



Empresa de Pesquisa Energética

ETHANOL SUPPLY SCENARIOS AND OTTO CYCLE DEMAND

2023-2032

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. For the reference transport demand from EPE, the present document discusses **three ethanol supply scenarios** and its consequences for the fuel demand in light vehicles and the **national balance of “A” gasoline** from 2023 up to 2032. This document also includes the bioelectricity from sugarcane exported to the National Interconnected System, the potential of biogas production, an evaluation of the investments associated to each scenario and the sugar-energy sector 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 in installation and closing of production units, 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 July 2022 as a reference for producing plants in operation and authorizations for expansion and construction

by the ANP (2022b). In relation to sugarcane, the effective installed capacity was 730 Mtc and was considered the expansion of 24 Mtc and the construction of four new units, with construction authorization by ANP. For corn ethanol, the production capacity was 4,6 billion liters and was adopted the expansion of 1 billion liters and the construction of 12 new units, as authorized by ANP (2022b). In 2032, Brazil will export 2.3 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 the installation and closing of production units was considered, based on the actions of sector agents and government incentives. Thus, it is estimated that the expansion of production capacity for conventional sugarcane ethanol will add 4, 7 and 9 new plants, with a variation of the installed capacity of nominal milling of 30, 47 and 59 million tons, in the low, medium and high growth scenarios, respectively, related to July 2022. E2G generation will be integrated with the E1G and produce 819, 563 and

315 million liters by 2032, in the low, medium and high growth scenarios, respectively. For corn ethanol, the study considers flex and dedicated plants, forecasting production of 7.1, 9.1 and 11.8 billion liters for the low, medium and high growth scenario.

Sugar production in the period of 2021-2032 will grow at a rate of 2.2% per year, reaching 44.8 million tons in 2032 for the low and medium scenarios and 47.7 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 2032.

Table 1: Supply scenarios results for 2032

GROWTH SCENARIOS	AREA (MHA)	YIELD (TC/HA)	SUGARCANE (MTC)	TRS (MT)	ETHANOL SUPPLY (BILLION LITRES)
Low	9.0	78.6	708	101	40.7
Medium	9.2	81.4	751	107	46.8
High	9.5	84.7	807	115	52.9

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; the vehicle efficiency gains at 1% p.a.; 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 47.3 million units in 2032, a rate of 2.2% p.a., leading the demand for Otto cycle fuels, reaching 60.8 billion liters of gasoline equivalent. At the end of the period, flex fuel vehicles will represent 89% of the national fleet.

Table 2: Demand scenarios results for 2032

GROWTH SCENARIOS	FUEL ETHANOL (BILLION LITRES)	A GASOLINE (BILLION LITRES)	HYDROUS ETHANOL MARKET SHARE ON FLEX FUEL (%)
Low	37.2	31.5	38
Medium	43.4	27.4	48
High	49.4	23.5	57

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, volumes of gasoline A imports will be necessary in 2023. In the low-growth scenario, however, there is a gasoline deficit between in 2030 and 2032, when it reaches 3.4 billion liters, lower than the historical maximum (4.9 billion liters in 2020). For the medium and high scenarios, there will be no import for the period.

OTHER RESULTS

The study also showed that, in 2032, the sugarcane bioelectricity is expected to inject 5.6 GWm, 6.0 GWm and 6.4 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, the volumes produced would reach 11.1, 12.0 and 12.9 Billion Nm³ in 2032, for low, medium and high growth scenarios, respectively. In contrast, avoided GHG emissions from use of fuel ethanol (EG1) and bioelectricity will reach 62.0, 65.2 and 67.8 MtCO₂ in 2032 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 22.9 billion, 38.6 billion and 55.4 billion reais for growth scenarios low, medium and high, respectively.

The document considers that the ethanol supply trajectory by 2032 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.