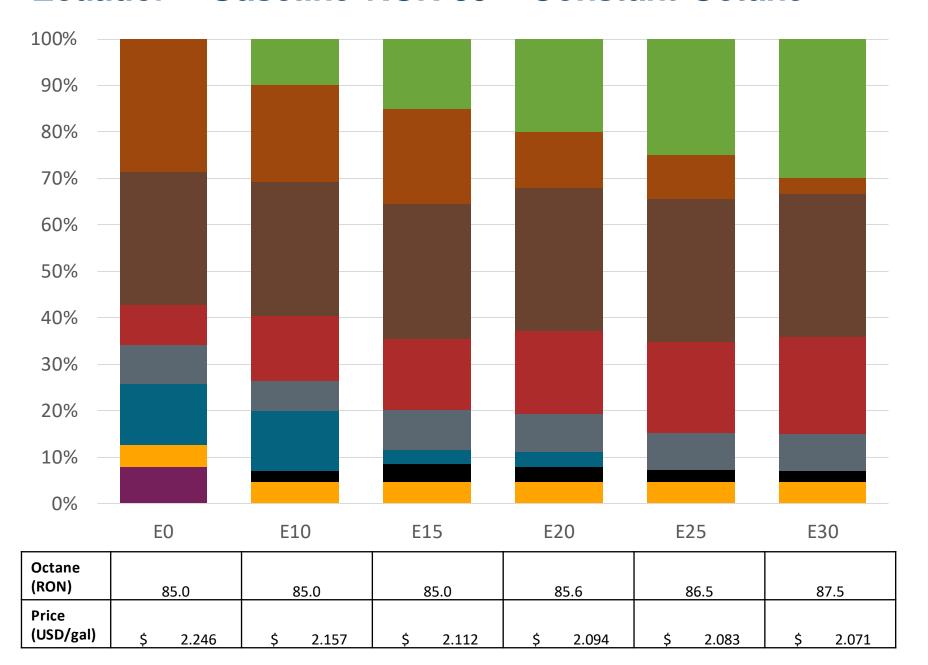




Source: Faro90

Ecuador – Gasoline RON 85 – Constant Octane

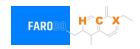


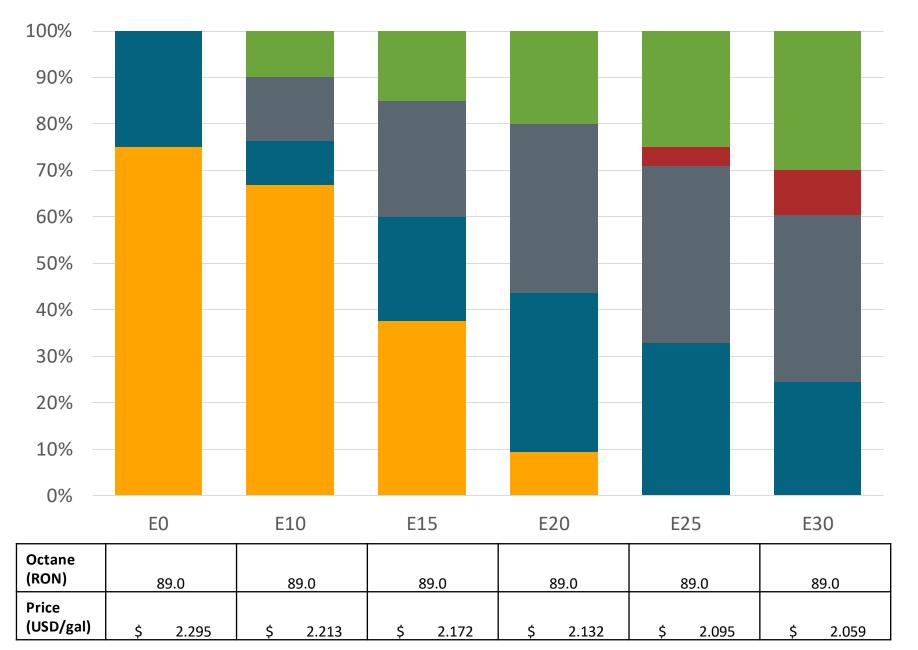


Ethanol
Reformate
Isomerate
Normal pentane
Catalytic Gasoline
Low octane blendstock
High octane blendstock
Light Primary Naphtha
Heavy Primary Naphtha

