



TECHNICAL NOTE

Investments and Operating and Maintenance Costs in the Biofuel Sector: 2024 - 2033

MINISTÉRIO DE
MINAS E ENERGIA

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■ Document Identification and Revisions



Study area

Division for Oil, Gas and Biofuel Studies (DPG)

Department of Petroleum Derivatives and Biofuels (SDB)

Study

Investments and Operating and Maintenance Costs in the Biofuel Sector: 2024 - 2033

Revision	Issue date	Description
r0	21/12/2023	Original Publication

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Introduction

This technical note aims to disclose assumptions and investment estimates (CAPEX, capital expenditure) and operational and maintenance costs (OPEX, operational expenditure) related to biofuels for the period 2024-2033, including ethanol (sugarcane and corn), biodiesel, biogas (from the sugar-energy sector) and BioQAV/Green Diesel. The supply and demand values for biofuels refer to the average scenario of the document Ethanol Supply and Demand Scenarios for the Otto Cycle 2024-2033 and to internal studies on the horizon up to 2033 (EPE, 2023a; 2022a).

1. Ethanol

It is estimated that the Brazilian ethanol production will reach 46 billion liters in 2033, according to the average growth scenario presented in the document Ethanol Supply and Demand Scenarios for the Otto Cycle (EPE, 2023a). In addition to the participation of conventional sugarcane, the volumes of corn ethanol and lignocellulosic ethanol will reach, respectively, 12.7 billion and 1 billion liters in 2033. The amount of sugarcane destined for the production of biofuel is estimated at 382 million tons, about 53% of the total (EPE, 2022a).

First generation sugarcane ethanol

In the study period (2024-2033), it is estimated that 1 new unit (greenfields) of sugarcane will enter, which will increase the nominal crushing capacity by 3 million tons (ethanol¹ production capacity of 280 million liters) (ANP, 2023a). It is also considered the expansion of the capacity of ethanol production in existing plants, by 2,3 billion liters, as authorized by the ANP (2023a).

For the evaluation of the necessary investments in the medium term (last five years), it was considered that the units would be mixed, with an optimized technological profile and an average size of 4 million tons of nominal sugarcane crushing capacity, with an average investment of R\$ 600.8/tc / tc² (IBGE, 2023; FGV, 2023; LNBR, 2022). For the expansion of existing units, an average investment of R\$ 269,4/ton was adopted. Such values consider the leasing of land, agricultural machinery and the industrial part with optimized cogeneration, as detailed in Table 1.

¹ Considers a harvest with 200 days.

² Note: CAPEX was given per ton of sugarcane, as it is possible to allocate part of the ATR to produce sugar, which does not occur in the E2G and corn ethanol units.

Table 1. CAPEX estimate of first generation sugarcane mills

CAPEX	R\$_(dec. 2021) / tc
New units (<i>Greenfield</i>)	600.8
Industrial (includes optimized cogeneration)	478.4
Agricultural machinery (includes trucks)	95.9
Lease (Midwest region)	26.5
Expansion of existing plants (<i>Brownfield</i>)	269.41

Source: EPE based on IBGE (2023), FGV (2023), LNBR (2022) and NOVACANA (2022a)

Thus, based on the flow of units, investments in industrial capacity, only for first generation sugarcane ethanol, will be around 6.2 billion, of which 4.0 billion are related to expansions and the rest to the greenfield units.

The cost of forming the sugarcane field considered the participation of each producing region (Center-South and Northeast) and their relative costs, recorded in the 2022/23 (Center-West and North-Northeast) harvests (PECEGE, 2023). The proportion of 17% between the areas of plant cane (new + renovated) and total cane was also assumed. In this way, an average cost of approximately R\$ 37.6 /tc was obtained. Investment in the formation of sugarcane for ethanol was estimated at R\$ 23.2 billion.

Regarding operating costs (OPEX), an indicator of 2.16 R\$/liter was used, with 87% for biomass, based on LNBR (2022), which results in the value of R\$ 643 billion in the whole period. The OPEX calculation considered the cane destined for the production of ethanol from all units in operation each year.

