

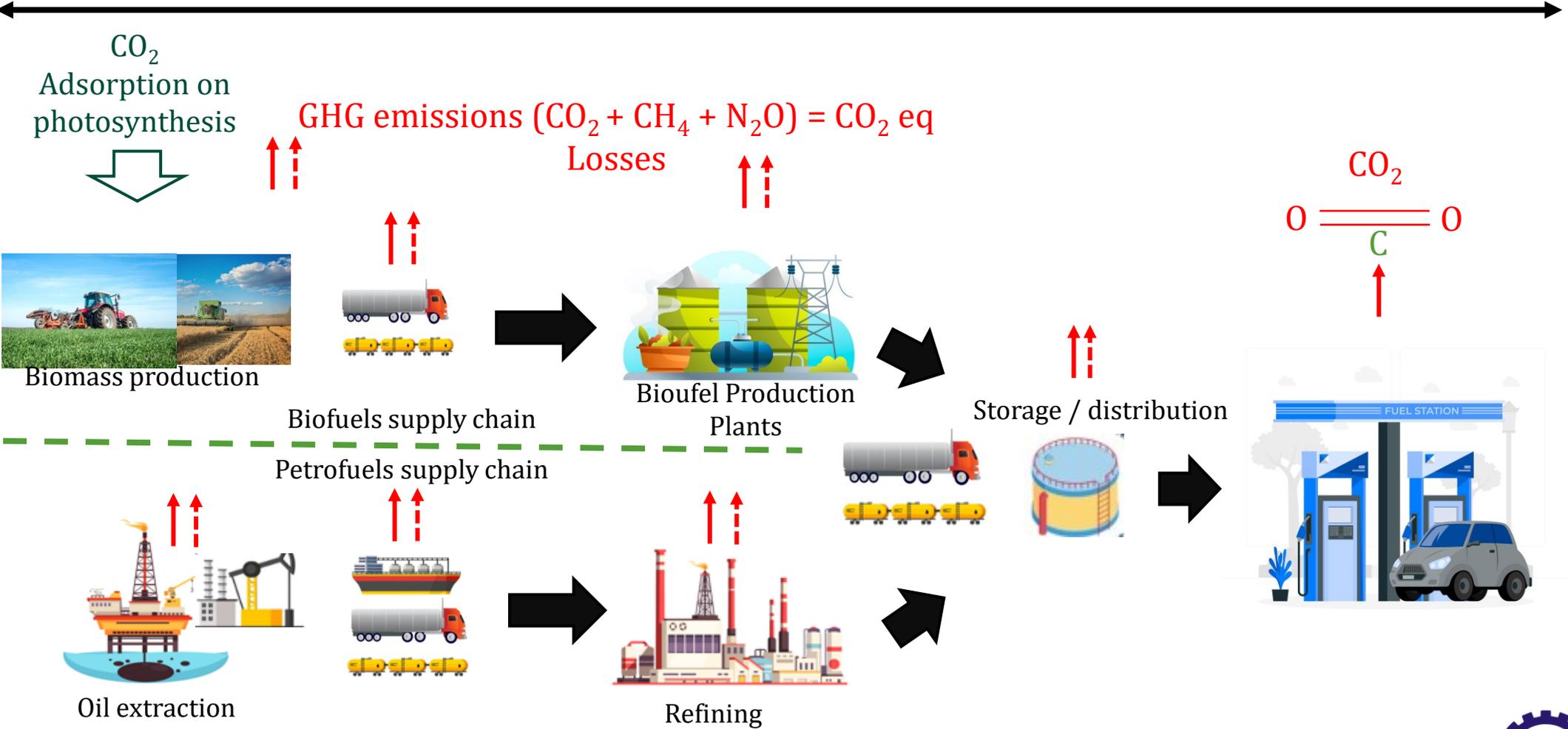
BIOFUEL AND GHG EMISSIONS

Prof. Dr. José Eduardo Holler Branco