Prices are average Jan 22 – Feb 23. They do not include local distribu

Ecuador - Gasoline RON 89 - Constant Octane





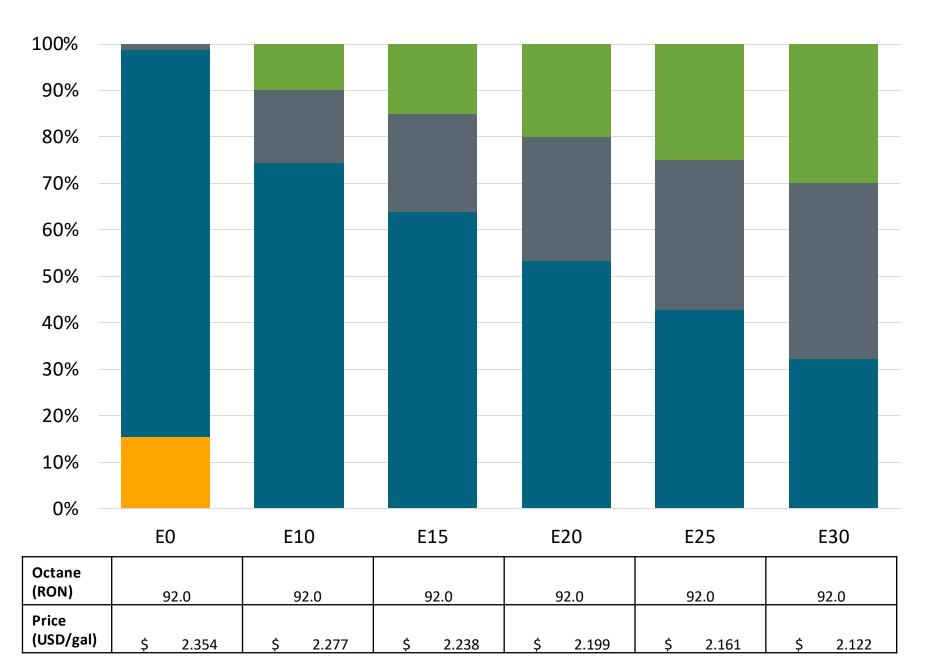
Ethanol
Isomerate
Catalytic Gasoline
Light Primary Naphtha
Heavy Primary Naphtha

Prices are average Jan 22 – Feb 23.