Lignocellulosic ethanol

For lignocellulosic ethanol (2G, second generation), the entry of thirteen units attached to the first generation was considered, with an average specific ethanol production capacity of 82,000 m³/year during the study period. The investment estimate is based on the values of the commercial units in operation in Brazil and the announcements made in 2023 for projects of this type, establishing a factor of R\$ 14.60/liter (RAÍZEN, 2022; 2023). Thus, investments total R\$ 15.6 billion in 2033. The volume projected for the production of E2G, of 1 billion liters in 2033, is also considered (EPE, 2023a). The estimated operating cost is R\$ 1.7/liter (LNBR, 2022), which leads to an OPEX of R\$ 9.7 billion.

Corn ethanol

With regard to corn ethanol, the reference scenario projects an increase of ethanol production capacity in 6.5 billion liters, considering the expansion authorized by ANP and the entry of new units, most full (ANP, 2023a). Thus, the production capacity totalizes 5.5 billion liters of ethanol, totaling 13.7 billion liters in 2033, with production reaching 12.7 billion liters.

The CAPEX for the implementation of a flex plant is R\$ 1.28/liter and, for a full plant, it is R\$ 2.53/liter (LNBR, 2022). OPEX was only considered for the latter type of unit and is equivalent to R\$ 1.84/liter (IBGE, 2023; NOVACANA, 2022b). For the flex unit, it was assumed that this expense will be allocated to the sugarcane ethanol producing unit. In this way, the estimated investment in the construction of corn ethanol plants is around R\$ 15.5 billion and operating costs of R\$ 93.7 billion.

Ethanol outflow infrastructure

With the projected expansion of the ethanol market, in addition to increasing storage capacity, it is necessary to invest in diversifying the modes used in distribution, to make the transport system more efficient. EPE published the Indicative Oil Pipeline Plan (PIO) and the studies developed seek to improve the analysis of the logistical supply flows, through the technical, economic and environmental feasibility study of transport pipeline projects and associated systems with a view to meeting existing national demands. (EPE, 2023c).

Logum Logística S.A. invests in a project to build its own pipelines and use existing ones, with an annual handling capacity of 9.0 billion liters. The total estimated value for the project is R\$ 5.2 billion, of which R\$ 1.2 billion has already been invested in the sections built and currently in operation (Ribeirão Preto (SP) – Paulínia (SP), Uberaba (MG) - Ribeirão Preto (SP)) (EPE, 2023b; LOGUM, 2023).

Table 2 summarizes investments in ethanol in the period from 2024 to 2033, for brownfield and greenfield units.

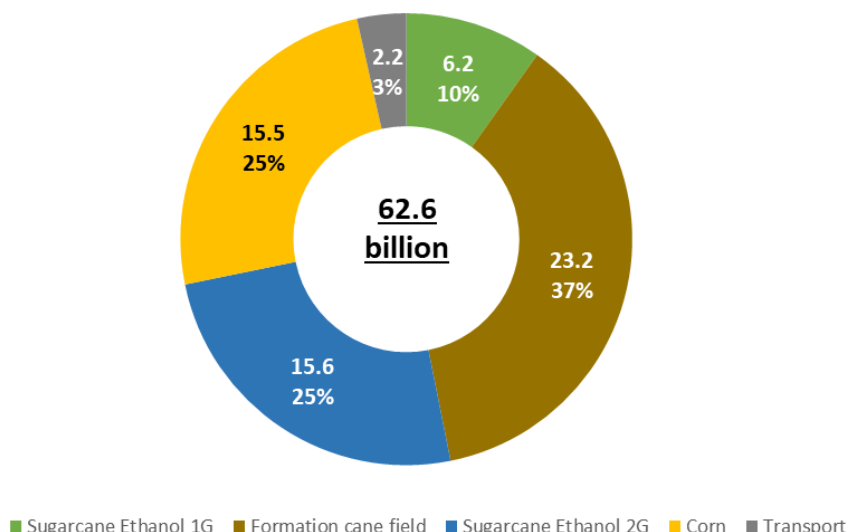
Table 2. CAPEX and OPEX estimates for ethanol between 2024 and 2033

