Empresa de Pesquisa Energética

ETHANOL SUPPLY SCENARIOS AND OTTO CYCLE DEMAND 2018-2030

EXECUTIVE SUMMARY

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Natural Gas and Biofuels Department / Division of Oil, Gas and Biofuel Studies

URL: http://www.epe.gov.br |**E-mail:** biocombustiveis@epe.gov.br

Head Office: Av. Rio Branco, nº 1 - 11º Andar – Zip Code: 20.090-003 – City/State: Rio de Janeiro/RJ

INTRODUCTION

The Ethanol Supply Scenarios and Otto Cycle Demand analysis aims to contribute for identifying opportunities and challenges to satisfy fuel demand of Otto cycle light vehicles in Brazil (ethanol and gasoline motors). The present document discusses **ethanol supply scenarios** and its consequences for the fuel demand in light vehicles and the **national balance of "A" gasoline** up to 2030. This study makes assumptions regarding ethanol from lignocellulose, corn ethanol and energy cane. In addition, the document included the supply of the bioelectricity from sugarcane to the National Interconnected System and the potential of biogas production, as well as an evaluation of the sugar-energy sector contribution for greenhouse gases emissions (GHG) reduction in the Energy Sector and an assessment of associated investments.

Technical Team

Executive Coordination
Giovani Vitória Machado

Technical Coordination.
Angela Oliveira da Costa

Technical Team
Angela Oliveira da Costa
Marina D. Besteti Ribeiro
Rachel Martins Henriques
Rafael Barros Araujo

The enactment of the National Biofuels Policy Act (RenovaBio) in December 2017 provides huge opportunities for production expansion and biofuels use in the national energy matrix, with a focus on regular fuel supply and forecast of the country's fuel market share of these sources of energy. RenovaBio also aims to cooperate to meet Brazilian commitments to the Paris Agreement under the United Nations Framework Convention on Climate Change, aiming to enhance its role in mitigating GHG.

ETHANOL SUPPLY

The study provides three scenarios for ethanol supply, **High Growth, Medium Growth and Low Growth**, which are distinguished by the effectiveness of RenovaBio, reflected by the increase in biofuel production, by the revenues from the commercialization of its carbon credit (CBIO) and the effectiveness of the responses of the stakeholders. Another issue concerns about 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 the industry, which will induce its growth to a greater or lesser degree. Common assumptions for all scenarios are: an effective installed capacity of 744 Mtc cane milling, the construction of two new units and expansion of the milling capacity of 23 existing ones (32 Mtc). Also, in the same way for all three scenarios, E2G generation will be integrated with the 1st and produce 2.0 billion liters by 2030. In the same year, Brazilian ethanol exports will reach 2.7 billion liters and biofuel demand for non-fuel use 1.4 billion liters. Considering that part of the sugarcane industry will seek the implementation of good agricultural practices and technologies, sugarcane yield will reach 139 kg ATR / tc by 2030.

Specifically for each scenario, this study estimates that the price of CBIO will contribute, somehow, to the expansion of ethanol production. Thus, it estimates that the expansion of production capacity for conventional sugarcane ethanol will add 12, 26 and 34 new units, with a variation of the installed capacity of nominal milling of 80, 151 and 224 million tons, in the low, medium and high growth scenarios, respectively. For corn ethanol, the study considers flex and dedicated plants, with possibility of supplying the market of the North and Northeast regions, forecasting production of 1.5, 2.3 and 3.4

billion liters, in the low, medium and high growth scenarios, respectively. Sugar production in the period of 2017-2030 will grow at a rate of 1.4% per year, reaching 45.8 million tons in 2030 for the low and medium scenarios and 48.8 million tonnes for the high growth scenario, at the end of the period. The study estimates that the insertion of "energy cane" will occur gradually, and should be used preferentially to ethanol production. In 2030, it will represent 260,000 hectares in the medium and low growth scenarios and 500,000 ha in the high growth scenario. The table below summarizes the results of area, productivity, processed cane, total ATR and ethanol supply for the year 2030.

Table 1: Supply scenarios results for 2030

Scenarios of growth	Area (Mha)	Yield (tc/ha)	Sugarcane (Mtc)	TRS* (Mt)	Ethanol supply (billion litres)
Low	9.7	83.8	812	113	42.8
Medium	10.1	87.2	880	122	49.4
High	10.4	90.6	945	132	54.0

FUEL DEMAND OF OTTO CYCLE LIGHT VEHICLE

In addition to the economic scenario (GDP of 3% on average), the global fuel demand for Otto cycle light vehicles fleet considers a few other aspects, such as the registration of new light vehicles (5 million vehicles in 2030, 4.2% hybrid),

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 non-entry of pure electric or diesel cars in the period; the production of flex fuel hybrids by national automakers from 2021; the 27% mandatory anhydrous ethanol content in C 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[1] of light vehicles reaches the mark of 54.4 million units in 2030, a rate of 3.1% p.a., leading the demand for Otto cycle fuels, reaching 69.1 billion liters of gasoline equivalent.

Table 2: Demand scenarios results for 2030

Scenarios of growth	Fuel ethanol (billion litres)	A Gasoline (billion litres)	Hydrous ethanol market share on Flex Fuel (%)
Low	38.7	38.1	33
Medium	45.3	33.7	43
High	50.0	30.6	50

The analysis considers historical data on domestic production, presented in the Brazilian Energy Balance (BEN2017) and the production forecast, according to previous EPE studies for the evaluation of A gasoline balance. Considering the latter, imports of this fuel would be necessary for the three supply scenarios during the entire period, with the exception of the 2021-2026 range, for the high growth scenario. These imports would reach 10.8, 6.5 and 3.4 billion liters in 2030 for the low, medium and high growth scenarios, respectively.

OTHER RESULTS

The study showed that the bioelectricity of sugarcane, in the most conservative assessment, should inject in 2030, 5.0 and 4.3 average GW in the high and low growth scenarios, respectively. Also, it showed that the use of vinasse and filter cake for production of biogas, for the period, allows the generation of 8.3 $MMNm^3$ and 6.8 $MMNm^3$ for the respective scenarios. In contrast, avoided GHG emissions from use of fuel ethanol and bioelectricity share may range from 72 $MtCO_2$ to 65 $MtCO_2$ for the high and low growth scenarios, respectively. Estimated investments for the expansion of existing brownfield units, new units (Greenfield), second generation ethanol and corn ethanol (Flex and Full), are in the range of 33, 54 and 86 billion BRL in the low, medium and high growth scenarios, respectively. The document considers that the ethanol supply trajectory by 2030 will be defined by the execution of the RenovaBio and the degree of effectiveness of the stakeholders' actions towards the production factors' improvement. Further development studies are relevant to determine the magnitude and the performance of the public policies aimed at supplying the Otto cycle fuel market. Moreover, it contributes to Brazil meets international commitments under the Paris Agreement.

[1] Cars and light commercial vehicles.