They do not include local distributions of the control of t

Ecuador - Gasoline RON 92 - Constant Octane





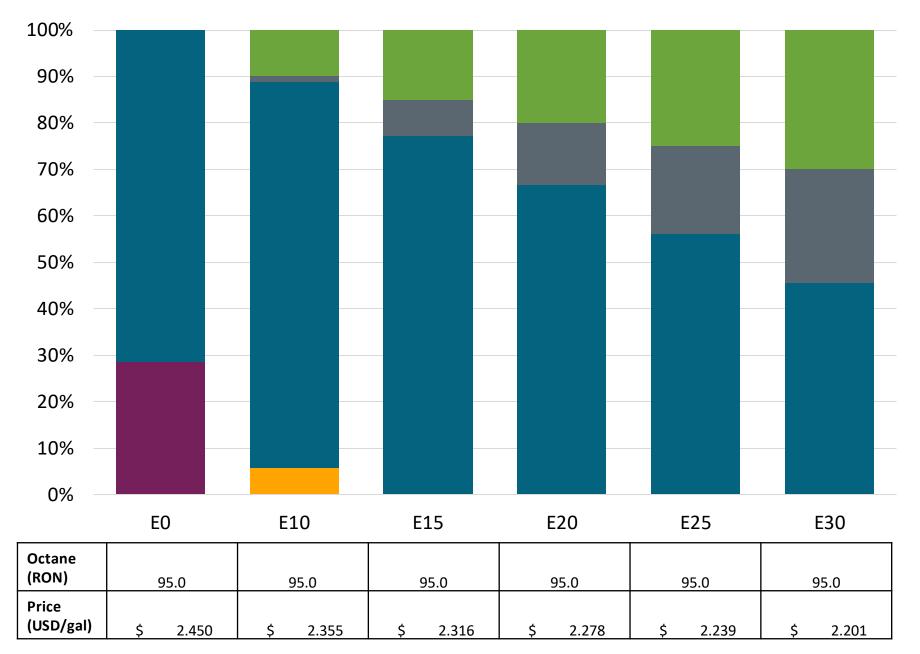
Catalytic Gasoline Light Primary Naphtha

Prices are average Jan 22 – Feb 23. They do not include local distribution costs,

import or gas station margins, taxes and subsidies.