ETANOL	CAPEX (R\$ Billion)	OPEX (R\$ Billion)
Sugarcane Ethanol 1G	6.2	80.9
Formation of the cane field	23.2	561.9
Sugarcane Ethanol 2G	15.6	9.7
Corn Ethanol	15.5	93.7
TOTAL	60.4	746.2
Transport	2.2	n/e

Source: EPE based on LNBR (2022), NOVACANA (2022a, 2022b, 2002c) and LOGUM (2022)

Graphic 1 presents the participation and values of industrial CAPEX and formation of sugarcane for ethanol between 2024 and 2033.

Graphic 1: CAPEX for ethanol between 2024 and 2033 (billion of R\$ and %)



Source: EPE based on IBGE (2023), FGV (2023), LNBR (2022), LOGUM (2023), NOVACANA (2022a, 2022b) and RAÍZEN (2022, 2023)

Incorporating the investments and costs related to sugar production, the values for 1G cane would reach R\$ 11.5 billion in industrial part and R\$ 43.4 to the formation of the sugarcane field (R\$ 55 billion). The operational costs will reach and R\$ 1.2 trillion, respectively.

2. Biodiesel

Biodiesel consumption is determined by its percentage to be added to the projected demand for diesel B, which reaches 82.1 billion liters in 2033³ (EPE, 2022b).

On April 1, 2023, the addition of biofuel was changed to 12%, according to CNPE Resolution N° 3/2023 (CNPE, 2023a), which also established its growth, on the same day and month, to 13% (B13) in 2024, to 14% in 2025 and to 15% in 2026. After this period (2027-2032), the BX mixture follows the provisions of the CNPE Resolution. Thus, biodiesel demand will reach 12.3 billion liters in 2033 (EPE, 2022a).

³ Projections based on studies for Energy Expansion Plan 2032 (EPE, 2022b)

In this study, investments calculation in this segment was based on data on the expansion and construction of new biodiesel units by ANP (ANP, 2023a). According to information made available up to November 2023, the 12 expansion requests reach 0.85 billion liters and the construction of 8 new units adds up to 0.93 billion liters. On this total (1.8 billion liters), an average CAPEX of R\$ 0.68/liter/year was applied for new units and R\$ 0.49/liter/year for expansions (BIODIESELBR, 2022), which represents investments of R\$ 1.05 billion (until 2033). Adopting a utilization factor of 92%, due to scheduled stoppages and adverse events, the effective biodiesel production capacity would be 15 billion liters at the end of the period, which would represent an idle capacity of about 19% for the production of 12.3 billion liters in 2033.

Considering that soy will remain the main feedstock used in the production of biodiesel, an average of 66% during the study period, the projection of investments in its processing capacity is based on the implementation of units of 4,000 t/day (ABIOVE, 2016) , with an estimated cost of R\$ 519 million. These units produce bran, food soy oil and for other purposes, including the production of biodiesel. For the analysis of the need for additional crushing of grains, only the additional demand for soybean oil for biodiesel production was considered and the crushing production capacity of 69 million tons in December 2023. It should be noted that necessary investments for the processing of other types of oilseeds were not considered, although there are ongoing public policies for greater diversification of inputs. It was estimated that it will be necessary to implement eighth soybean processing units, totaling 11.5 Mt/year, which would represent an investment of R\$ 4.2 billion by 2033.

The OPEX for biodiesel production was estimated based on average sales prices at biofuel commercialized between productions and distribution in 2022 and 2023 (ANP, 2023b) and on information from industry experts (UBRABIO, 2019), being updated based on soybean prices until December 2023 (INDEX MUNDI, 2023), resulting in a factor of R\$ 0.82/liter. Operating costs between 2024 and 2033 are estimated at R\$ 92.8 billion. It is noteworthy that the main component of this cost is the fatty input used as raw material. It is observed that the biodiesel production units have an intermittent profile throughout the year and the sector had peculiarities with regard to the product commercialization system, auctions until December 2021, and free negotiation between producers and distributors from January of 2022 on (CNPE, 2020). Thus, it is estimated that this cost indicator has a wide range.

