

Ethanol Blending in Gasoline - Panamá

June, 2023

Ethanol Blending in Latin America

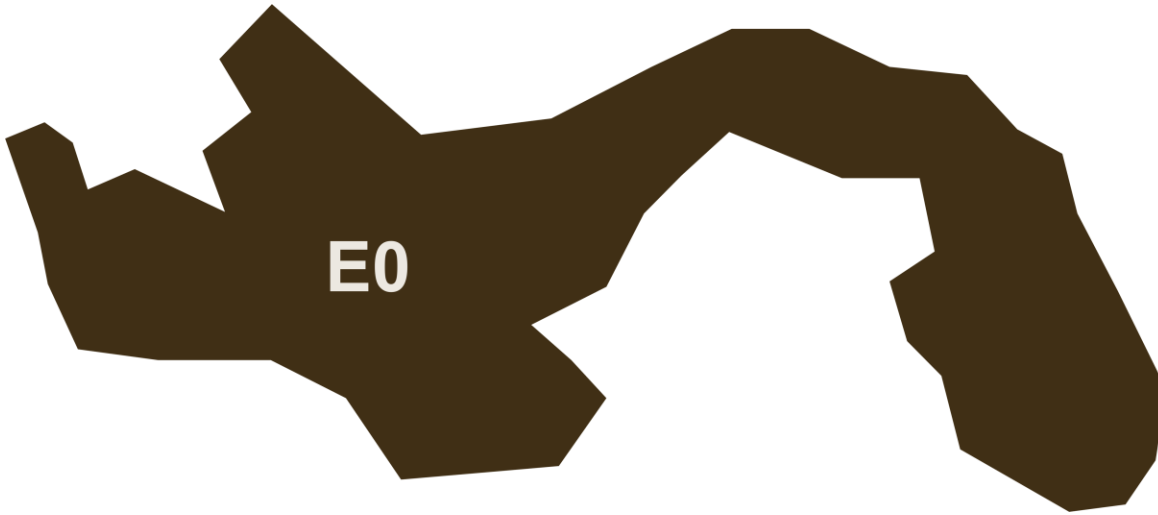
There are important fuel quality and environmental impact of vehicle emission challenges in the Region.

- 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 - Panamá

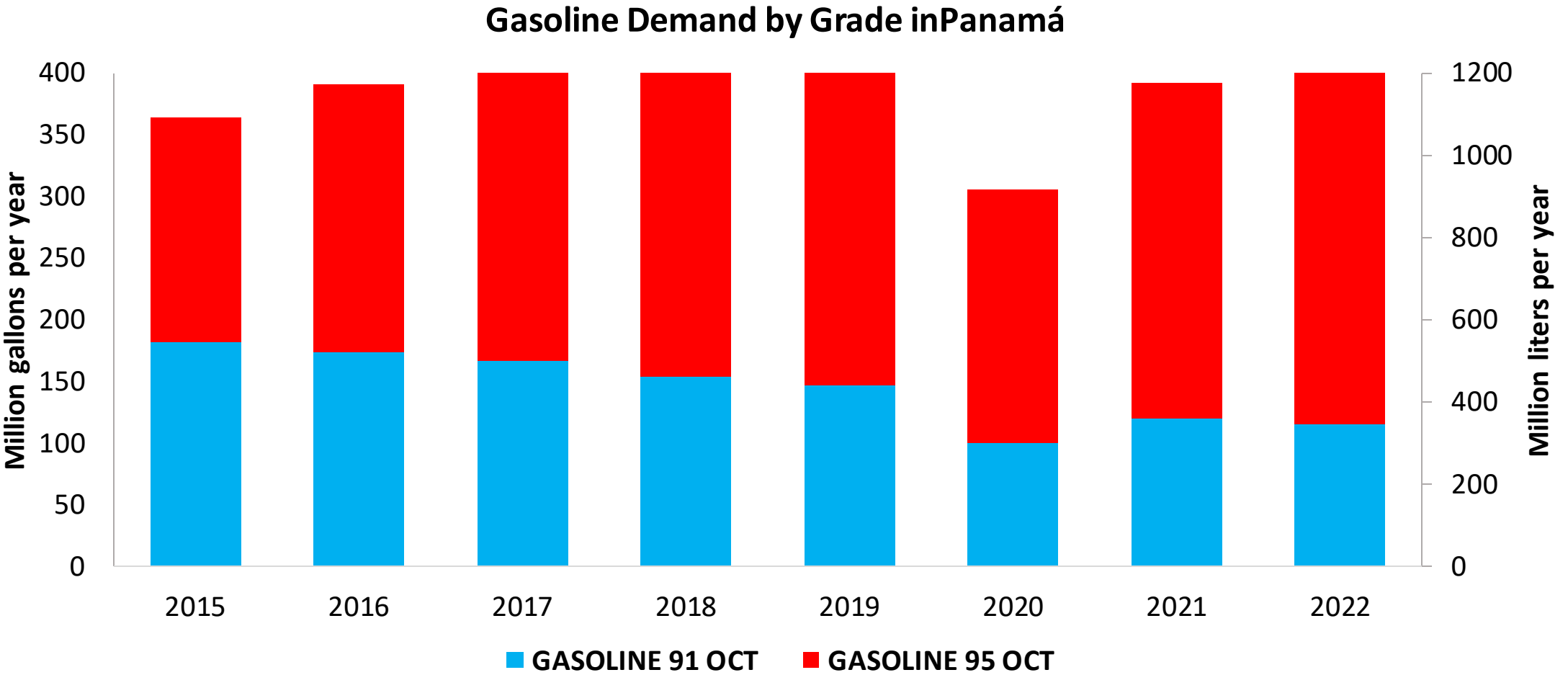


In 2022, regular gasoline (RON 91) represented 28.3% of the volume consumed while premium gasoline (RON 95) reached 71.7%. Gasoline is supplied only with imports, mainly from United States, the Netherlands and Germany.

