# “SAF Opportunities in Brazil”

**Prof. Donato Aranda**

**UFRJ and UBRABIO**

LIPCAT
Laboratório de Intensificação de Processos e Catálise

PROCAT
UNIDADE PROTÓTIPO DE CATALISADORES

Ubrabio
União Brasileira do Biodiesel e Bioquerosene

**November/2022**

# Brazilian Ethanol Experience

- 1925: First ethanol/gasoline experiment
- 1975: Ethanol program starts after 1st world oil crisis
- 1993: Mandatory E-20 to E-25
- 2003: Flex Fuel vehicles
- 2006: 80% of new sold vehicles are flex (2.5 millions / year)
- 600 millions ton of avoid $CO_2$ emissions due to ethanol as biofuel (2003-2021)
- Currently: E27 (10 billion L) and E100 (20 billion L) (~ 400 plants)
- Corn Ethanol: 2.5 billion L/year (fast growing)
- Two E2G Industrial Plants

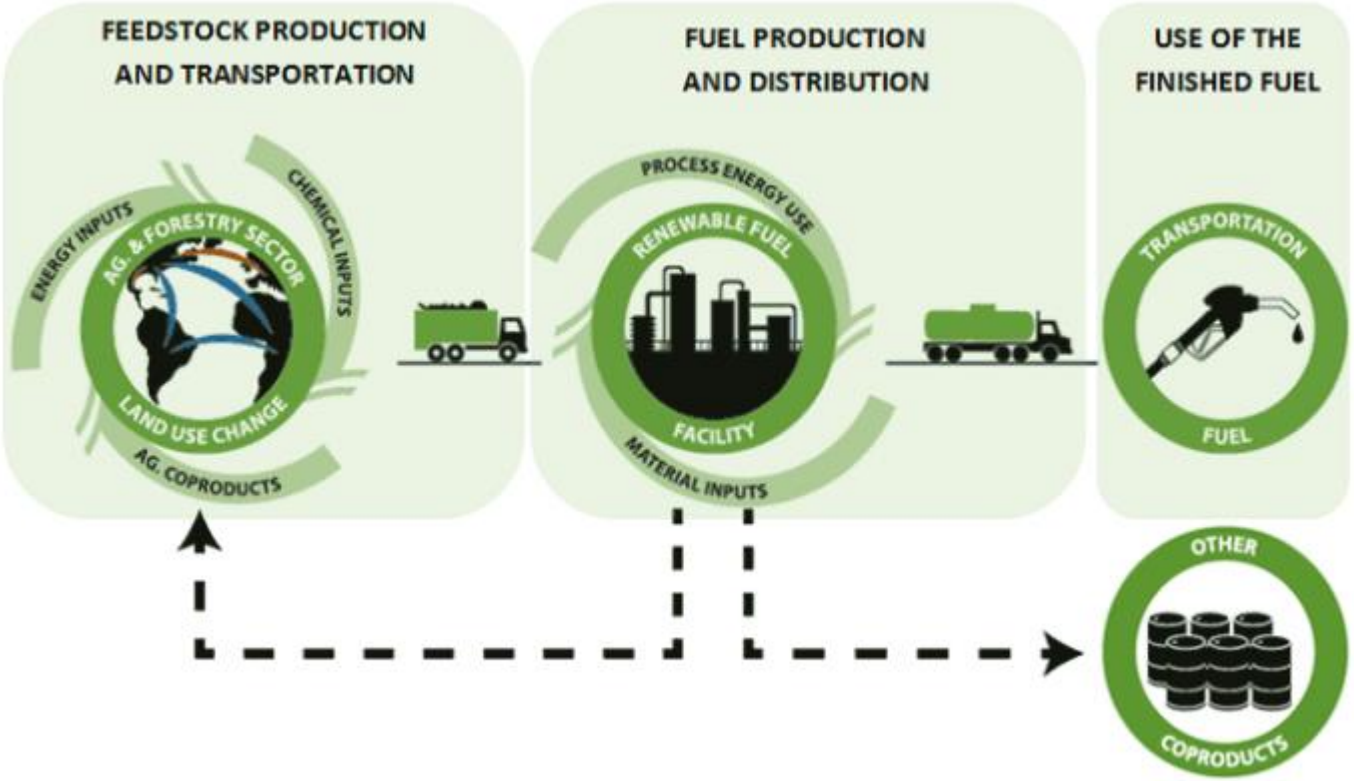
1532: Martim Afonso de Sousa introduces sugar cane in Brazil

# Brazilian Biodiesel Experience

- 1980: First Biodiesel Patent – Expedito Parente
- 2002: ProBiodiesel
- 2005: Biodiesel Legislation
- 2006: 1st Biodiesel Plant
- 2008: B2 Mandatory
- 100 millions ton of avoid $CO_2$ emissions due to as biodiesel as biofuel (2008-2021)
- Currently: B10 (6 billion L) ~ 52 plants
- Raw Materials: 70% Soybean Oil, 20% Animal Fat, 10% others

