

# INVESTMENTS AND OPERATING AND MAINTENANCE COSTS IN THE BIOFUEL SECTOR: 2022–2031

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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 2022–2031, 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 2031) (EPE, 2021a).

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## I. ETHANOL

The projection of national ethanol production will reach 46.4 billion liters by 2031, according to the document Ethanol Supply Scenarios and Otto Cycle Demand (average growth). In addition to the participation of conventional sugarcane, the volumes of lignocellulosic ethanol and corn ethanol reach, respectively, 8.1 billion and 0.4 billion liters in 2031. The amount of sugarcane for the biofuel production is estimated at 439 million tonnes, about 57% of the total (EPE, 2021a, 2021b).

During the study period (2022–2031), it is estimated the entry of 9 new units (greenfields), which increase the nominal capacity of sugarcane crushing by 21 million tons, and the expansion of 1.1 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 3.7 million tons of nominal sugarcane crushing capacity, with an average investment of R\$359.8/tc. For the

expansion of existing units, an average investment of R\$256.0/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
<b>New units (Greenfield)</b>			<b>359.8</b>
Industrial cogeneration)	(includes optimized		287.6
Agricultural machinery (includes trucks)			67.9
Land leasing (Center-West region)			4.3
<b>Expansion of existing plants (Brownfield)</b>			<b>256.0</b>

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 4.3 and 0.3 billion reais for the greenfields and brownfields units respectively.

The cost of sugarcane field formation considered the participation of each producing region (Center-South and Northeast) and its relative costs, recorded in the 2020/21 crop (PECEGE, 2021). 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\$ 26.44 / tc was obtained. The investment in sugarcane field formation for ethanol was estimated at 17.6 billion reais.

In relation to operating costs (*OPEX*), were considered agricultural, industrial and administrative aspects, which total in 2031, respectively, R\$428 billion, R\$88 billion and R\$66 billion, estimated based on PECEGE (2021). 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 90,000 m<sup>3</sup>/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\$2.1 billion in 2031 and the *OPEX* is \$4.0 billion.

Regarding corn ethanol, the reference scenario projects the entry of 33 units by 2031, nine of flex type (process sugarcane and corn) and twenty four of the full type (only process corn). Thus, the added production capacity will be 5.2 billion liters of ethanol, totaling 9.0 billion liters by 2031, with production reaching 8.1 billion liters. The *CAPEX* for the implementation of a flex plant 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\$9.2 billion and operating costs of R\$11.0 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, 2021).

Table 2 summarizes the investments in ethanol from 2022 to 2031.

**Table 2: Investment estimates and operating and maintenance costs for 2022 – 2031 – ethanol**

	<i>Capex</i> (billion R\$)	<i>OPEX</i> (billions R\$)
1G Cane <sup>1</sup>	22	582 <sup>2</sup>
2G Cane	2	4
Corn	9	11
<b>TOTAL</b>	<b>33</b>	<b>597</b>
<b>Transport</b>	<b>4</b>	<b>n/e</b>

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\$40 billion and R\$1.0 trillion, respectively.

## II. BIODIESEL

Biodiesel consumption is determined by the percentage to be added to the projected demand for diesel B, which reaches 81.4 billion liters by 2031. The biodiesel blend in diesel will be 10% in the year 2022, according to CNPE Resolution N<sup>o</sup> 25 of 2021 (CNPE, 2021), subsequently following the CNPE Resolution N<sup>o</sup> 16/2018 (CNPE, 2018) in the following years. Thus, the demand for biodiesel reaches 11.6 billion liters by 2031.

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 2021, the requests for expansion reach 0.4 billion liters and the construction of 13 new units totals 2.6 billion liters. For this total of 3.0 billion liters added, an average *CAPEX* of R\$ 0.35/liter/year was applied (ABIOVE, 2016), representing investments of R\$ 1 billion (up to 2031). 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, 2021a).

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, although there are public policies for greater diversification of inputs in progress. 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\$ 3.84 / liter. Operating costs between 2022 and 2031 are estimated at R\$ 376 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), which will be replaced in January 2022 by direct trade between producers and distributors, in accordance with CNPE Resolution nº 14 of December 9, 2020 (CNPE, 2020). 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, 2021b) document. The study estimated that the potential for biogas production by fermenting vinasse and filter cake will reach 6.5 billion Nm<sup>3</sup> in the year 2031, 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 (2020a; 2020b), referring to the profile of a biomethane producing plant of 16.5 million Nm<sup>3</sup> / year. The CAPEX for biogas production would be around R\$18.4 billion at the end of the period. Considering the beneficiation to obtain the biomethane, the sum is R\$22 billion, due to the necessary contribution for the acquisition of the separation unit. When estimating the OPEX, an accumulated expenditure between 2022 and 2031 of around R\$11.7 billion is obtained for biomethane.

### IV. OTHER BIOFUELS

The PDE 2031 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 Biojet, HVO (hydrotreated vegetable oil), bionaphtha and LPG, with an average global profile of about 400,000 m<sup>3</sup> per year and a production ratio of 35% for Biojet and 52% for HVO. The projected investment required for its installation will be in the order of 700 million reais (92% utilization factor). The operating costs related to the production of these biofuels in this plant are not related here (EPE, 2021a).