In 2011, 2% v/v ethanol blends with gasoline were authorized, with a planned gradual increase until reaching 20% v/v by 2016. However, in 2013 it was limited to 5% v/v and by 2014 blending stopped because the only national producer announced its production cease due to political dispute. A new mandate implementation has been approved (starting with E5 in 2024 and reaching E10 in 2026).

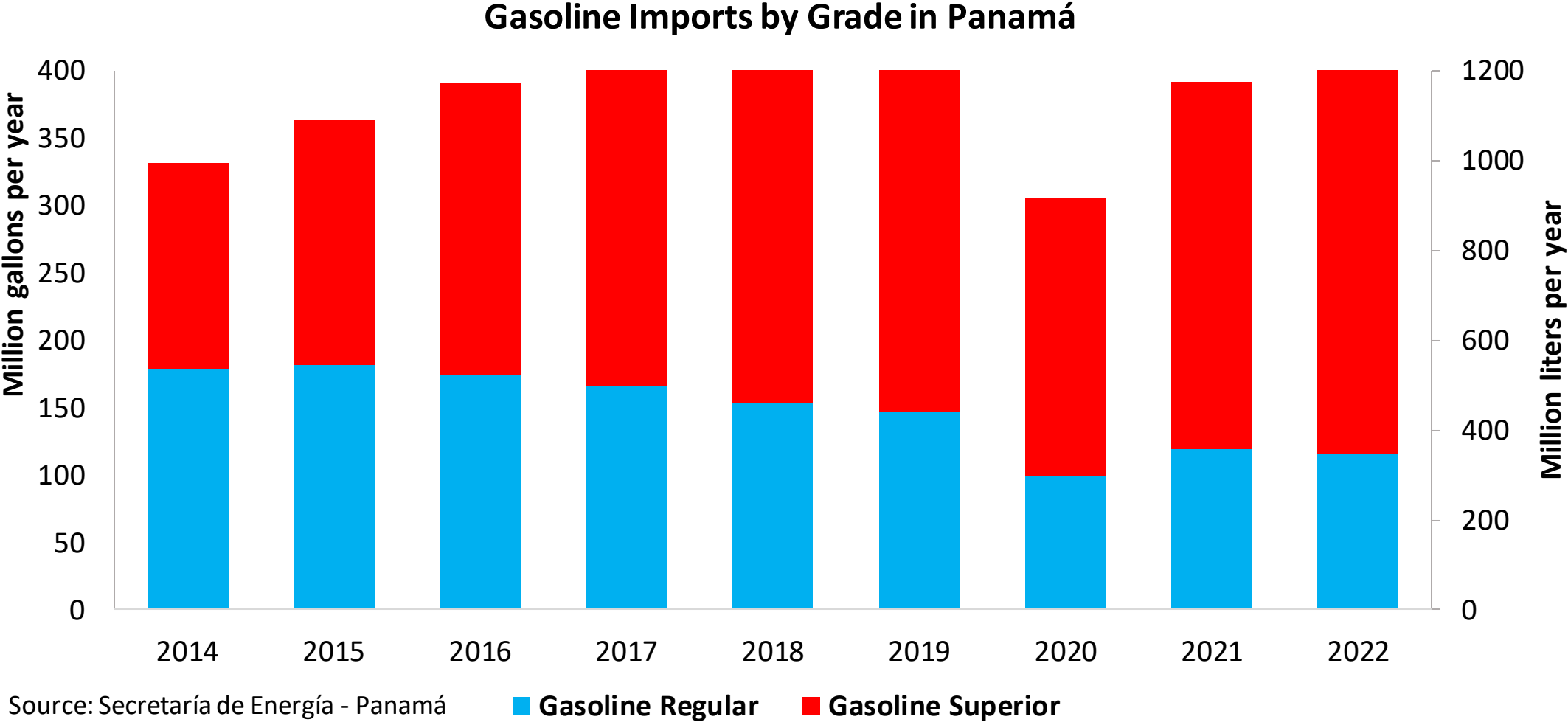
Source: Secretaría de Energía - Panamá

Gasoline Demand in Panamá



Source: Secretaría de Energía - Panamá

Gasoline Imports to Supply Demand in Panamá

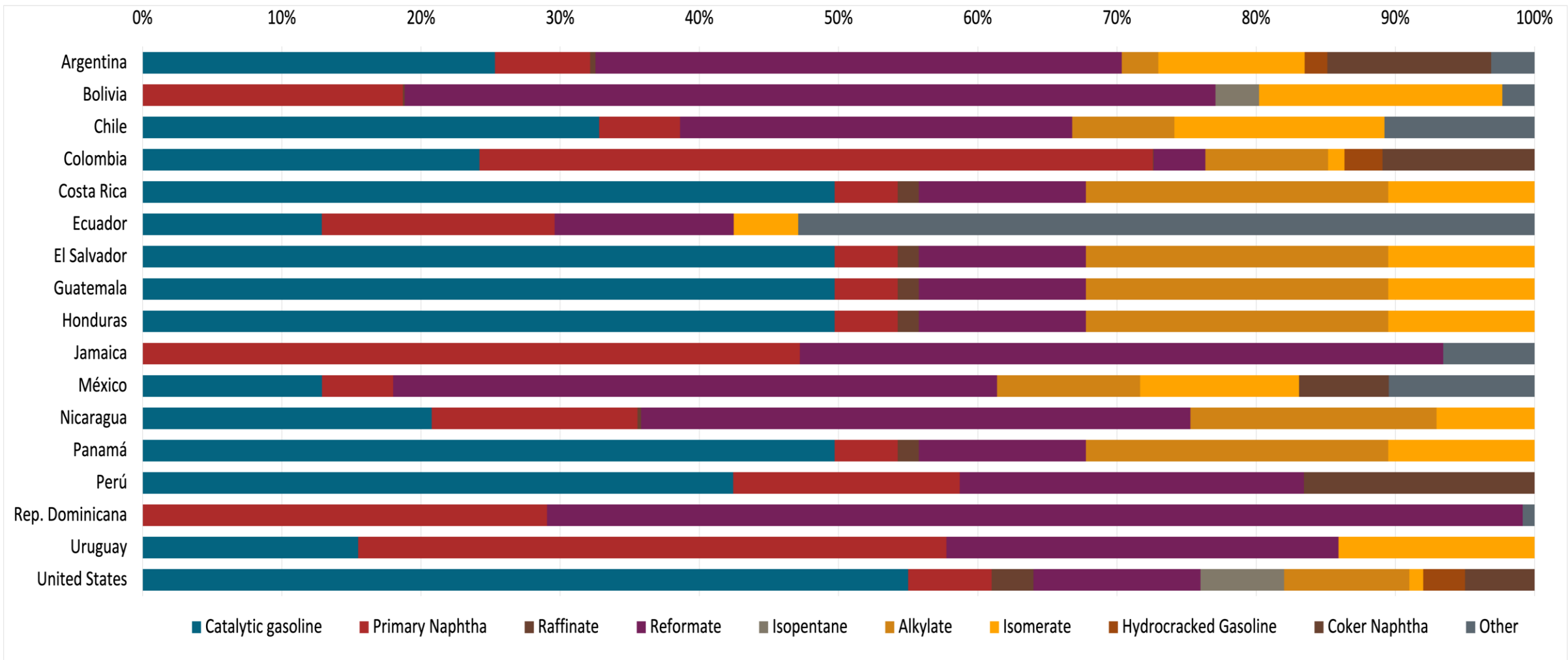


Gasoline Quality in Panamá

Name	DGNTI-COPANIT 83-2013/ Resolution 425/2020		EN 228:2012 + A1:2017 (Euro 6 enabling)			
Implementation Date	2014/2021		2017			
Applicability	Whole country	Whole country	All countries			
Selected Grade	RON 91	RON 95	RON 95 E5	RON 95 E10	RON 98 E5	RON 98 E10