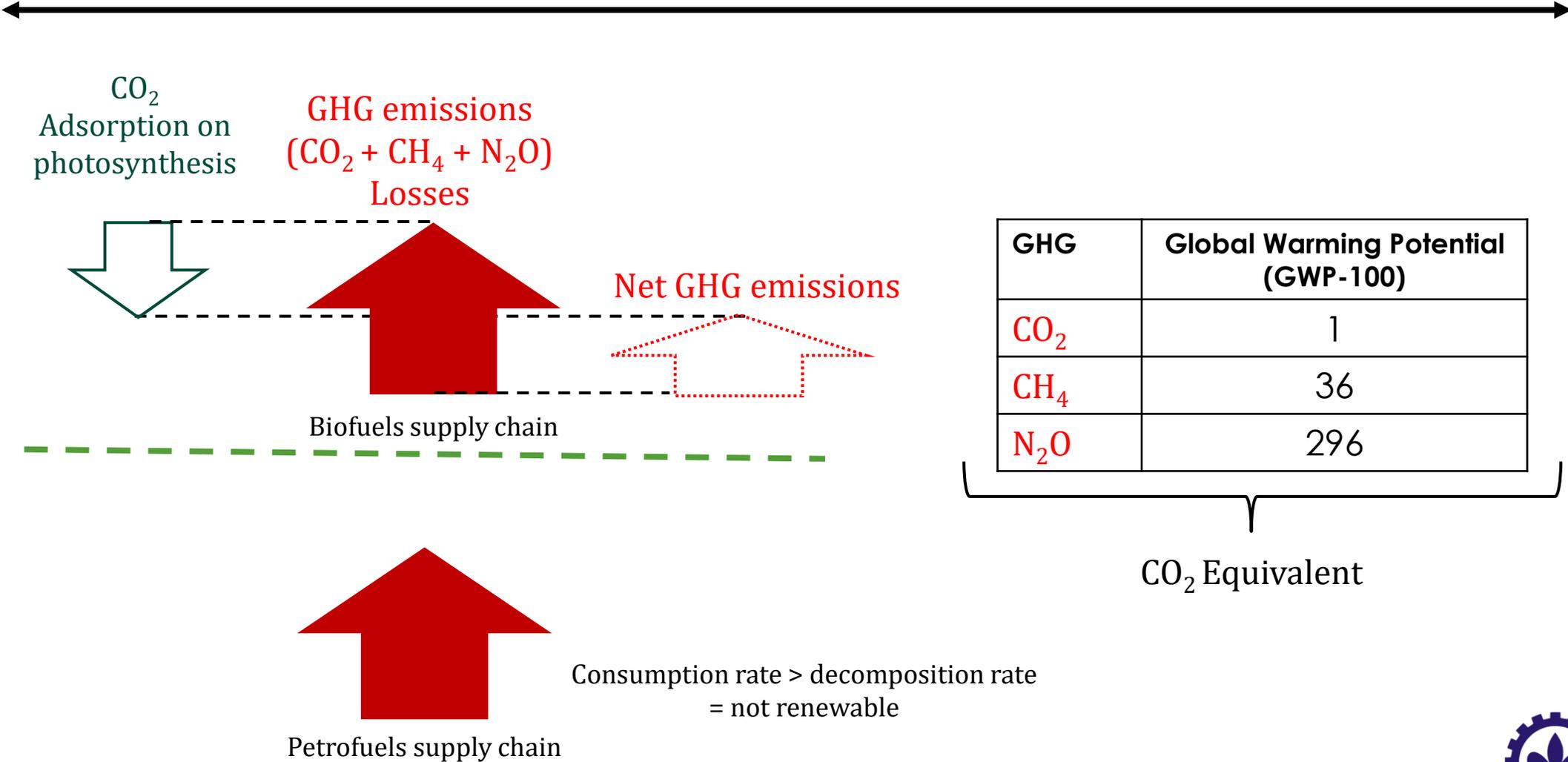
Biofuel vs Petrofuel Life-Cycle

Well-to-Wheels Lifecycle Analysis (LCA)



