Empresa de Pesquisa Energética

INVESTMENTS AND OPERATING AND MAINTENANCE COSTS IN THE BIOFUEL SECTOR: 2021–2030

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INTRODUCTION

This report aims to present the calculation methodology, assumptions and estimates of investments (*CAPEX*, *capital expenditure*) and operating and maintenance costs (*OPEX*, *operational expenditure*) relating to biofuels for the period 2021–2030, including ethanol (sugarcane and corn), biodiesel, biogas (sugar-energy sector) and Biojet/Green Diesel. The supply and demand values of biofuels refer to the study cycle that supported the elaboration of the Ten Year Energy Expansion Plan (PDE 2030).

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I. ETHANOL

The projection of national ethanol production will reach 45 billion liters by 2030, according to the document Otto Cycle Supply Scenarios and Demand Scenarios (average growth). In addition to the participation of conventional sugarcane, the volumes of lignocellulosic ethanol and corn ethanol reach, respectively, 5.7 and 0.4 billion liters in 2030. The amount of sugarcane for the biofuel production is estimated at 472 million tonnes, about 60% of the total (EPE, 2020a, 2020b).

During the study period (2021–2030), it is estimated the entry of 9 new units (greenfields), which increase the nominal capacity of sugarcane crushing by 32 million tons, and the expansion of 45 million tons (nominal) in existing first generation sugarcane units.

For the evaluation of the necessary investments, it was considered that the units would be mixed or distilleries, with optimized technological profile and average size of 3.5 million tons of nominal sugarcane crushing capacity, with an average investment of R$360.00/tc For the expansion of existing units, an average investment of R$256.00/tc was adopted. These values take into consideration the lease of land, agricultural machinery, and the industrial part with optimized cogeneration, as detailed in Table 1.

Table 1: CAPEX estimate of first generation sugarcane mills

CAPEX	R$(dec. 2017)/tc
New units (*Greenfield*)	**359.6**
Industrial (includes optimized cogeneration)	287.6
Agricultural machinery (includes trucks)	67.8
Land leasing (Center-West region)	4.3
Expansion of existing plants (*Brownfield*)	**256.0**

Note: The *CAPEX* was given per ton of sugarcane, since part of the production may be used for sugar, which does not occur in the E2G and Ethanol units of corn.
Source: EPE based on CTBE (2018) and UNICA (2014)

Thus, based on the flow of units, investments in industrial capacity, only for ethanol, will be in the order of 6.7 and 6.9 billion reais for the greenfields and brownfields units respectively.

The cost of sugarcane field formation considered the participation of each producing region (Centro-Sul and

Nordeste) and its relative costs, recorded in the 2018/19 crop (PECEGE, 2019). It was also assumed the proportion of 17% between the areas of sugarcane plant (new + renewed) and total sugarcane. Thus, an average cost of approximately R$ 23.75 / tc was obtained. The investment in sugarcane field formation for ethanol was estimated at 17 billion reais.

In relation to operating costs (*OPEX*), were considered agricultural, industrial and administrative aspects, which total in 2030, respectively, R$430, R$106 and R$57 billion, estimated based on PECEGE (2019). The OPEX calculation considered sugarcane for ethanol production from all units in operation each year.

For lignocellulosic ethanol (2G, second generation), it was considered that the units will be attached to the first generation, with a specific average ethanol production capacity of 100,000 m^3/year over the study horizon. The estimated investments are based on the values of commercial units operating in Brazil, estimated at R$5.60/liter, which may be reduced, due to the learning curve of the sector. The estimated operating cost is R$2.50/liter. Investments total R$2.2 billion in 2030 and the *OPEX* is $2.6 billion.

Regarding corn ethanol, the reference scenario projects the entry of 25 units by 2030, seven of flex type (process sugarcane and corn) and eighteen of the full type (only process corn). Thus, the added production capacity will be 3.6 billion liters of ethanol, totaling 6.4 billion liters by 2030, with production reaching 5.7 billion liters. O *CAPEX* for the implementation of a plant flex is $1.60/liter and for a mill full, is $1.80/liter. The *OPEX* was only considered for this last type of unit and is equivalent to R$0.34/liter (IMEA, 2017). To the unit flex, it was assumed that this expense will be allocated to the sugarcane ethanol production unit. Thus, the estimated investment in the construction of corn ethanol plants is around R$6.5 billion and operating costs of R$7.6 billion.

With the projected expansion of the ethanol market, in addition to the increased storage capacity, it is necessary to invest in the diversification of the modes used for distribution, for the efficiency of the transportation system. Logum Logística SA invests in its own pipeline construction project and the use of existing pipelines, with annual handling capacity of 6 billion liters. The estimated total value for the project is R$5.2 billion, of which R$1.2 billion has already been invested in stretches built and currently in operation (Ribeirão Preto (SP) – Paulínia (SP), Uberaba (MG) – Ribeirão Preto (SP)) (LOGUM, 2019).

Table 2 summarizes the investments in ethanol from 2021 to 2030.