Ecuador – Gasoline RON 95 – Constant Octane



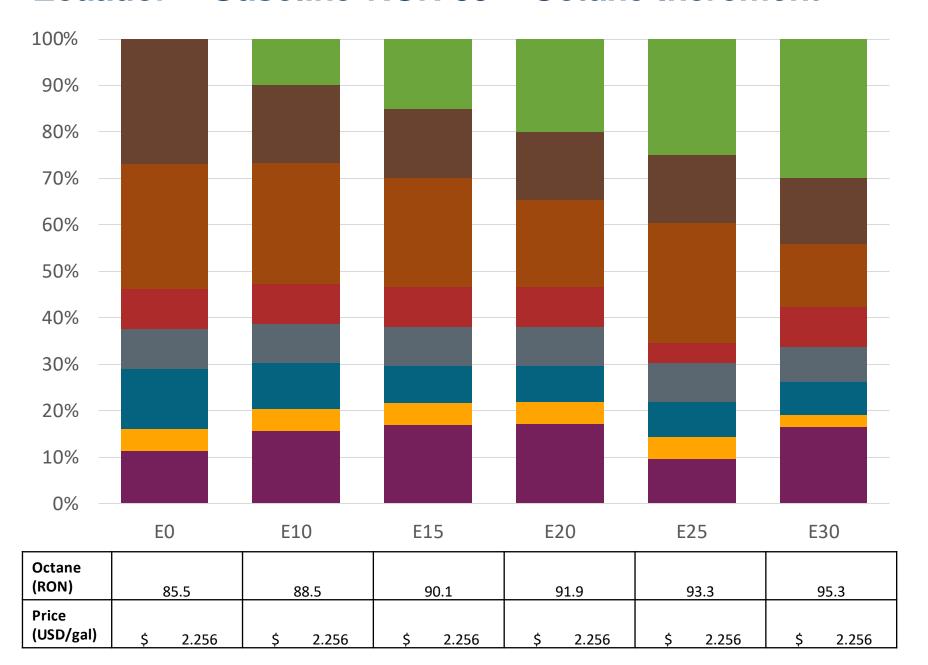


Ethanol Reformate Isomerate Catalytic Gasoline Light Primary Naphtha

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

Ecuador – Gasoline RON 85 – Octane Increment



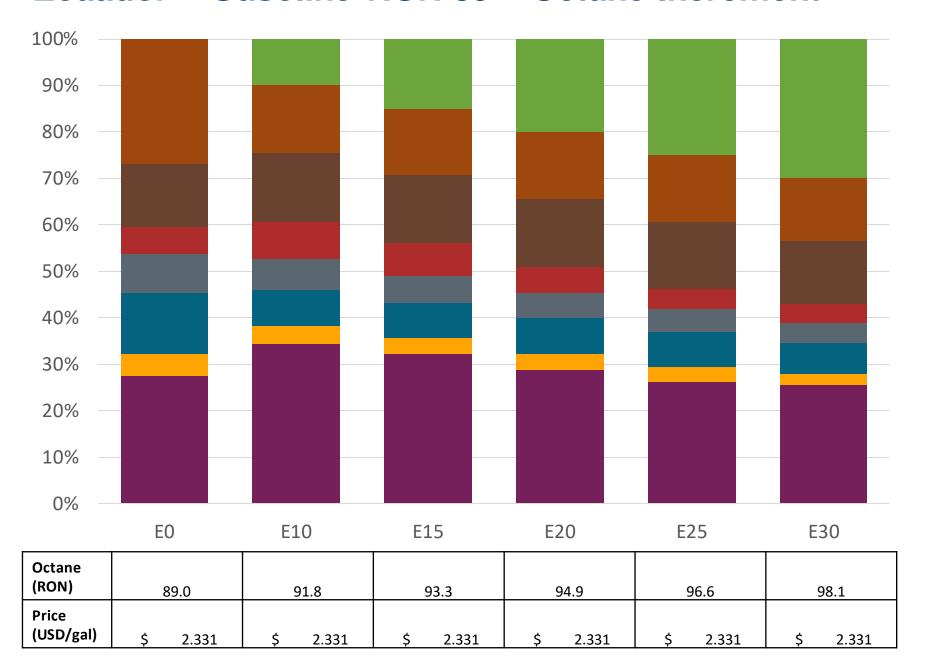


Ethanol
Reformate
Isomerate
Catalytic Gasoline
Low octane blendstock
High octane blendstock
Light Primary Naphtha
Heavy Primary Naphtha

Prices are average Jan 22 – Feb 23.

Ecuador – Gasoline RON 89 – Octane Increment

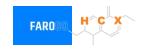


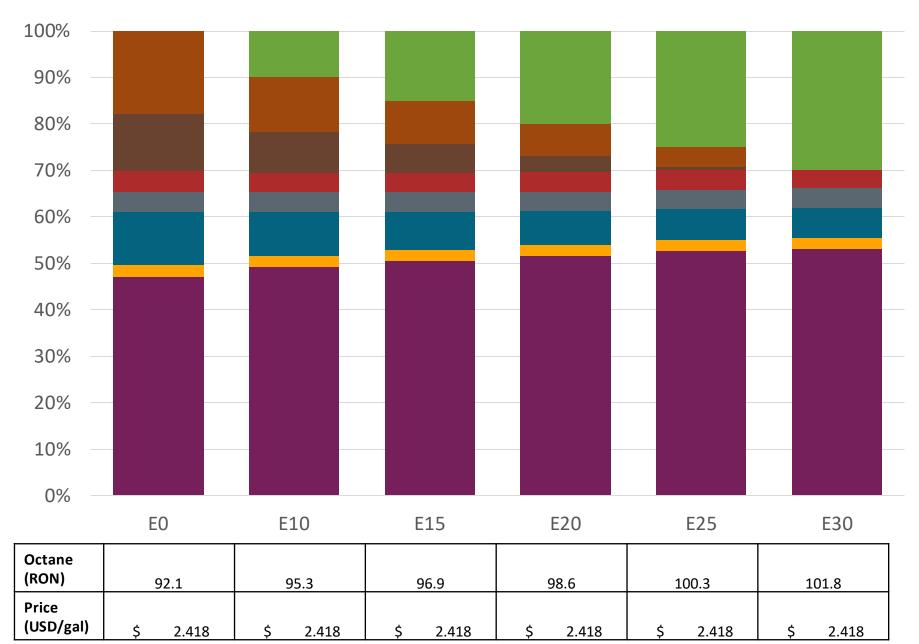


Ethanol
Reformate
Isomerate
Catalytic Gasoline
Low octane blendstock
High octane blendstock
Light Primary Naphtha
Heavy Primary Naphtha