### V. ABSTRACT

Based on the study cycle that underpinned the preparation of PDE 2031 (EPE, 2021a), it is estimated that investments (CAPEX) and operating (OPEX) costs for ethanol, biodiesel and biogas/biomethane and Biojet/Green Diesel will be 60.7 and 985 billion reais, respectively. Considering investments related to sugar production (1G cane), CAPEX totals R\$78.7 billion.

**Table 3: Investment estimates and maintenance and operating costs 2022–2031**

	CAPEX (billion R\$)	OPEX (billion R\$)
Ethanol	37	597
Biodiesel	1	376
Biomethane	22	12
Biojet / Green Diesel	0.7	n/e
<b>TOTAL</b>	<b>60.7</b>	<b>985</b>

Note: For biomethane, it is considered the production potential between 2022 and 2031.  
Source: EPE.

## References

- 1) ABIOVE – Associação Brasileira das Indústrias de Óleos Vegetais; APROBIO – Associação dos Produtores de Biodiesel do Brasil; UBRABIO – União Brasileira do Biodiesel e do Bioquerosene. **Biodiesel: opportunities and challenges in the long run**. Brasília, Oct 6 2016. Available at: [http://www.abiove.org.br/site/ FILES/Portugues/07102016-131231-07\\_10\\_2016\\_n-cenario\\_para\\_o\\_biodiesel\\_em\\_2030\(2\).pdf](http://www.abiove.org.br/site/FILES/Portugues/07102016-131231-07_10_2016_n-cenario_para_o_biodiesel_em_2030(2).pdf). Accessed in: 01 dec. 2020
- 2) ANP – Agência Nacional do Petróleo, Gás Natural e Biocombustíveis. **Market Information – Biodiesel**, 2020. Available at: <http://www.anp.gov.br/producao-de-biocombustiveis/biodiesel/informacoes-de-mercado>. Accessed in: 18 feb, 2020.
- 3) BNDES – Banco Nacional do Desenvolvimento Econômico e Social. **Personal Communication**, 2020.
- 4) BNDES (2020b). Statistics - Performance: Disbursements year by year. Available at: <https://www.bndes.gov.br/wps/portal/site/home/transparencia/estatisticas-desempenho/desembolsos>, accessed in: 14 jul, 2020.
- 5) CNPE – Conselho Nacional de Política Energética. CNPE Resolution No. 16 of November 29, 2018. Provides for the evolution of the mandatory addition of biodiesel to diesel sold to the final consumer, anywhere in the national territory. *Diário Oficial da União*, Brasília, DF, 08 Dec. 2018. Available at: [http://www.mme.gov.br/documents/10584/71068545/Resolucao\\_16\\_CNPE\\_29-10-18.pdf](http://www.mme.gov.br/documents/10584/71068545/Resolucao_16_CNPE_29-10-18.pdf). Accessed in: 01 dec. 2020.
- 6) \_\_\_\_\_. Resolução CNPE nº 14 de 9 de dezembro de 2020. Estabelece as diretrizes para a comercialização de biodiesel em todo território nacional, e dá outras providências. *Diário Oficial da União*, Brasília, DF, 09 nov. 2020. Disponível em: <https://www.gov.br/mme/pt-br/assuntos/conselhos-e-comites/arquivos/conselhos-e-comites/res-14-cnpe.pdf>. Acesso em: 01 dez. 2020.
- 7) \_\_\_\_\_. Resolução CNPE nº 25 de 22 de novembro de 2021. Estabelece como de interesse da Política Energética Nacional a fixação do teor de mistura obrigatória do biodiesel no óleo diesel fóssil em 10% (dez por cento), para o ano de 2022. *Diário Oficial da União*, Brasília, DF, 17 dez. 2021. Disponível em: [https://www.gov.br/mme/pt-br/assuntos/conselhos-e-comites/cnpe/resolucoes-do-cnpe/resolucoes-2021/copy2\\_of\\_ResolucoesCNPE252021.pdf](https://www.gov.br/mme/pt-br/assuntos/conselhos-e-comites/cnpe/resolucoes-do-cnpe/resolucoes-2021/copy2_of_ResolucoesCNPE252021.pdf). Acesso em: 20 dez. 2021.
- 8) CTBE – Laboratório Nacional de Ciência e Tecnologia do Bioetanol. **Personal communication**, 2018.
- 9) EPE – Empresa de Pesquisa Energética. **Supply and demand scenarios for Otto cycle 2022–2031**. Rio de Janeiro: EPE, 2021b. Available at: [www.epe.gov.br](http://www.epe.gov.br).
- 10) \_\_\_\_\_. 10-Year Energy Expansion Plan 2031: Biofuels Supply. Rio de Janeiro: EPE, 2021a.
- 11) IMEA – Instituto Mato-Grossense de Economia Agropecuária. **Corn ethanol clusters in Mato Grosso**. Cuiabá – Mato Grosso, 2017.
- 12) Logum Logística SA **ANP Information**, 2020.
- 13) PECEGE – Programa de Educação Continuada em Economia e Gestão de Empresas/ESALQ/USP. **Production costs of sugarcane, sugar, ethanol and bioelectricity**. Closing of the 2020/21 harvest. Piracicaba, 2021. Available at: <http://pecege.dyndns.org/>. Accessed in: 23 nov, 2021.
- 14) UBRABIO – União Brasileira do Biodiesel e Bioquerosene. **Personal Communication**, 2019.
- 15) UNICA – União da Indústria de Cana-de-açúcar. **Personal Communication**, 2014.