Benzene Content	< 5% v/v / <1,5% v/v	< 5% v/v / <1,5% v/v	< 1 %v/v	< 1 %v/v	< 1 %v/v	< 1 %v/v
Aromatics	< 50% v/v	< 50% v/v	< 35 %v/v	< 35 %v/v	< 35 %v/v	< 35 %v/v
Olefins	< 30% v/v	< 30% v/v	< 18 %v/v	< 18 %v/v	< 18 %v/v	< 18 %v/v
Lead Content	< 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	> 91	> 95	> 95	> 95	> 98	> 98
MON	-	-	> 85	> 88	> 85	> 88
AKI						
Sulfur Content	< 500 mg/kg / < 150 mg/kg	< 500 mg/kg / < 150 mg/kg	< 10 mg/kg	< 10 mg/kg	< 10 mg/kg	< 10 mg/kg
Oxygen Content	-/ < 0,7% v/v	-/ < 0,7% v/v	<2,7 % m/m	<3,7 % m/m	<2,7 % m/m	<3,7 % m/m
Ethanol (EtOH)	10% v/v	10% v/v	<5 %v/v	<10 %v/v	<5 %v/v	<10 %v/v
RVP 37.8°C (Summer)	< 69 kPa (< 76 kPa if ethanol is added)	< 69 kPa (< 76 kPa if ethanol is added)	<> 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	0% v/v if ethanol is added	0% v/v if ethanol is added	-	-	-	-
Ehters 5 or more C Atoms	-	-	Based on oxygen content	<22 %v/v	Based on oxygen content	<22 %v/v

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:



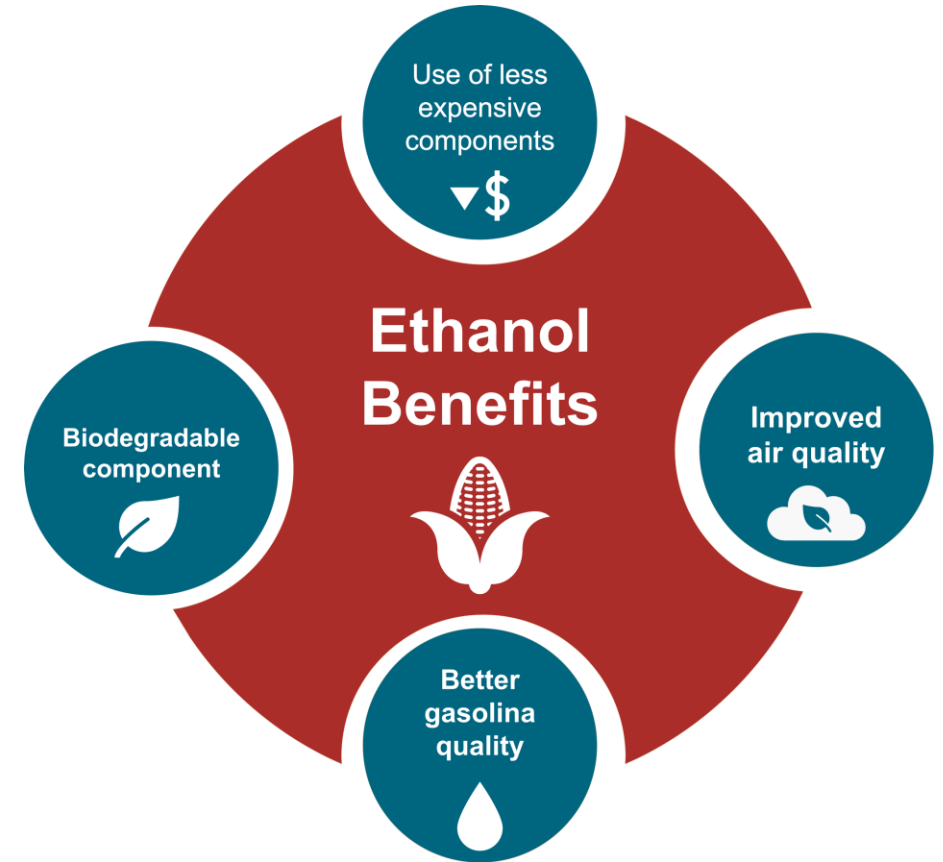
Gasoline Blending Optimization

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:

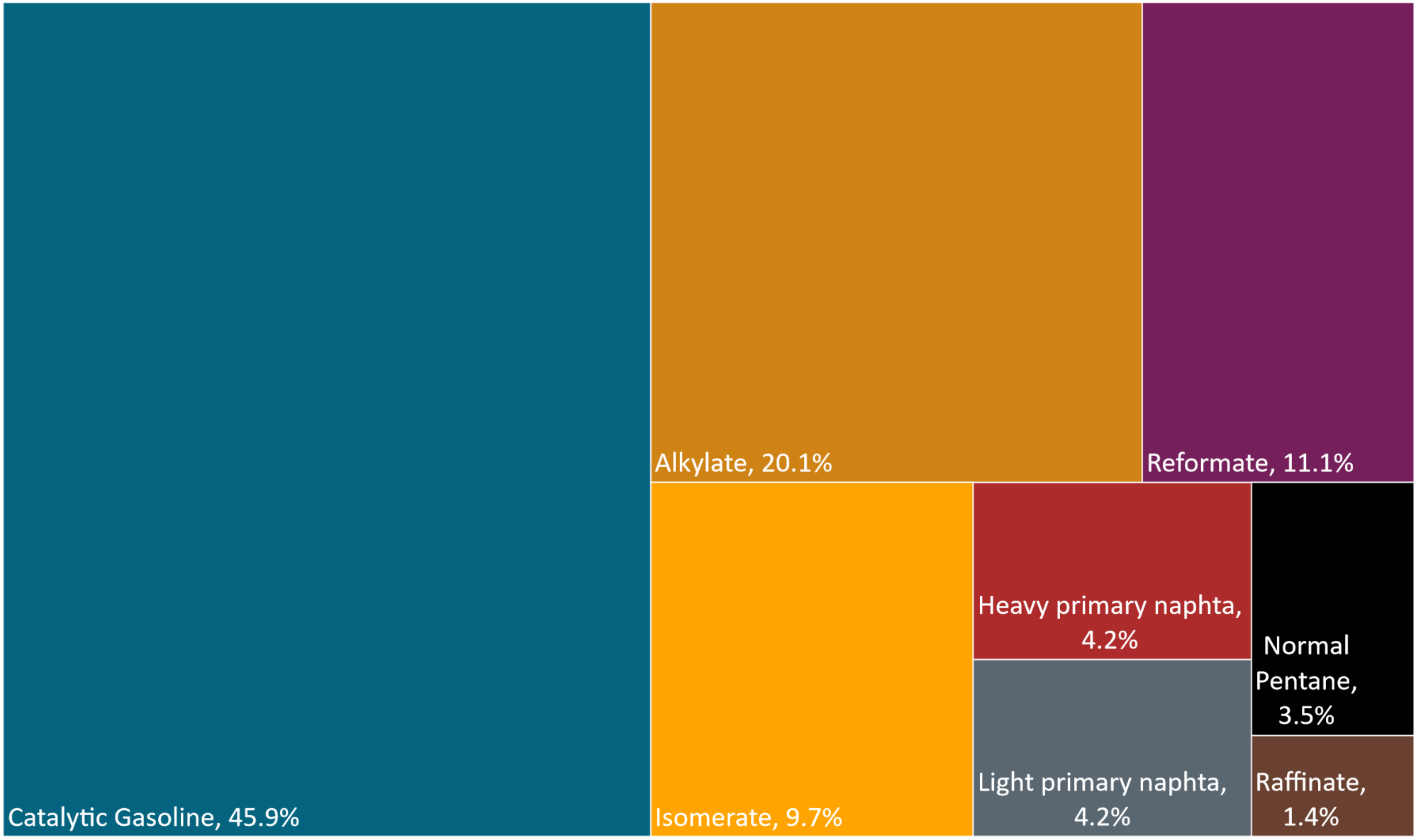
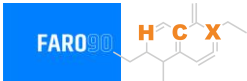
- Components prices,
- Properties each component affects,
- Quality parameters by country, and
- Component availability by country.

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.