3. Biomethane from sugarcane sector

The methodology for estimating the investments required for the construction of a biomethane unit, took as reference four existing projects related to sugarcane sector, three in São Paulo and one in Mato Grosso, wich registers in ANP indicate a short-term operating perspective (ANP, 2023a). These total a production capacity of 71 million Nm³/year (around 230 Nm³/day) and CAPEX R\$ 838 million (ANP, 2023a; BNDES, 2023; MME, 2022), which results in an investment factor of R\$ 11.78 / Nm³ / year. It is estimated that the OPEX will be around R\$ 100 million.

Biomethane production was based on the document Scenarios of Ethanol Supply and Demand of the Otto Cycle (EPE, 2023a), which estimated that the potential for biogas production through fermentation of vinasse, filter cake and straws and tips⁴ will reach in 2033, in the medium scenario, 11.2 billion Nm³ or 6.1 billion Nm³ of biomethane⁵. Thus, the estimated CAPEX for the production of this biomethane potential would be around R\$ 72.3 billion at the end of the period.

It was accepted that the production of biomethane will take place in a continuous area with the plants in the sugar-energy sector, using part of the existing facilities.

Operation and maintenance costs were calculated based on data provided by BNDES (2020a; 2020b), referring to the profile of a plant producing biogas of 33 million Nm³/year and 18.2 million Nm³/year of biomethane. Considering the sector's production potential, there's an accumulated expenditure between 2024 and 2033 of the order of R\$ 8 billion for biomethane, having as reference a factor of R\$ 0.141/Nm³.

4. Other Biofuels

The projections incorporate the participation of new biofuels, whose perspective of entering the national energy matrix should occur within the horizon of this study (EPE, 2022b). Sustainable aviation fuels (SAF) 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 the definition of technology for its production, as well as the choice of different raw materials that can be used in the process.

In order to estimate investments over the ten-year horizon, a survey was made about projects published by companies in the sector, for units with production of SAF, HVO (hydrotreated vegetable oil), bionaphtha and LPG, summarized in Figure 1, as well as the raw materials to be used.

The projected investment necessary for the installation of these types of plant will be in the order of R\$ 16 billion, according to the partnership announced between Vibra Energia and Brasil BioFuels (BBF) (BRASIL BIOFUELS, 2023), and ACELEN (2023), both estimate to start its operation in 2025, and PETROBRAS (2023), with implantation in 2027. Production capacity is estimated in 2.400 kt/year (2.2 billion liters/year). Operating costs related to the production of these biofuels at this plant are not listed here.

⁴ It was considered 20% of straw removed from the field (SUCRE, 2019).

⁵ It was assumed that all biogas production will be purified, originating biomethane and there will be no allocation for electrical generation from this input.