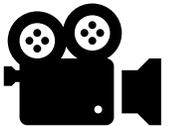
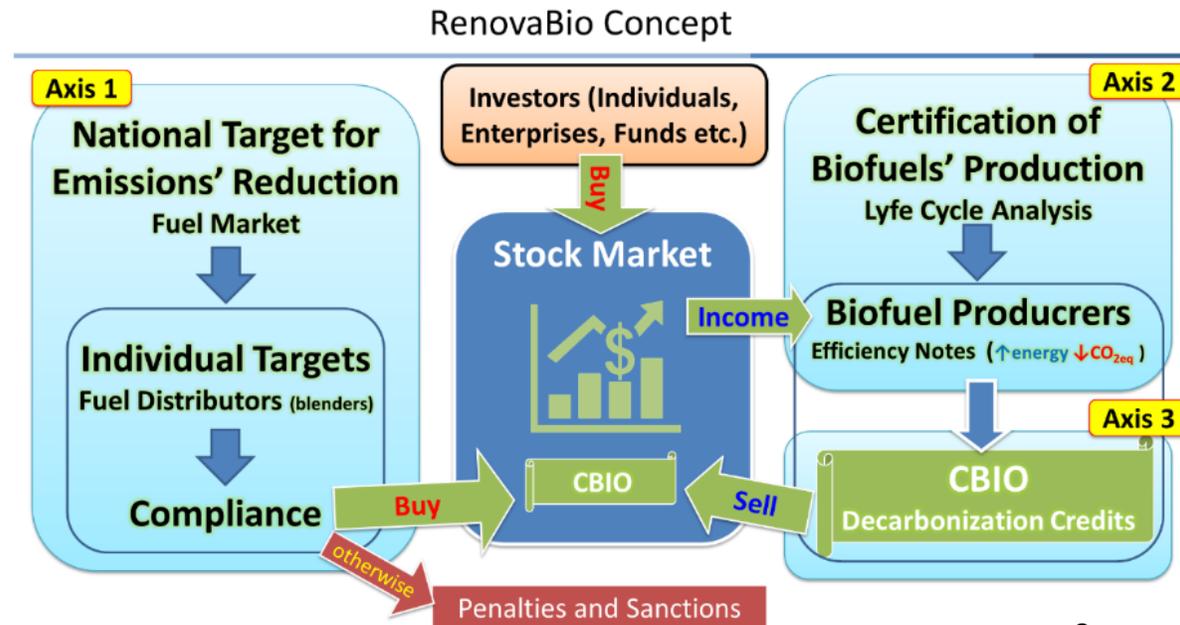
Biofuel vs Petrofuel Life-Cycle

Whel-to-wheels Lifecicle Analisys (LCA)



RENOVABIO

- Law 13.576/2017 - Brazilian National Biofuel Policy (RenovaBio) => Biofuels contributing to Brazilian energy security and the mitigation of greenhouse gas emissions (GHG)
- One CBIO = 1 ton of CO₂ eq avoided into the atmosphere
- Individual CBIOs targets for fuel distributors, proportional to their shares in the fossil fuel market
- To be eligible, the biomass processed in the plants cannot come from the areas where there has been suppression of native vegetation