Prices are average Jan 22 – Feb 23. They do not include local distribution costs,

Ecuador – Gasoline RON 92 – Octane Increment

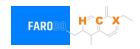


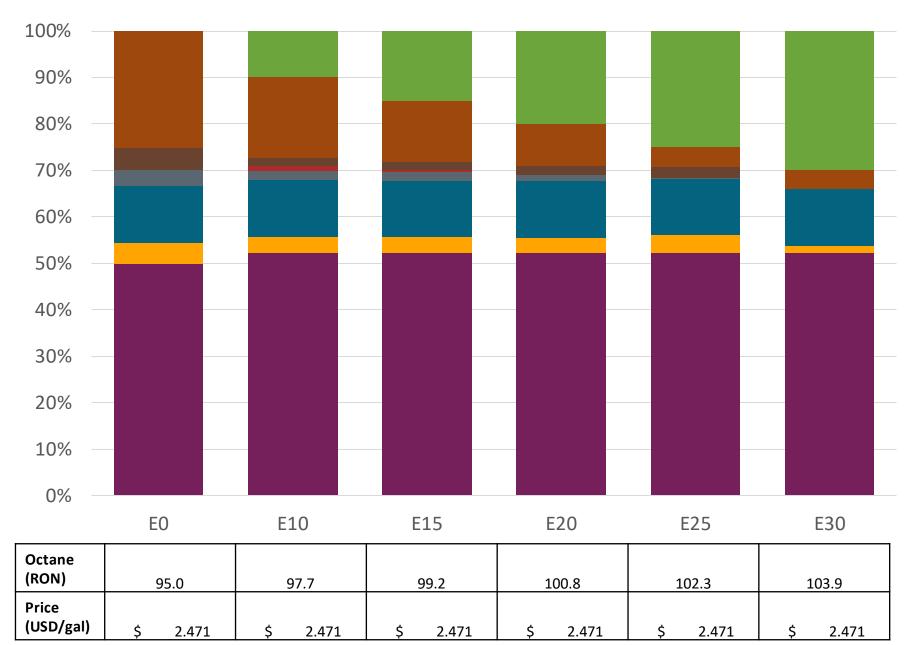


Ethanol
Reformate
Isomerate
Catalytic Gasoline
Low octane blendstock
High octane blendstock
Light Primary Naphtha
Heavy Primary Naphtha

Prices are average Jan 22 – Feb 23. They do not include local distribu

Ecuador – Gasoline RON 95 – Octane Increment





Reformate Catalytic Gasoline Low octane blendstock High octane blendstock Light Primary Naphtha Heavy Primary Naphtha

Prices are average Jan 22 – Feb 23. They do not include local distribution costs,

import or gas station margins, taxes and subsidies.

Vehicle Emission Impact for Ethanol Gasoline Blending

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

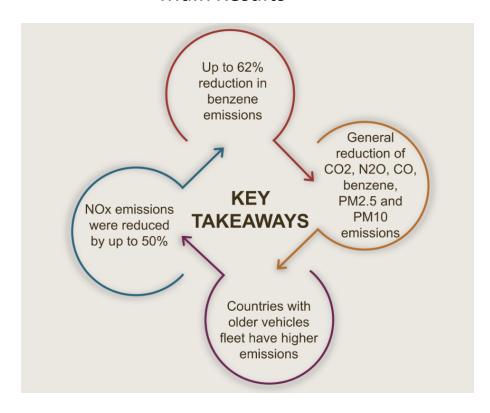
The model uses the Base Emission Rates from IVE model, as well as its Adjustment Factors based on:

- 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*.

