# INVESTMENTS AND OPERATING AND MAINTENANCE COSTS IN THE BIOFUEL SECTOR: 2018–2030

Empresa de Pesquisa Energética

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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 2018–2030, including ethanol (sugarcane and corn), biodiesel and biogas (sugar-energy sector). The supply and demand values of biofuels refer to the study cycle that supported the elaboration of the Decennial Energy Expansion Plan (PDE 2027).

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## I. ETHANOL

The projection of national ethanol production will reach 49 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, 2.0 and 2.3 billion liters in 2030 (EPE, 2018).

During the study period (2018–2030), it is estimated the entry of 19 new units (greenfields), which increase the nominal capacity of sugarcane crushing by 67 million tons, and the expansion of 55 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$260.00/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) | 67.9 |
| 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 UNEM (2018)

Thus, based on the flow of units, investments in industrial capacity, only for ethanol, will be in the order of 15 and 8 billion reais for the greenfields and brownfields units respectively.

In relation to operating costs (*OPEX*), were considered agricultural, industrial and administrative aspects, which total in 2030, respectively, R$425, R$165 and R$91 billion, estimated based on PECEGE (2017). 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 ethanol production capacity of 80 thousand $m^3$/year until 2026 and 100 thousand $m^3$/year, between 2027 and 2030. 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$13 billion in 2030 and the *OPEX* is $5.8 billion.

Regarding corn ethanol, the reference scenario projects the entry of nine units by 2030, five of flex type (process sugarcane and corn) and four of the full type (only process corn). Additionally, expansions are estimated at three units, two flex is full, which are already operating. Thus, the added production capacity will be 2.7 billion liters of ethanol, totaling 3.3 billion liters by 2030. 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$5 billion and operating costs of R$4 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 million $m^3$. 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, 2018).

Table 2 summarizes the investments in ethanol from 2018 to 2030.

**Table 2: Investment estimates and operating and maintenance costs for 2018 – 2030 – ethanol**

| | *Capex* (billion R$) | *OPEX* (billions R$) |
|---|---|---|
| 1G Cane[1] | 23 | 682[2] |
| Cana 2G | 13 | 19 |
| Corn | 5 | 4 |
| **TOTAL** | **41** | **705** |
| **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$38 billion and R$1.15 trillion, respectively.

## II. BIODIESEL

Biodiesel demand is determined by the percentage to be added to the projected demand for diesel B, which reaches 68 billion liters by 2030. The addition of biofuel will occur according to CNPE Resolution No. 16 (2018). With the implementation of blend B10 in March 2018 and B11 from June 2019, 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 12 billion liters by 2030.

For the evaluation of the necessary investments, it was considered that the plants have an average size of 700 thousand liters per day of nominal capacity. The average investment for this profile is R$0.40/liter/year, considering an overcapacity of 20% (ABIOVE, 2016).

Based on these assumptions, investments in expansion and construction of new units, which have already been authorized by ANP and those required to meet demand in the period, total approximately R$3 billion.

For the projection of investments in soybean processing capacity, we used as a base the implementation of units of 4,000 tons/day (ABIOVE, 2016). Although the processing units also produce bran, food soybean oil and for other purposes, as a simplification, all *CAPEX* for biodiesel production, that is, the various production results were assumed as co-products. Similarly, no investments considered necessary for the processing of other types of oilseeds were considered. With that, the *CAPEX* projected at the end of the period will be R$8 billion (average investment of R$265/ton/year). Thus, investments in the biodiesel sector total R$11 billion.

Biodiesel production units have an intermittent production profile throughout the year. Additionally, the sector has peculiarities regarding the product marketing system (auctions). Thus, considering the need for further study on this topic, we chose not to present the operating cost estimate of biodiesel production in the present study. Nevertheless, the main component of the *OPEX*, in general, it is the cost of the fatty input used as a raw material.

## III. BIOGAS

Investments in biogas production were based on tapping the potential presented in the Otto Cycle Ethanol Supply Scenarios (EPE, 2018) document. The study estimated that the potential for biogas production by fermenting vinasse and filter cake will reach 7.7 MMNm³ 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 referring to a 25,000 $Nm^3$/day biomethane plant, supplied by ABIOGÁS (2017). The *CAPEX* for biogas production would be around R$11 billion at the end of the period. Considering the beneficiation to obtain the biomethane, the sum is R$19 billion, due to the necessary contribution for the acquisition of the separation unit. When estimating the *OPEX*, an accumulated expenditure between 2018 and 2030 of around R$17 billion is obtained for biomethane.

## IV. ABSTRACT

Based on the study cycle that underpinned the preparation of PDE 2027, it is estimated that investments and operating costs for ethanol, biodiesel and biogas/biomethane will be of the order of 75 and 722 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 2018–2030**

| | *Capex* (billion R$) | *OPEX* (billions R$) |
|---|---|---|
| Ethanol | 45 | 705 |
| Biodiesel | 11 | n/e |
| Biogas/Biomethane | 19 | 17 |
| **TOTAL** | **75** | **722** |

Note: For biogas, the production potential is considered between 2018 and 2030.
Source: EPE based on ABIOGAS (2017), ABIOVE (2016), CTBE (2018), IMEA (2017), LOGUM (2018) and UNICA (2014).

### *References*


1) ABIOGAS – Associação Brasileira de Biogás e Biometano. **Biomethane – Horizonte 2030**. Personal communication, 2017.
2) 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.** Brasilia, 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. Accessed in: 13 nov. 2018.
3) 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. Disponível em: http://www.mme.gov.br/documents/10584/71068545/Resolucao_16_CNPE_29-10-18.pdf . Accessed in: 13 nov. 2018.
4) CTBE – Laboratório Nacional de Ciência e Tecnologia do Bioetanol. **Personal communication**, 2018.
5) EPE – Empresa de Pesquisa Energética. **Supply and demand scenarios for Otto cycle 2018–2030**. Rio de Janeiro: EPE, 2018. Available at: www.epe.gov.br. Accessed in: 13 Jun 2018.
6) IMEA – Instituto Mato-Grossense de Economia Agropecuária. **Corn ethanol clusters in Mato Grosso**. Cuiabá – Mato Grosso, 2017.
7) Logum Logística SA **Personal communication**, 2018.
8) PECEGE – Programa de Educação Continuada em Economia e Gestão de Empresas/ESALQ/USP. **Production costs of sugarcane, sugar, ethanol and bioelectricity in Brazil**. Closing of the 2016/17 harvest. Piracicaba, 2017. Available at: http://pecege.dyndns.org/. Accessed in: 13 nov. 2018
9) UNICA – Sugarcane Industry Union **Comunicação pessoal**, 2014.


REVISION 1: Part of the text on corn ethanol was corrected and the 'TOTAL' line of Table 2 was adjusted to the appropriate Table 3.