BIOFUEL LIFE-CICLE

Average efficiency notes of RENOVABIO

GHG emissions
g CO₂ eq / MJ

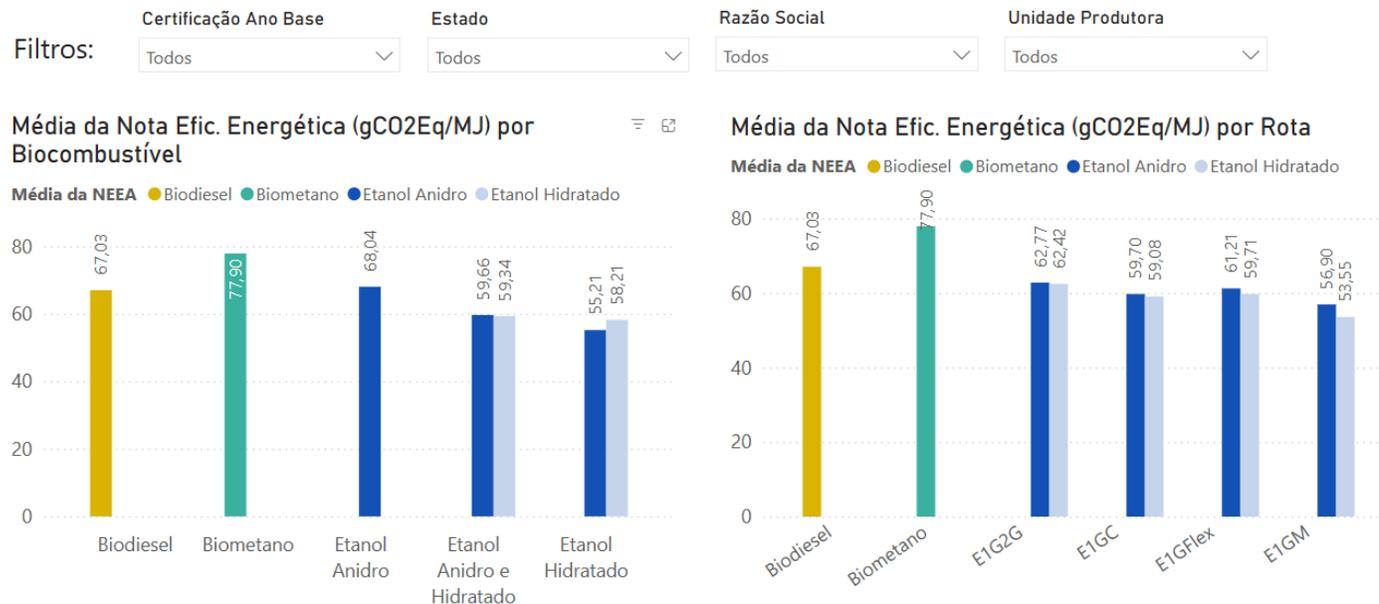
PETROFUELS

SUBSTITUTE
BIOFUELS

Efficiency
note



Painel Dinâmico RenovaBio
Nota Eficiência Energética



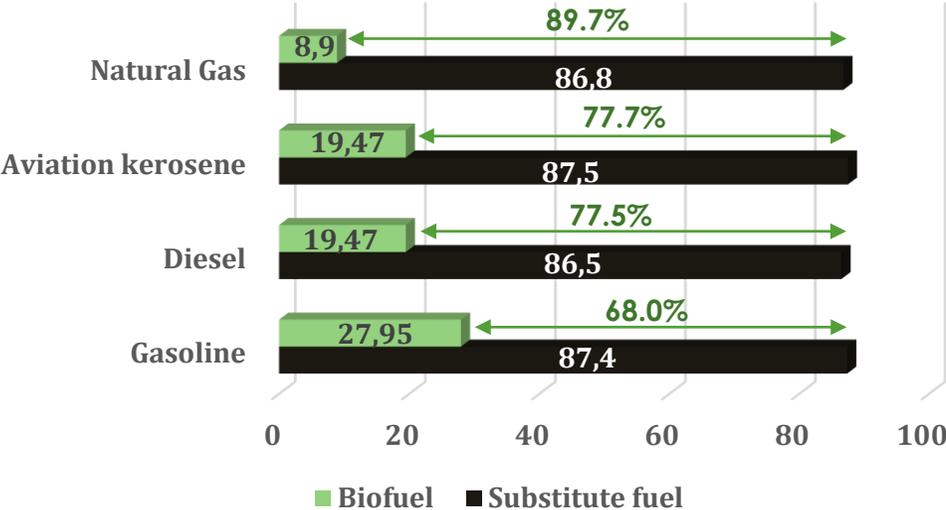
Diferença entre "etanol hidratado" e "etanol anidro e hidratado": No primeiro caso, refere-se aos processos de usinas que possuem apenas o certificado para etanol hidratado e no outro caso, usinas que possuem ambos os certificados.

