



Empresa de Pesquisa Energética

# ETHANOL SUPPLY SCENARIOS AND OTTO CYCLE DEMAND 2024-2033

## EXECUTIVE SUMMARY

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### INTRODUCTION

The Ethanol Supply Scenarios and Otto Cycle Demand analysis aims to contribute for identifying opportunities and risks to the fuel demand of Otto cycle light vehicles in Brazil. Considering transport demand reference from EPE, the present document discusses **three ethanol supply scenarios from sugarcane and corn** and its consequences for the fuel demand in light vehicles and the **national balance of “A” gasoline** from 2024 up to 2033. This document also includes the bioelectricity from sugarcane exported to the National Interconnected System, the potential of biogas production from sugarcane residuals, an evaluation of the investments associated to each scenario and the sugar and corn-energy sectors contribution for greenhouse gases emissions (GHG) reduction in the Energy Sector.

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### ETHANOL SUPPLY

This study provides three scenarios for ethanol supply denominated **High Growth, Medium Growth and Low Growth**, which differ in the increase in ethanol production.

Each scenario will present a greater or lesser attractiveness for ethanol, which will be reflected production capacity variation, different production factors and in technological innovations for this sector. Another issue concerns over the scope of government actions, whether direct or indirect, such as the tax differentiation between hydrous ethanol and C gasoline (CIDE, ICMS, PIS / COFINS) and the provision of specific financing lines for this industry, which will induce growth to a greater or lesser degree.

Specifically, the effectiveness of RenovaBio was reflected in the biofuels increase in production by revenues from Credit Decarbonization (CBIO) sales.

As common assumptions for all scenarios, was adopted the position of October 2023 as a reference for producing plants in operation and authorizations for expansion and construction

by the ANP (2023b). In relation to sugarcane, the effective installed capacity was 785 Mtc (49 billion liters for ethanol) and was considered, for all scenarios, the expansion of capacity for operating units in 2,3 billion liters of ethanol and a installation of one unit, with construction authorization by ANP (2023b). For corn ethanol and others, the production capacity was 6,4 billion liters and was adopted the expansion of 665 million liters (ANP, 2023b) and the increase in ethanol production capacity by 5.9 billion liters. In 2033, Brazil will export 2.8 billion liters of ethanol and consume 1.2 billion liters of it for non-energetic use. Sugarcane yield average will reach 142 kg TRS (Total Recoverable Sugar) / tons of sugarcane in the period.

For each scenario, the variation of ethanol production capacity and sugarcane and corn processing was considered, based on the actions of sector agents and government incentives. Thus, it is estimated that the expansion of production capacity for ethanol will reach 62,9, 66,3 e 71,5 in the low, medium and high growth scenarios, respectively. The installed capacity of nominal for sugarcane will be 865, 875 e 897 million tons and

for corn, 26,8, 33,6 e 42,2 million tons. E2G generation will be integrated with the E1G and have the capacity of 1,800, 1,200 and 730 million liters by 2033, in the low, medium and high growth scenarios, respectively.

Sugar production in the period of 2022-2033 will grow at a rate of 2.1% per year, reaching 45.7 million tons in 2033 for the low and medium scenarios and 49.1 million tonnes for the high growth scenario, at the end of the period.

The table 1 summarizes the results of area, productivity, processed cane, total ATR and ethanol supply for the year 2033.

**Table 1: Supply scenarios results for 2033**

GROWTH SCENARIOS	AREA (MHA)	YIELD (TC/HA)	SUGARCANE (MTC)	TRS (Mt)	ETHANOL SUPPLY (BILLION LITRES)
Low	8.6	79.3	681	97	40.4
Medium	8.8	81.6	719	102	46.5
High	9.0	84.1	759	108	51.0

From this ethanol supply, for low, medium and high growth scenarios, the part referring to sugarcane will 28.9, 32.3 and 33.8 billion liters; for corn, 10.3, 12.7 and 15.0 billion liters; and to 2G, 0.6, 1.0 and 1.7 billion liters.

## FUEL DEMAND OF OTTO CYCLE LIGHT VEHICLE

In addition to the economic scenario, the global fuel demand for Otto cycle light vehicles fleet considers a few other aspects, such as the registration of new light vehicles, the price of C gasoline at pump and the consumer preference between C gasoline and hydrous ethanol in flex fuel vehicles supply.

Other assumptions include: the 27% mandatory anhydrous ethanol content in C type gasoline in the period.; and the alignment of the producer's price of gasoline with international prices. As a result, the national fleet of light vehicles (cars and light commercial vehicles) reaches the mark of 46.1 million units in 2033, a rate of 1.9% p.a., leading the demand for Otto cycle fuels, reaching 63.3 billion liters of gasoline equivalent. At the end of the period, flex fuel vehicles will represent 86% of the national fleet.

**Table 2: Demand scenarios results for 2033**

GROWTH SCENARIOS	FUEL ETHANOL (BILLION LITRES)	A GASOLINE (BILLION LITRES)	HYDROUS ETHANOL MARKET SHARE ON FLEX FUEL (%)
Low	36.4	34.5	34
Medium	42.5	30.2	44
High	47.0	27.2	51

To evaluate the A type gasoline balance, the analysis the production forecast, according to The Ten-Year Energy Expansion studies. This exercise showed that, for all scenarios, there will be a need for imports throughout the study horizon, reaching 8.0, 4.0 and 1.0 billion liters in 2033, for the low, medium and high scenarios, respectively. For the high scenario, since 2027, imports will be below the historical maximum (4.9 billion liters in 2020) and, in the medium scenario, this fact will be observed from 2031 (EPE, 2023e)..

## OTHER RESULTS

The study also showed that, in 2033, the sugarcane bioelectricity is expected to inject 5.4 GWm, 5.7 GWm and 6.1 GWm in low, medium and high growth scenarios, respectively. Also considers that if all vinasse, filter cake and straw would be used exclusively for the production of biogas, and volumes vary from 11.8 to 11.0 Billion Nm<sup>3</sup> (which represents between 6.5 billion Nm<sup>3</sup> and 6.0 billion Nm<sup>3</sup> of biomethane) in 2033, for low, medium and high growth scenarios, respectively. In contrast, avoided GHG emissions from use of fuel ethanol (sugarcane and corn) and bioelectricity will reach 65.8, 70.1 and 71.3 MtCO<sub>2</sub> in 2033 for the low, medium and high growth scenarios, respectively.

The estimated investments for the expansion of existing sugar-energy units (brownfield), new units (greenfield), second generation ethanol and corn ethanol (flex and full), are 27.4 billion, 42.6 billion and 62.3 billion reais for growth scenarios low, medium and high, respectively.

The document considers that the ethanol supply trajectory by 2033 will be defined by the effectiveness public policies, such as RenovaBio, and the degree of the stakeholders' actions towards the production factors' improvement.

This study shows to be relevant to contribute at the performance of public policies aimed at supplying the Otto cycle fuel market vehicles and to Brazil's meets international

commitments under the Paris Agreement, contributing to the country's energy planning in the medium and long term.