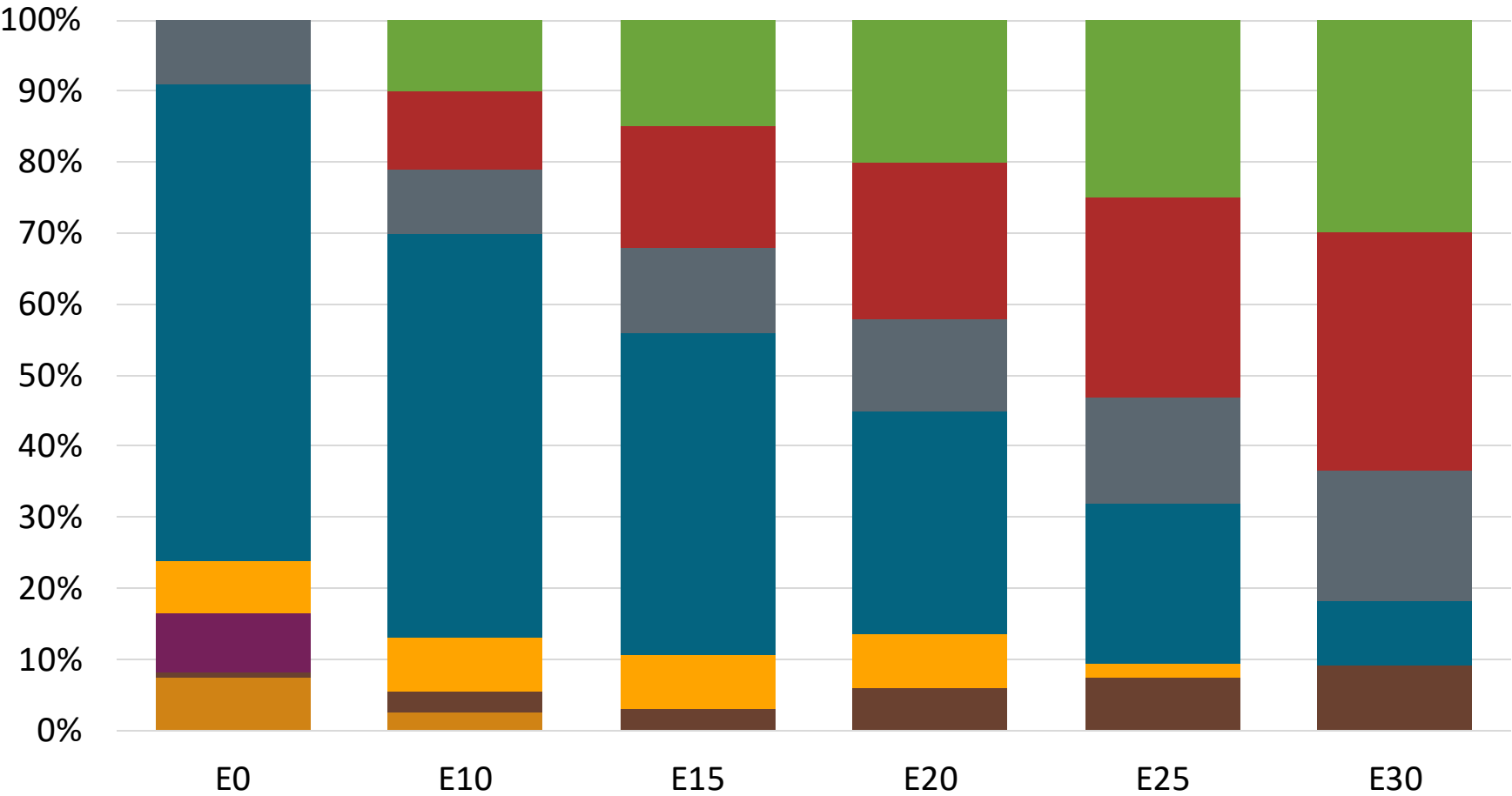
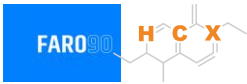