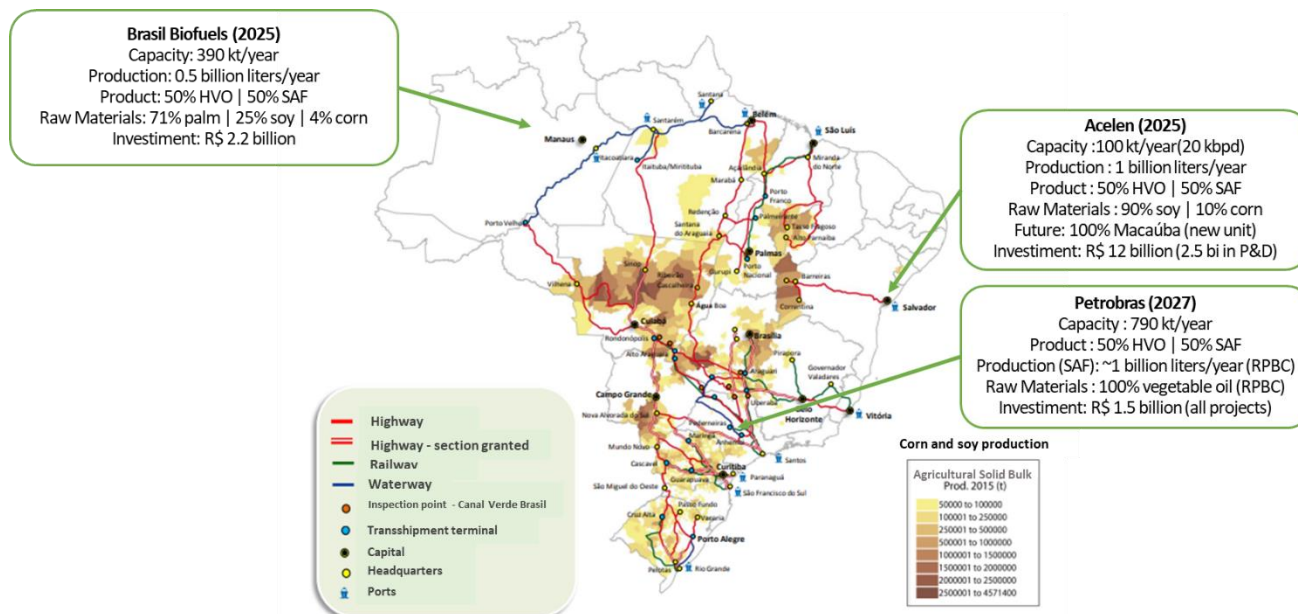


Figure 1: SAF and green diesel projects

Source: EPE adaptad from MINFRA (2017) and based on ACELEN (2023), BRASIL BIOFUELS (2023) and PETROBRAS (2023).

5. Summary

Based on the study cycle for the 2033 horizon (EPE, 2023a; 2022a), it is estimated that investments (CAPEX) and operating costs (OPEX) for ethanol, biodiesel, biogas/biomethane and BioQAV/Green Diesel will be around 84 billion and 839 billion reais, respectively.

Table 3. CAPEX and OPEX estimates for biofuels between 2024 and 2033

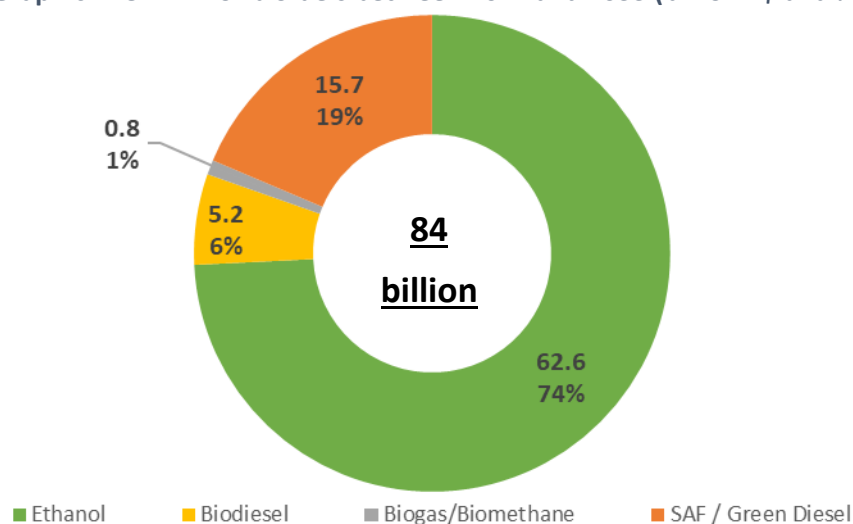
	CAPEX (R\$ Billions)	OPEX (R\$ Billions)
Ethanol	62.6	746.2
Biodiesel	5.2	92.8
Biomethane¹	0.8	0.1
SAF / Green Diesel	15.7	n/e
TOTAL	84.3	839

Note 1: For biomethane, only projects under construction are considered.

Source: EPE.

Graphic 2 shows the participation and values of industrial CAPEX for biofuels and sugarcane plantation formation for ethanol between 2024 and 2033.

Graphic 2: CAPEX for biofuels between 2024 and 2033 (billion R\$ and %)



Source: EPE

Considering investments related to sugar production (1G cane), CAPEX totals R\$ 110 billion and OPEX R\$ 1.296 billion.