Table 2: Investment estimates and operating and maintenance costs for 2021 – 2030 – ethanol

	Capex (billion R$)	*OPEX* (billions R$)
1G Cane[1]	31	591[2]
Cana 2G	2	3
Corn	6	8
TOTAL	**39**	**602**
Transport	**4**	**n/e**

Note 1: Considers units brownfield + greenfield for cane 1G.
Note 2: Does not include sugarcane plantation expenses.
Source: EPE based on CTBE (2018), IMEA (2017), LOGUM (2018) and UNICA (2014)

Note that, incorporating the investments and costs related to sugar production (1G cane), the values reach R$53 billion and R$1 trillion, respectively.

II. BIODIESEL

Biodiesel demand is determined by the percentage to be added to the projected demand for diesel B, which reaches 79 billion liters by 2030. The addition of biofuel will occur according to CNPE Resolution No. 16 (2018). With the implementation of blend B13 in March 2021, there will be a progressive increase in biodiesel content, reaching 15% in 2023. This percentage will be maintained until the end of the study period. Thus, the demand for biodiesel reaches 11.4 billion liters by 2030.

In the present study cycle, the investment calculation for this segment was based on data on expansion and construction of new biodiesel units published by ANP, whose scope was expanded in 2020 (ANP, 2020). According to the information provided until July 2020, the requests for expansion reach 0.9 billion liters and the construction of new units totals 1.9 billion liters. For this total of 2.8 billion liters added, an average CAPEX of R$ 0.35/liter/year was applied (ABIOVE, 2016), representing investments of R$ 1 billion. It is observed that, using a utilization factor of 92%, due to scheduled stops and adverse events, the effective capacity of biodiesel production is equivalent to the estimated demand for the end of the period. (EPE, 2020a). The previous

methodology used a capacity factor of 80%, considering the expected biodiesel demand at the end of the 10-year horizon.

Considering that soybean will remain as the main input used in biodiesel production, the projection of investments in its processing capacity is based on the implementation of units of 4,000 t/day (ABIOVE, 2016). These units produce bran, food soybean oil and for other purposes, including biodiesel production. It is noteworthy that no investments were considered necessary for the processing of other types of oilseeds. It has been estimated that the current soybean processing capacity will be sufficient for biodiesel production in the 10-year horizon.

The OPEX for biodiesel production was estimated based on average sales prices in biofuel auctions between 2015 and 2019 (ANP, 2020) and information from industry experts (UBRABIO, 2019), resulting in a factor of R$ 2.30 / liter. Operating costs between 2021 and 2030 are estimated at R$ 225 billion. It is noteworthy that the main component of this cost is the fatty intake used as raw material. It is observed that biodiesel production units have an intermittent profile throughout the year and the sector has peculiarities regarding the product marketing system (auctions). Thus, it is estimated that this cost indicator has a wide range.

III. BIOGAS

Investments in biogas production were based on tapping the potential presented in the Otto Cycle Ethanol Supply Scenarios (EPE, 2020b) document. The study estimated that the potential for biogas production by fermenting vinasse and filter cake will reach 6.9 billion Nm^3 in the year 2030, in the medium growth scenario. It was admitted that the production of biogas will take place in continuous area to the plants of the sugar – energy sector, using part of the existing facilities.

The investments were calculated based on data provided by BNDES (2020), referring to the profile of a biomethane producing plant of 16.5 million Nm^3 / year. The *CAPEX* for biogas production would be around R$19 billion at the end of the period. Considering the beneficiation to obtain the biomethane, the sum is R$23 billion, due to the necessary contribution for the acquisition of the separation unit. When estimating the *OPEX*, an accumulated expenditure between 2021 and 2030 of around R$12 billion is obtained for biomethane.

IV. OTHER BIOFUELS

The PDE 2030 projections incorporate the participation of new biofuels whose perspective of entry into the national energy matrix should occur within the horizon of this study. Biojet and Green Diesel for use in Diesel cycle engines emerge as drop in alternatives to their fossil analogues. There are technical and economic challenges to be overcome for the feasibility of this scenario, among which stand out the definition of technology for its production, as well as the choice of the various raw materials that can be used in the process.

To estimate the necessary investments, the premise was the introduction of a mixed unit with a consortium production of HVO (hydrotreated vegetable oil), bionaphtha and LPG, with an average global profile of about 300,000 m^3 per year and a production ratio of 45% for Biojet and 35% for HVO. The projected investment required for its installation will be in the order of 1.5 billion reais. The operating costs related to the production of these biofuels in this plant are not related here (EPE, 2020a).

V. ABSTRACT

Based on the study cycle that underpinned the preparation of PDE 2030, it is estimated that investments and operating costs for ethanol, biodiesel and biogas/biomethane and Biojet/Green Diesel will be 68.5 and 839 billion reais, respectively. Considering investments related to sugar production (1G cane), CAPEX totals R$90 billion.

Table 3: Investment estimates and maintenance and operating costs 2021–2030

	CAPEX (billion R$)	*OPEX* (billion R$)
Ethanol	43	602
Biodiesel	1	225
Biomethane	23	12
Biojet / Green Diesel	1.5	n/e
TOTAL	**68.5**	**839**

Note: For biomethane, it is considered the production potential between 2021 and 2030.
Source: EPE.

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