Blending Components- Panama



Source: Faro90

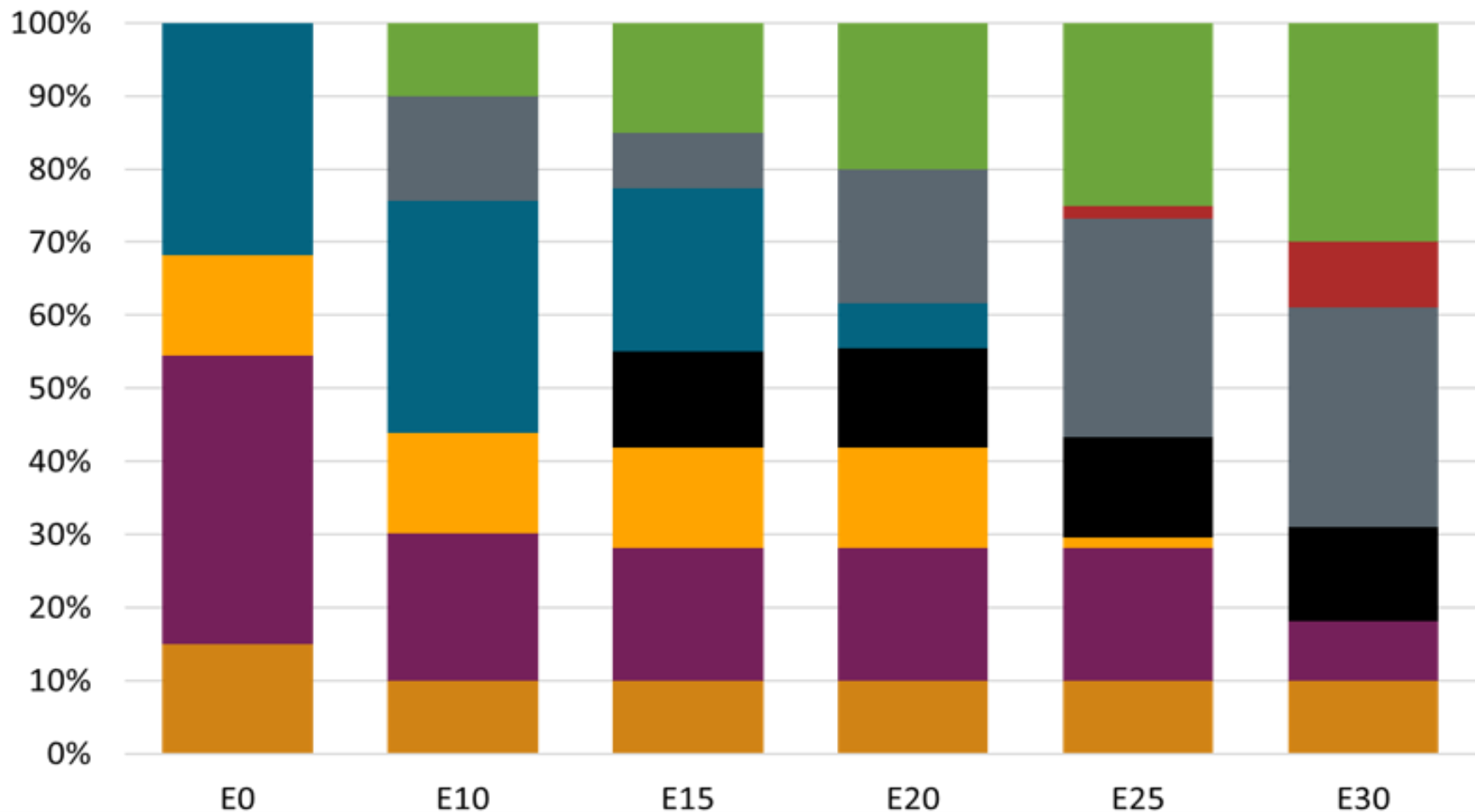
Panama – Regular – Constant Octane



Octane (RON)	91.0	91.0	91.0	91.0	91.2	91.3
Price (USD/gal)	\$ 2.331	\$ 2.189	\$ 2.127	\$ 2.067	\$ 2.009	\$ 1.945