[Microsoft Power BI](#)

Source: RENOVABIO (2023)

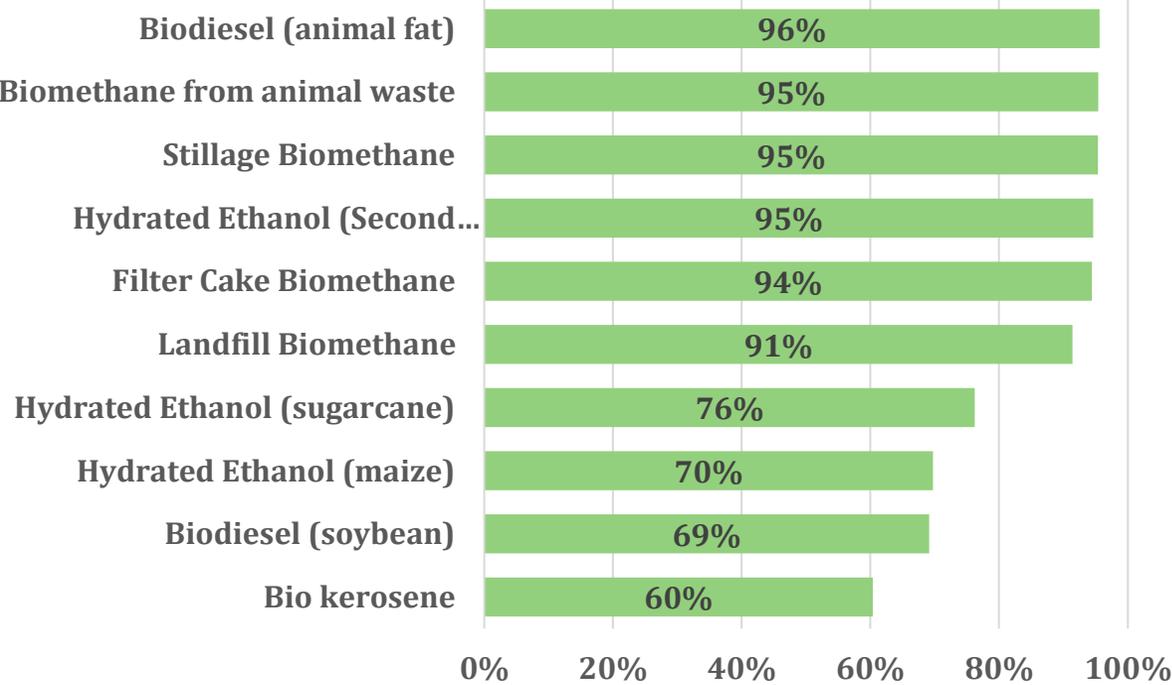
Biofuel vs Petrofuel Cycle Life-Cycle

GHG emissions of main biofuels in Brazil g CO₂ eq / MJ



Source: elaborated based on average CI of biofuels producers certified on RENOVAIO.

Potential Cutting on GHG emissions of main biofuels in Brazil



Source: elaborated based on reference CI parameters adopted Lei nº 13.576/2017, (2017), Matsuura (2018)

GHG emissions of main petrofuels adopted in Law nº 13.576/17 – RENOVAIO)

- Gasoline: 87.4 g CO₂ eq / MJ (Cavallet et al., 2016)
- Diesel: 86.5 g CO₂ eq / MJ (GP2-USP, 2012)
- Aviation kerosene: 87.5 g CO₂ eq / MJ (Jong. et al., 2017)
- Average gasoline-diesel-Natural gas: 86.8 g CO₂ eq / MJ (GHG Protocol, 2012)