Acknowledgments

We would like to thank the National Bank for Economic and Social Development (BNDES), the Continuing Education Program in Economics and Business Management/ESALQ/USP, the Brazilian Union of Biodiesel and Biokerosene (ABIOVE), for providing the information used in the preparation of this document, and, in particular, to the National Biorenewables Laboratory (LNBR) team for updating the CAPEX and OPEX of the typical sugarcane and corn ethanol units that supported this study.

References

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: oportunidades e desafios no longo prazo. Brasília, 6 out. 2016. Disponível em: [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). Acesso em: 01 dez. 2023.

_____. Pesquisa de Capacidade Instalada da Indústria de Óleos Vegetais – 2023a. Notícias. Disponível em: <https://abiove.org.br/estatisticas/pesquisa-de-capacidade-instalada-da-industria-de-oleos-vegetais-2019/>. Acesso em: 01 dez. 2023.

_____. Estatísticas, 2023b. Disponível em: <https://abiove.org.br/estatisticas/>. Acesso em: 05 dez. 2023.

ACELEN. Acelen avança em projeto de biorrefino na Bahia de olho no mercado dos EUA, 2023. Disponível em: <https://epbr.com.br/acelen-avanca-em-projeto-de-biorrefino-na-bahia-de-olho-no-mercado-dos-eua-e-anuncia-escritorio-em-houston/>. Acesso em: 18 dez. 2023

ANP - Agência Nacional do Petróleo, Gás Natural e Biocombustíveis. Autorização para produção de biocombustíveis, 2023a. Disponível em: <http://www.anp.gov.br/producao-de-biocombustiveis/autorizacao-para-producao-de-biocombustiveis>. Acesso em: 01 dez. 2023.

_____. Preços dos produtores e importadores de derivados de petróleo e biodiesel, 2023b. Disponível em: <https://www.gov.br/anp/pt-br/assuntos/precos-e-defesa-da-concorrencia/precos/precos-de-produtores-e-importadores-de-derivados-de-petroleo>. Acesso em: 01 dez. 2023.

BIODIESELBR. Levantamentos dos investimentos plantas de biodiesel (diversas reportagens), 2022. Disponível em: <https://www.biodieselbr.com/>. Acesso em: 05 out. 2023.

BNDES - Banco Nacional do Desenvolvimento Econômico e Social. Comunicação pessoal, 2020a.

_____. Estatísticas – Desempenho: Desembolsos anos a ano, 2020b. Disponível em: <https://www.bndes.gov.br/wps/portal/site/home/transparencia/estatisticas-desempenho/desembolsos>. Acesso em: 29 nov. 2023.

_____. Comunicação pessoal, 2023.

BRASIL BIOFUELS. Brasil pode ser líder na produção de biocombustível de segunda geração, 2023. Grupo BBF. Disponível em: https://brasilbiofuels-institucional-prd.s3.sa-east-1.amazonaws.com/wp-content/uploads/2023/12/13105822/Release-pos-evento_Seminario-Agronegocio.pdf. Acesso em: 18 dez. 2023.

CNPE – Conselho Nacional de Política Energética. 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: 05 out. 2023.

_____. Resolução nº 03, de 20 de março de 2023. Altera a Resolução CNPE nº 16, de 29 de outubro de 2018, que dispõe sobre a evolução da adição obrigatória de biodiesel ao óleo diesel; e dá outras providências. Conselho Nacional de Política Energética. Brasília: Diário Oficial da União. Disponível em: <https://www.gov.br/mme/pt-br/assuntos/conselhos-e-comites/cnpe/resolucoes-do-cnpe/2023/ResCNPE32023.pdf>. Acesso em: 12 de abril de 2023.

EPE – Empresa de Pesquisa Energética. Cenários de oferta de etanol e demanda ciclo Otto 2024 – 2033. Rio de Janeiro: EPE, 2023a. Disponível em: www.epe.gov.br.

EPE – Empresa de Pesquisa Energética. Análise de Conjuntura dos Biocombustíveis: ano 2022. Rio de Janeiro: EPE, 2023b. Disponível em: www.epe.gov.br.