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

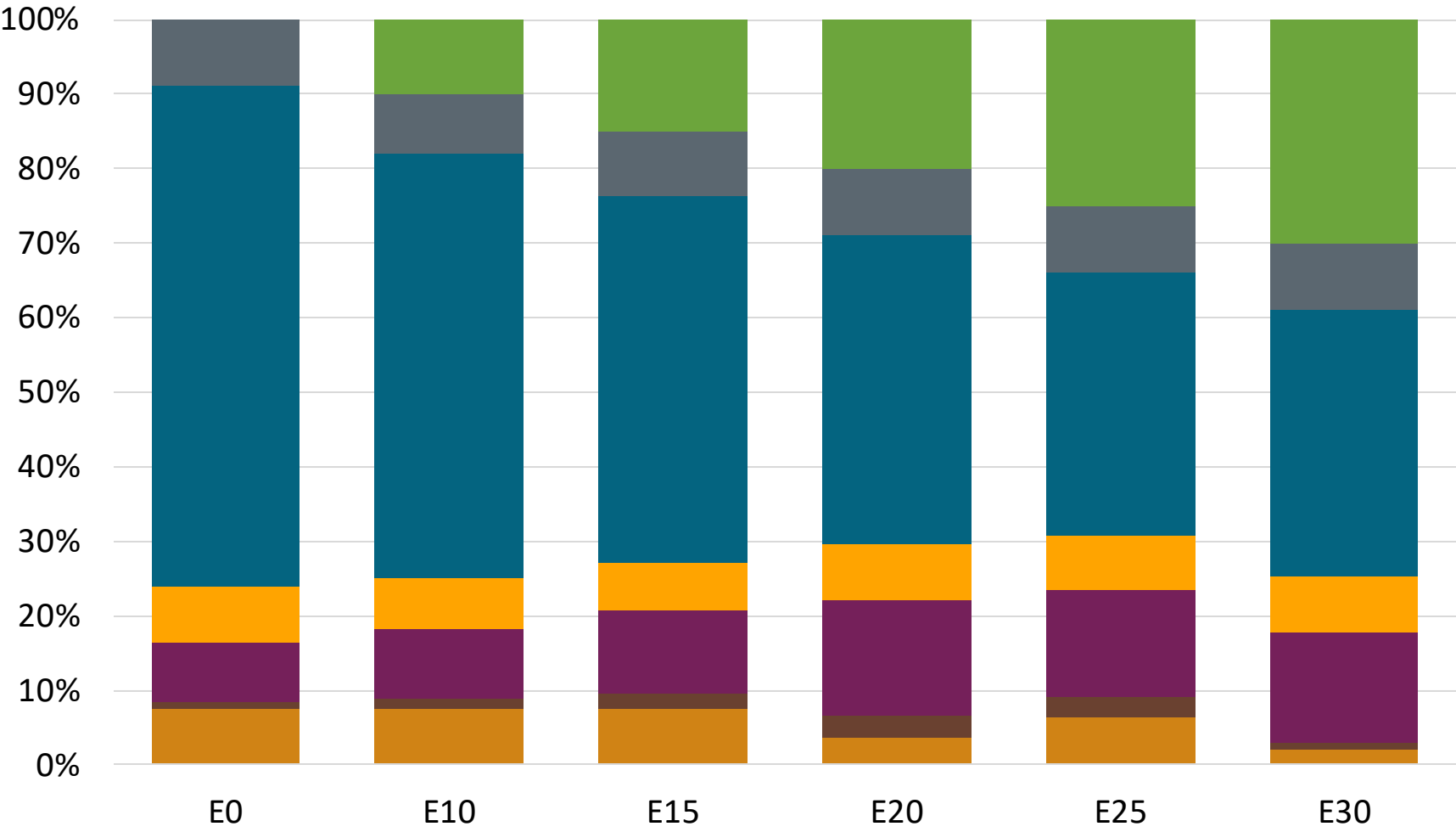
Panama – Premium – Constant Octane



Octane (RON)	E0	E10	E15	E20	E25	E30
Price (USD/gal)	\$ 2.497	\$ 2.364	\$ 2.273	\$ 2.198	\$ 2.116	\$ 2.032

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

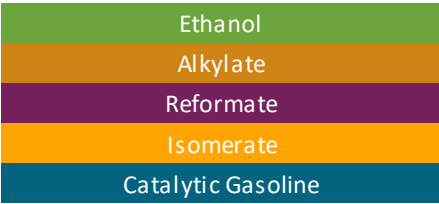
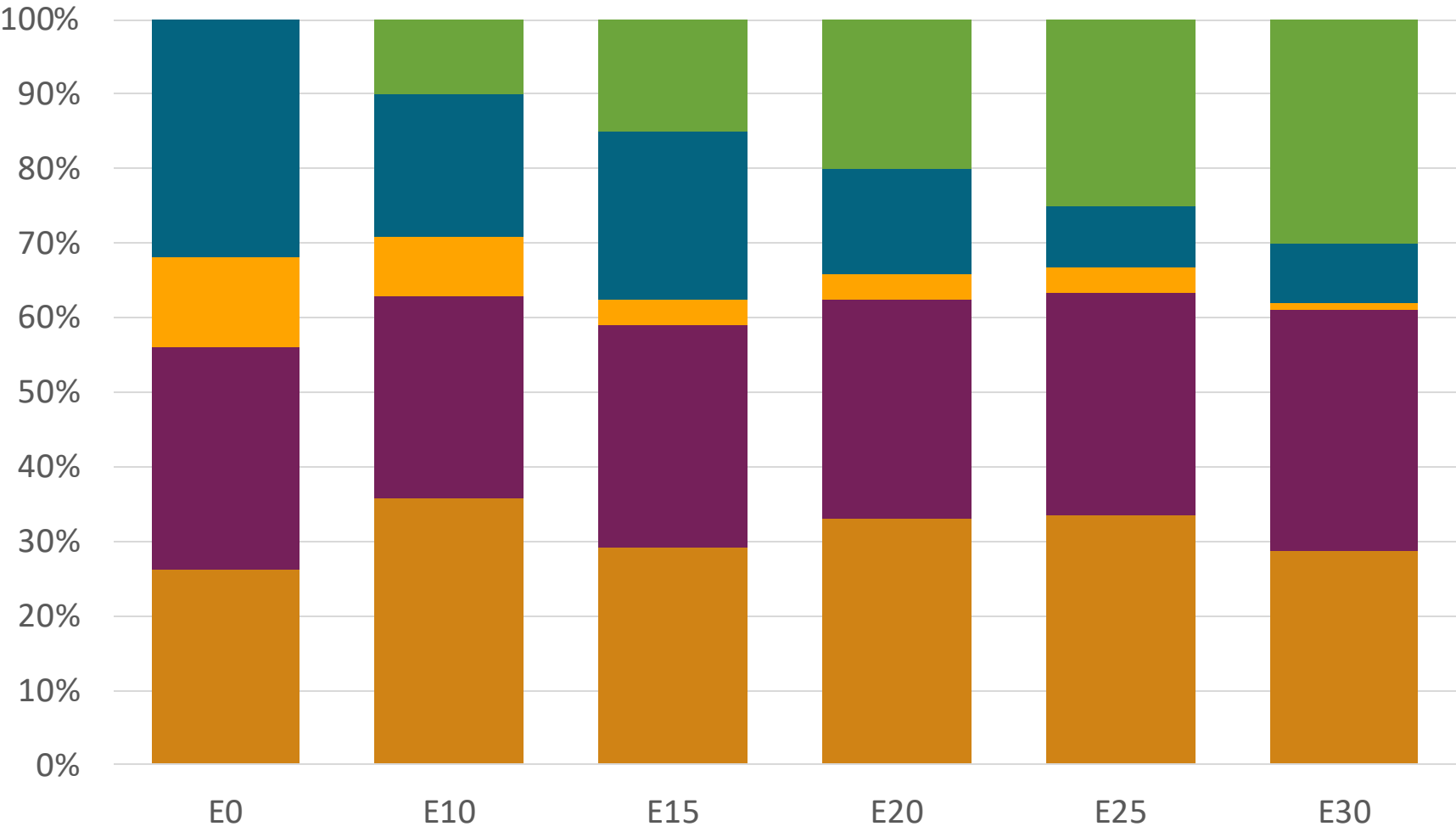
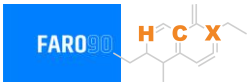
Panama – Regular – Octane Increment



Octane (RON)	91.0	95.7	97.8	99.7	101.6	103.8
Price (USD/gal)	\$ 2.326	\$ 2.326	\$ 2.326	\$ 2.326	\$ 2.326	\$ 2.326

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

Panama – Premium – Octane Increment



Octane (RON)	95.0	99.1	101.5	103.2	105.0	106.8
Price (USD/gal)	\$ 2.484	\$ 2.484	\$ 2.484	\$ 2.484	\$ 2.484	\$ 2.484

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 \(IVE\)](#).