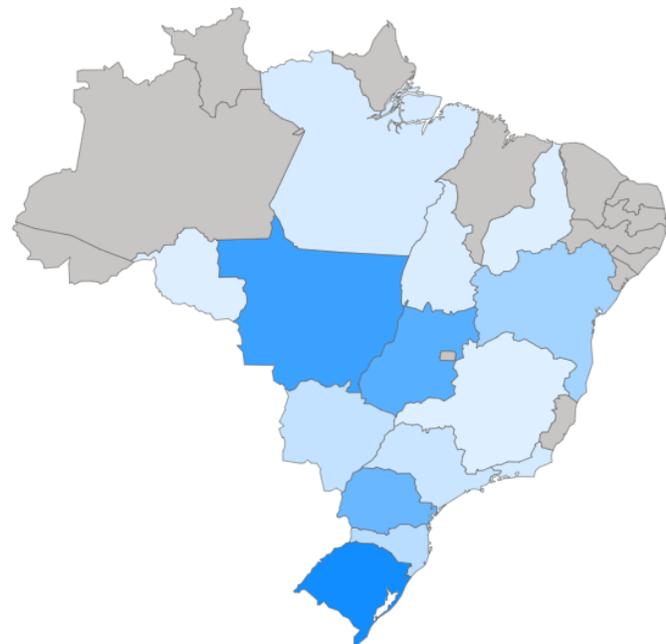
Biodiesel production in Brazil



Painel Dinâmico
Matéria-prima

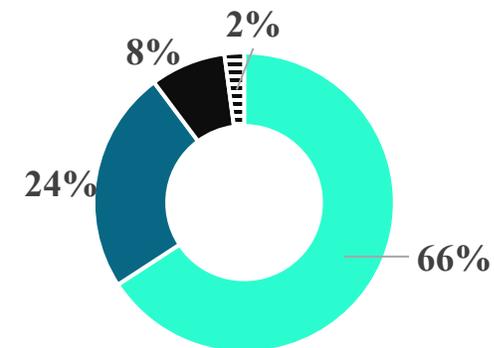


? Posso ajudar?



Brazilian Biodiesel Production (2023)

8 million cubic meters



■ Soybean

■ Animal fats

■ Others

■ Palm/Dendê Oil

Biofuel vs Petrofuel Cycle Life-Cycle

Average carbon intensity of biodiesel produced from different biomasses (g CO₂ eq / MJ)

g CO ₂ eq / MJ	Soybean	Palm	Cotton	Used frying oil ¹	Animal fat ^{1, 2}
Agriculture + Oil extraction	20.59	15.91	59.78	-	-
Biodiesel production	4.28	4.28	4.28	4.28	4.28
Transportation	1.39	1.39	1.39	1.39	1.39
Combustion	0.44	0.44	0.44	0.44	0.44
Total	26.70	22.02	65.89	6.11	6.11

¹ For the categories “Used Frying oil” and “Animal fat” the emission of agriculture and oil extraction is zero, because these are residual oils (or fat) discarded by the production process of other products which those purpose is not the biodiesel production;

² Based on data of 15 Biodiesel producers certified in RENOVABIO

Average emission of Biodiesel produced in Brazil (g CO₂ eq / MJ)

Biomass	Share %	Carbon intensity (g CO ₂ eq / MJ)
Soybean	66%	26.70
Animal fats	24%	6.11
Others ¹	8%	25.74
Palm/Dendê Oil	2%	22.02
Brazil	100.00%	21.58

¹ Based on ANP (2023)

² Based on data of 15 Biodiesel producers certified in RENOVABIO

Biofuel vs Petrofuel Cycle Life-Cycle

Estimated diesel consumption, mandatory mixture of diesel in biodiesel, Carbon Intensity (CI) of diesel blend and avoided GHG emissions.

Year	Diesel consumption	Biodiesel / Diesel	CI of pure Diesel	CI of Biodiesel	CI of Diesel Blend	Avoided GHG emissions / year	
	Billion liters	%	g CO ₂ eq / MJ			%	10 ⁶ t CO ₂ eq.
2023	65.94	11.5%	86.5	21.58	79.48	8.12%	16.32
2024	68.90	13%	86.5	21.58	78.55	9.19%	19.28
2025	69.84	14%	86.5	21.58	77.94	9.90%	21.05
2026	70.60	15%	86.5	21.58	77.32	10.61%	22.80
2027	70.54	15%	86.5	21.58	77.32	10.61%	22.78
2028	70.47	15%	86.5	21.58	77.32	10.61%	22.75
2029	70.40	15%	86.5	21.58	77.32	10.61%	22.73
2030	70.34	15%	86.5	21.58	77.32	10.61%	22.71
Total 2023-2030							170.43