_____. Plano Indicativo de Oleodutos (PIO). Rio de Janeiro: EPE, 2023c. Disponível em: www.epe.gov.br.

_____. Cadernos de estudos do PDE 2032. Caderno de Oferta de Biocombustíveis. Rio de Janeiro: EPE, 2022a. Disponível em: www.epe.gov.br.

FGV - Fundação Getúlio Vargas. Índices de Preços, 2023. FGV Data.

IBGE. Instituto Brasileiro de Geografia e Estatística. Índice Nacional de Preços ao Consumidor Amplo (Tabela 1737), 2023. Disponível em: www.ibge.gov.br. Acesso em: 15 dez. 2023.

INDEX MUNDI. Commodity Prices Indices. Soybean and Palm Oil. INDEX MUNDI, 2023. Disponível em <https://www.indexmundi.com/commodities/>. Acesso em: 01 dez. 2023.

LNBR - Laboratório Nacional de Biorrenováveis. Comunicação Pessoal, 2022.

LOGUM LOGÍSTICA S.A. LOGUM Logística. Rio de Janeiro, 2023.

MINFRA – Ministérios dos Transportes, Portos e Aviação Civil. Corredores Logísticos Estratégicos: Volume I – Complexo Soja e Milho, 2017. Disponível em: https://www.gov.br/transportes/pt-br/centrais-de-conteudo/relatorio_corredores_logisticos_sojamilho_v1-2.pdf. Acesso em: 18 dez. 2023.

MME. Ministério de Minas e Energia. Portaria nº 65, de 06 de dezembro de 2022. Aprova o enquadramento no Regime Especial de Incentivos para o Desenvolvimento da Infraestrutura (REIDI) do Projeto “Planta Biogás – Unidade Costa Pinto – Raízen”. SPG/MME. Diário Oficial da União. Disponível em: <https://www.gov.br/mme/pt-br/assuntos/secretarias/sntep/reidi/portarias/2022/12-dezembro-1/portaria-n-65-spg-mme-2022.pdf>. Acesso em 01 dez. 2023.

NOVACANA. Levantamentos dos investimentos em biocombustíveis (diversas reportagens), 2022a. Disponível em: <https://www.novacana.com/>. Acesso em: 06 out. 2022.

_____. Etanol de milho se torna mais rentável que o de cana, mas ainda tem desafios pela frente, 2022b. Disponível em: <https://www.novacana.com/n/milho/etanol-milho-mais-rentavel-cana-ainda-desafios-frente-201022>. Acesso em: 26 out. 2022.

PECEGE – Programa de Educação Continuada em Economia e Gestão de Empresas/ESALQ/USP. Custos de produção de cana-de-açúcar, açúcar, etanol e bioeletricidade. Fechamento da safra 2022/23. Piracicaba, 2023. Disponível em: <http://pecege.dyndns.org/>. Acesso em: 20 dez. 2023.

PETROBRAS. Plano Estratégico 2024 – 2028+, 2023. Disponível em: <https://api.mziq.com/mzfilemanager/v2/d/25fdf098-34f5-4608-b7fa-17d60b2de47d/4f907ee7-d09d-8692-07d0-6d387fcca45d?origin=2>. Acesso em: 18 dez. 2023.

RAÍZEN. Avisos, Fatos Relevantes e Comunicados, 2022. Disponível em: <https://ri.raizen.com.br/divulgacoes-e-documentos/avisos-comunicados-e-fatos-relevantes/>. Acesso em: 05 out. 2022.

_____. Relatório Integrado 2022 – 2023, 2023. Disponível em: https://raizen-institucional-relatorios.s3.amazonaws.com/raizen/2023/pdf/RAIZEN_PT_FINAL.pdf. Acesso em: 07 dez. 2023.

SUCRE. Sugarcane Renewable Electricity, 2019. Disponível em: <https://lnbr.cnpem.br/sucre/>. Acesso em: 05 out. 2023.

UBRABIO – União Brasileira do Biodiesel e Bioquerosene. Comunicação pessoal, 2019.