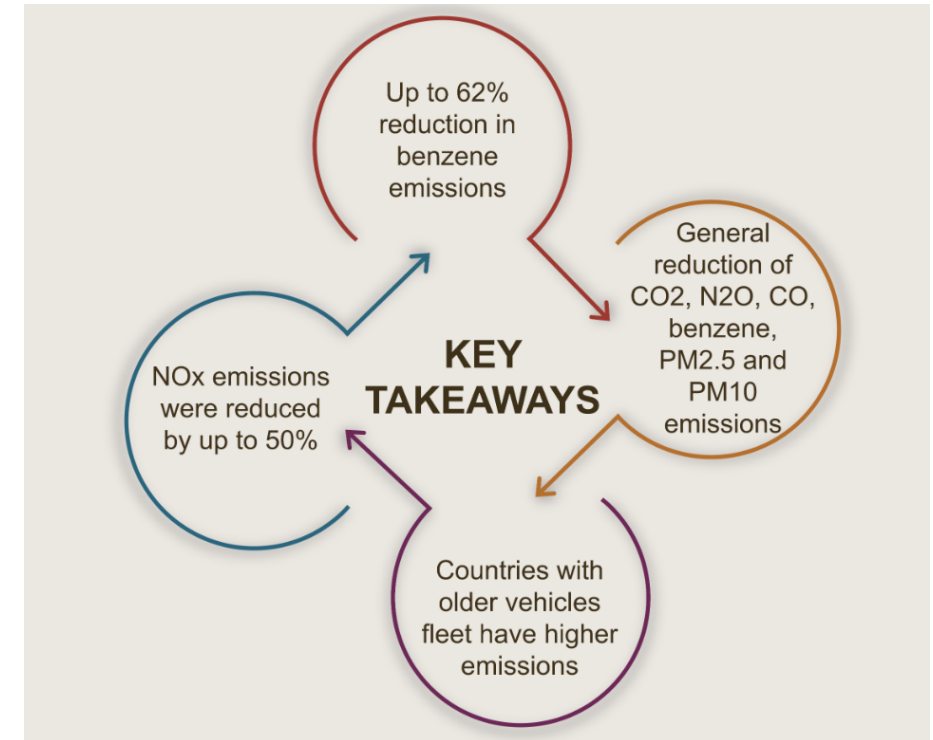
The model uses the Base Emission Rates from IVE model, as well as its Adjustment Factors based on:

- 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.*

Gasoline Vehicle Fleet - Panamá

Type	Motor	Tailpipe	Recuperator	Age	Number of vehicles					
Auto/Sml Truck	Multi FI-Pt	Euro V	PCV Tank	>4years, >80 mkm	<div></div> 158.603					248.888
				4-8 years, 80-160 mkm	<div></div> 180.576					
		Euro IV		<8 years, < 160 mkm	<div></div> 120.726					
				Euro III	<8 years, < 160 mkm	<div></div> 118.110				
		3-Ways		<8 years, < 160 mkm	<div></div> 112.096					
				<8 years, < 160 mkm	<div></div> 248.888					
Sml Engine	FI 4-ciclos	Euro III	PCV	>4 years, >80 mkm	<div></div> 5.544				20.966	
				4-8 years, 80-160 mkm	<div></div> 3.156					
		Euro II		4-8 years, 80-160 mkm	<div></div> 3.156					
				<8 years, < 160 mkm	<div></div> 20.966					
Truck	FI	Euro V	PCV	>4 years, >80 mkm	<div></div> 20.672				32.439	
				4-8 years, 80-160 mkm	<div></div> 23.536					
		Euro IV		<8 years, < 160 mkm	<div></div> 15.735					
				Euro III	<8 years, < 160 mkm	<div></div> 15.394				
		3-Ways		<8 years, < 160 mkm	<div></div> 14.610					
				<8 years, < 160 mkm	<div></div> 32.439					

Vehicle Fleet: **1,094,207**
Average Age: **11.9 años**
Motorcycles: **3%**

Gasoline Vehicle Fleet - 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
CO	10.38	9.70	9.50	9.35	9.24	9.06	-7%	-10%	-13%	1	3.5
VOC	0.81	0.78	0.78	0.78	0.78	0.78	-4%	-4%	-5%	95	255
VOCevap	0.43	0.43	0.44	0.45	0.46	0.47	0%	4%	7%	0.1	0.273
NOx	0.51	0.36	0.34	0.32	0.30	0.27	-30%	-38%	-46%	0.06	0.203
SOx	0.01	0.01	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	-4%	-4%	-4%		
Acetaldehyde	0.01	0.02	0.03	0.04	0.04	0.05	68%	249%	372%		
Formaldehyde	0.04	0.04	0.05	0.05	0.05	0.06	13%	39%	68%		
Benzene	0.05	0.04	0.04	0.04	0.04	0.04	-9%	-11%	-18%		
CO2	269.39	255.92	250.78	248.23	245.71	241.18	-5%	-8%	-10%		
N2O	0.01	0.01	0.01	0.01	0.01	0.01	-1%	2%	4%		
CH4	0.18	0.18	0.18	0.19	0.19	0.19	0%	4%	7%		
PM 2.5	0.02	0.02	0.01	0.01	0.01	0.01	-22%	-43%	-65%		
PM10	0.02	0.01	0.01	0.01	0.01	0.01	-22%	-43%	-65%	0.005	0.007
THC	0.28	0.29	0.30	0.32	0.33	0.35	3%	15%	24%		