Biofuel vs Petrofuel Cycle Life-Cycle

Light-duty vehicles energy matrix and the effects of ethanol in reducing GHG emissions

	cbm (million)	Mega Joules (billion)	Mega Joules (%)	CI (g CO ₂ eq / MJ)
Gasoline	31.2	925.94	58%	87.40
Anhydrous Ethanol (A)	11.8	351.22		30.17
Hidrated Etanol (H)	15.3	325.47		30.62
Total Ethanol (A + H)	27.1	676.69	42%	30.39
Total light vehicle fuel	58.3	1,602.63	100%	63.33

Current GHG emissions of Brazilian light-duty fleet

Emissions	million t CO ₂ eq / year	CI (g CO ₂ eq / MJ)
With ethanol	101.49	63.33
Whitout ethanol	140.07	87.40
Reduction promoted by ethanol	↓ 38.58	↓ 28%

The use of ethanol and biodiesel in Brazil is responsible for cutting GHG emissions in almost 60 million tonnes CO₂ eq. / year. As Brazil presents a total emission of around 1,500 million tonnes CO₂ eq. per year (MCTI, 2022), these biofuel are contributing for reducing around 4% of total GHG emissions in the country.

Potential reduction on ethanol GHG emissions

BECCS Bioenergy with Carbon Capture and Storage



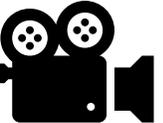
Start Technology & Suppliers Heat & Power Biofuels & Oils All subjects ▾

Biofuels & Oils

FS plans South America's first BECCS project at FS Lucas do Rio Verde in Brazil

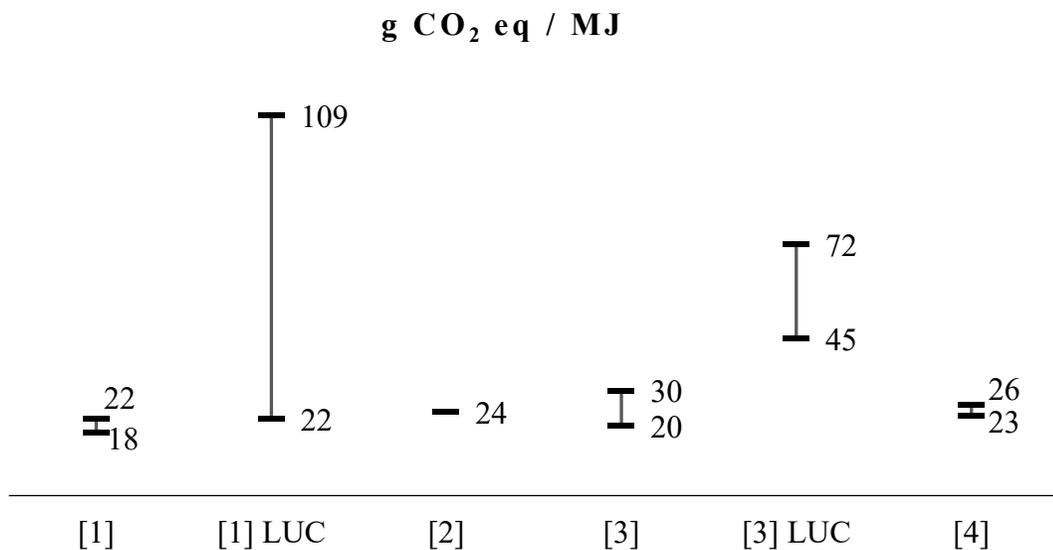
12 June 2021 by [Bioenergy International](#)

In Brazil, FS Agrisolutions Indústria de Biocombustíveis Ltda (FS) a joint venture between Summit Brazil Renewables I LLC a subsidiary of Summit Agricultural Group (SAG), and Tapajós Participações S.A (previously Fiagril), has announced a project to implement Bioenergy with Carbon Capture and Storage (BECCS) at its FS Lucas do Rio Verde ethanol biorefinery complex in the state of Mato Grosso (MT). The project would be Brazil's, and South America's first BECCS project.