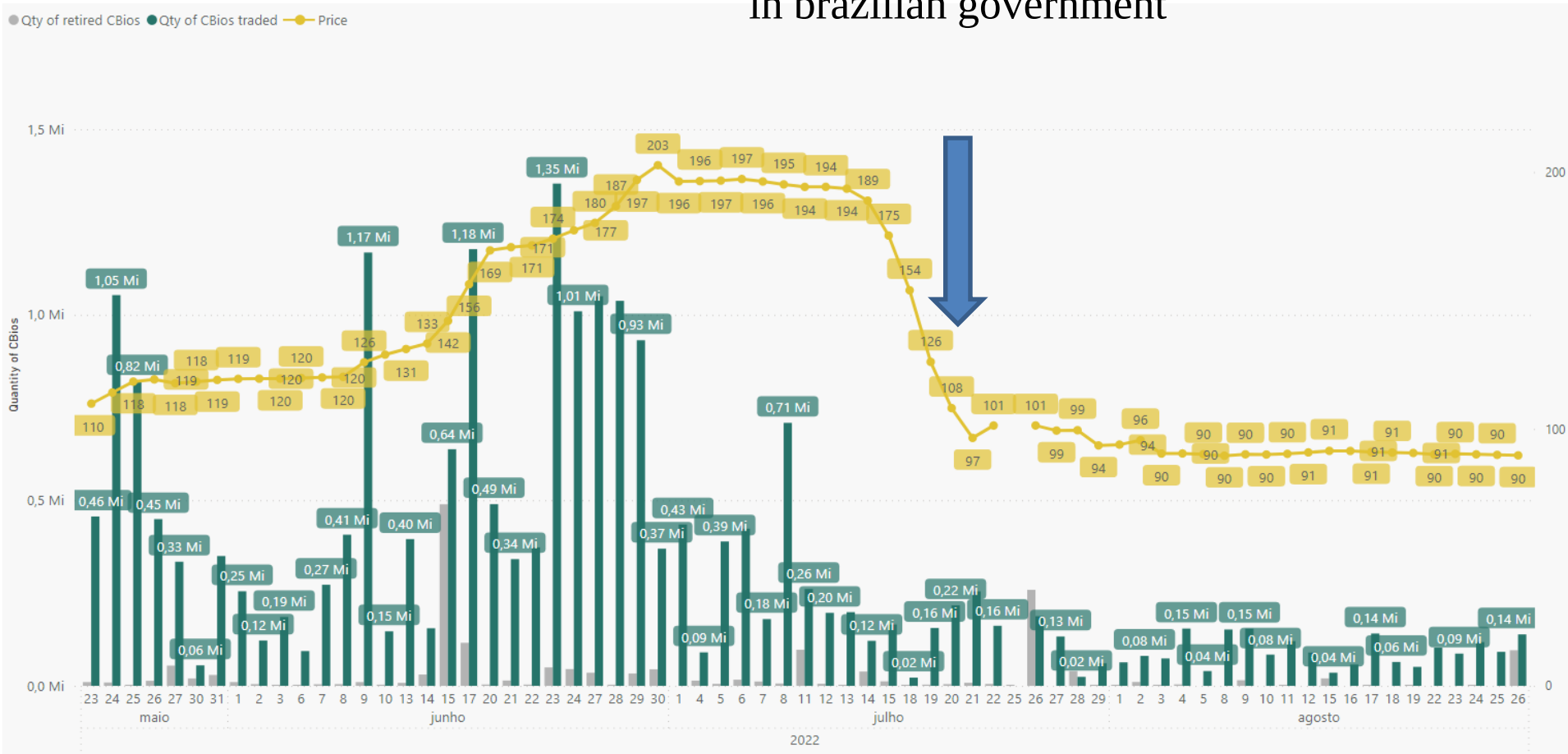
# Biofuels Comparison: Efficiency score/Renovabio