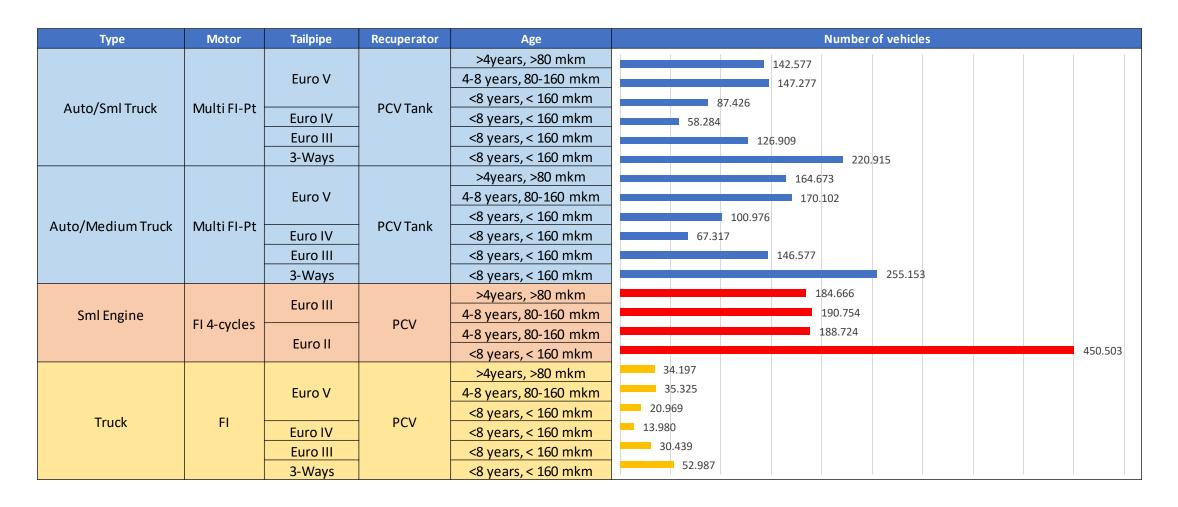
Main Results



^{*}Source: Bureau of transportation statistics.







Vehicle Fleet: **2,890,730** Average Age: **13 years**

Sources: CINAE, 2023; análisis de Faro90

Ecuador – Gasoline Vehicle 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	10.71	9.55	9.12	8.71	8.40	8.02	-11%	-19%	-25%	1	3.5
VOC	1.16	1.05	1.01	0.97	0.94	0.90	-10%	-16%	-22%	95	255
VOCevap	0.44	0.44	0.45	0.46	0.47	0.48	0%	4%	7%	0.1	0.273
NOx	0.55	0.39	0.36	0.34	0.32	0.30	-30%	-38%	-46%	0.06	0.203
SOx	0.01	0.00	0.00	0.00	0.00	0.00	-15%	-28%	-41%		
NH3	0.07	0.07	0.07	0.07	0.07	0.07	-2%	0%	1%		
Butadiene	0.01	0.01	0.01	0.01	0.01	0.01	-8%	-14%	-18%		
Acetaldehyde	0.02	0.03	0.05	0.07	0.08	0.09	68%	249%	372%		
Formaldehyde	0.08	0.09	0.10	0.11	0.12	0.13	13%	39%	68%		
Benzene	0.05	0.05	0.05	0.05	0.04	0.04	-9%	-11%	-18%		
CO2	241.01	228.96	224.36	222.08	219.89	215.84	-5%	-8%	-10%		
N2O	0.01	0.01	0.01	0.01	0.01	0.01	-1%	2%	4%		
CH4	0.26	0.26	0.26	0.27	0.27	0.28	0%	4%	7%		
PM 2.5	0.02	0.01	0.01	0.01	0.01	0.01	-22%	-43%	-65%		
PM10	0.04	0.03	0.03	0.02	0.02	0.01	-22%	-43%	-65%	0.005	0.007
ТНС	0.42	0.44	0.47	0.50	0.52	0.55	4%	20%	32%		

Source: Faro90