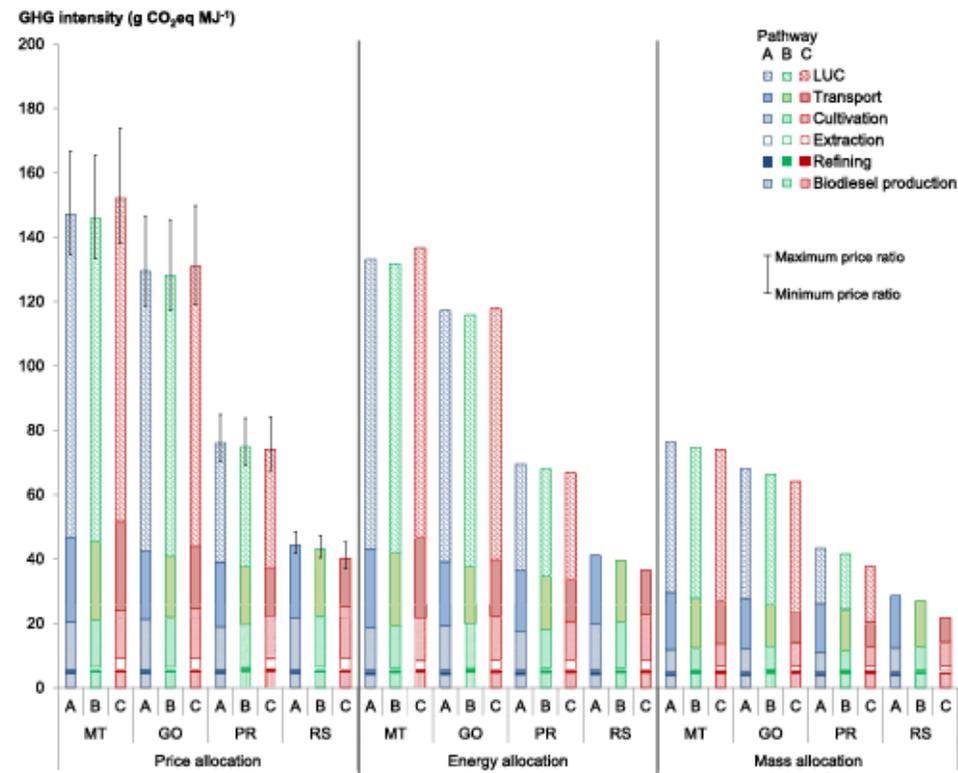


The analysis of Land Use Change (LUC)

Carbon intensity range of Brazilian soybean biodiesel measured by different authors.



Source: [1] Castanheira et al. (2015) ; [2] Knoope et al. (2019); [3] Costa (2021); [4] Cerri et al. (2017)



Source: Castanheira et al. (2015)

RENOVABIO

The Renovabio program requires that the biomass has been produced in an area where deforestation has not occurred



FINAL REMARKS

“By blending water and minerals from below with sunlight and CO₂ from above, green plants link the earth to the sky” (Fritjof Capra)

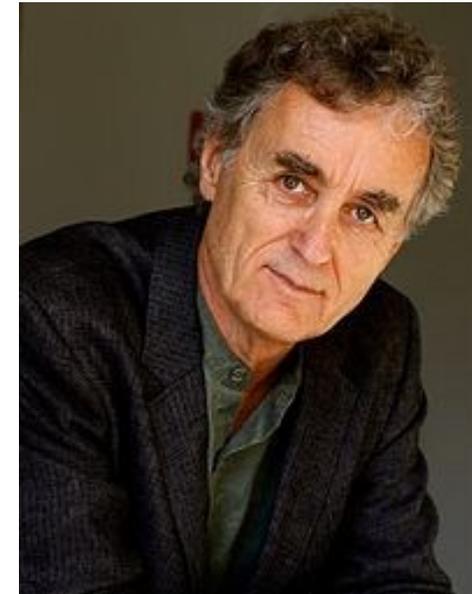


Image ®: Wikipédia

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Thank you!



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