## Lifecycle Analysis of Greenhouse Gas Emissions



# CBIO price in 2022 (May-August)

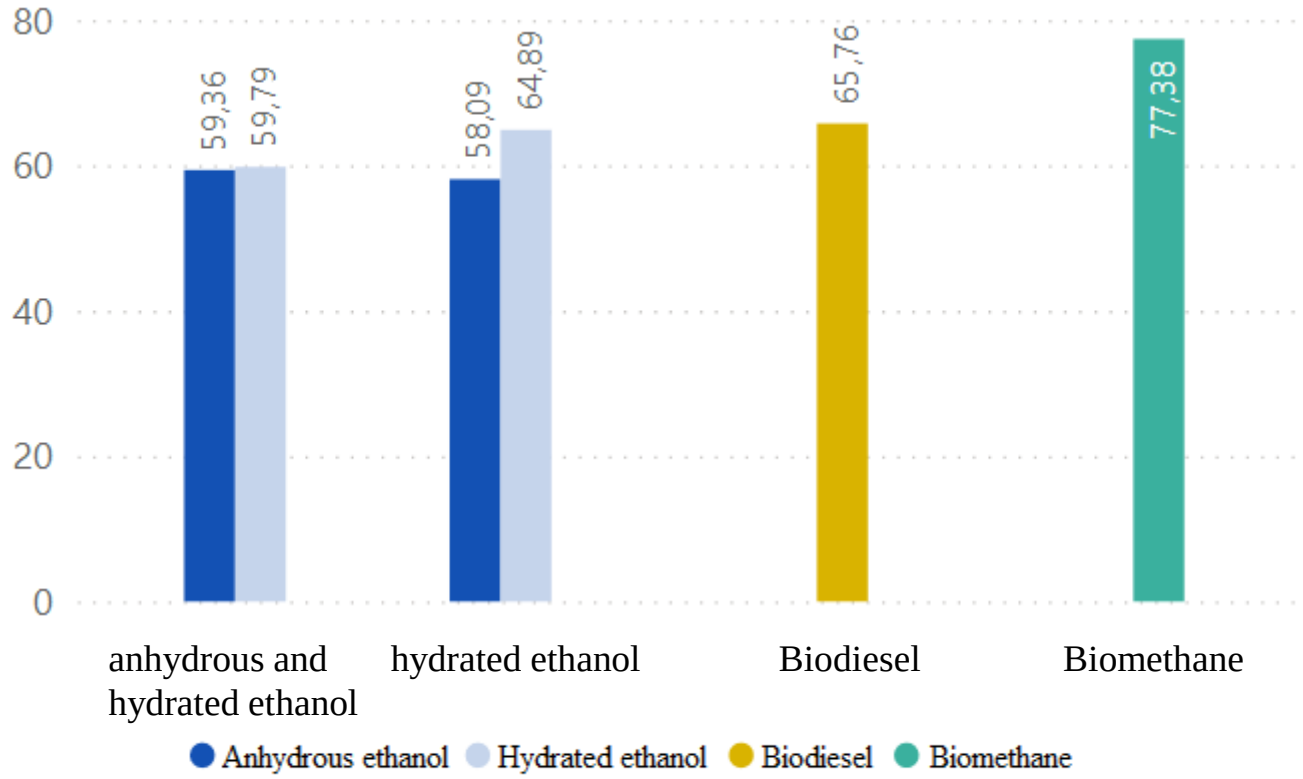
CBIO prices were strongly affected by some decisions in brazilian government



# Efficiency score

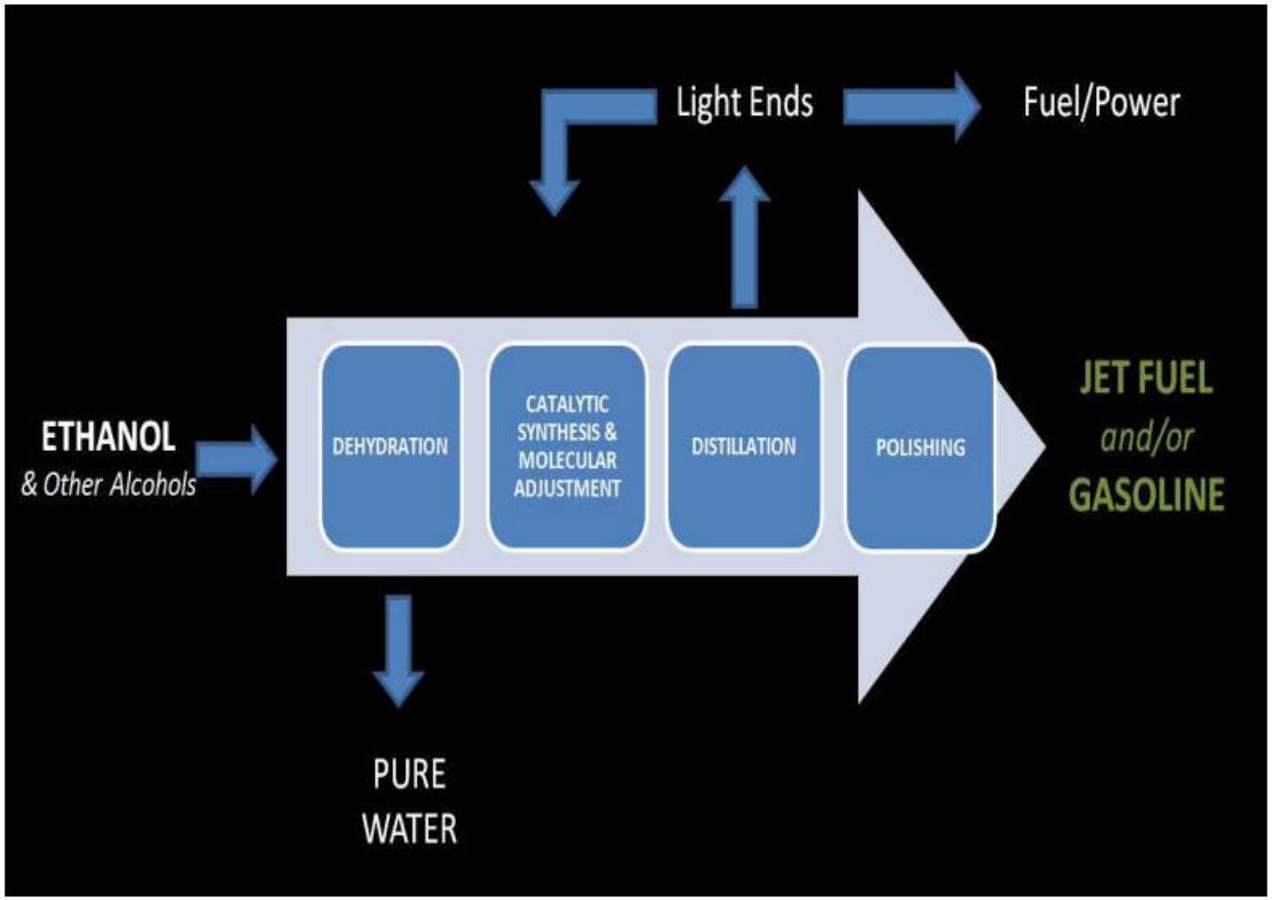
## Average of efficiency score per biofuel

gCO2/MJ



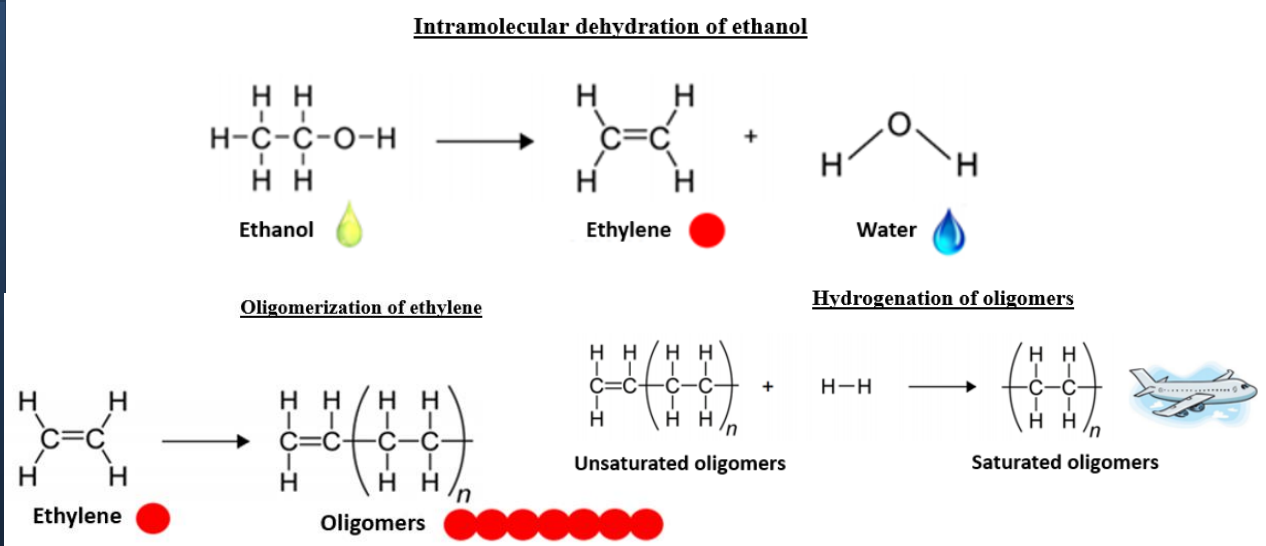

"Hydrated ethanol" is when the plant only has a certificate for hydrated alcohol and "anhydrous and hydrated ethanol" is when it has both

# Alcohol-to jet (ATJ)




- **Source: https://biomassmagazine.com/.**

# Alcohol-to jet (ATJ)




*Comment: Higher alcohols have a higher theoretical yield through ATJ upgrading although the maximum theoretical carbon yield is identical. The water molecule lost during dehydration is 37.5% of the mass of ethanol, but only 23.7% of butanol.*

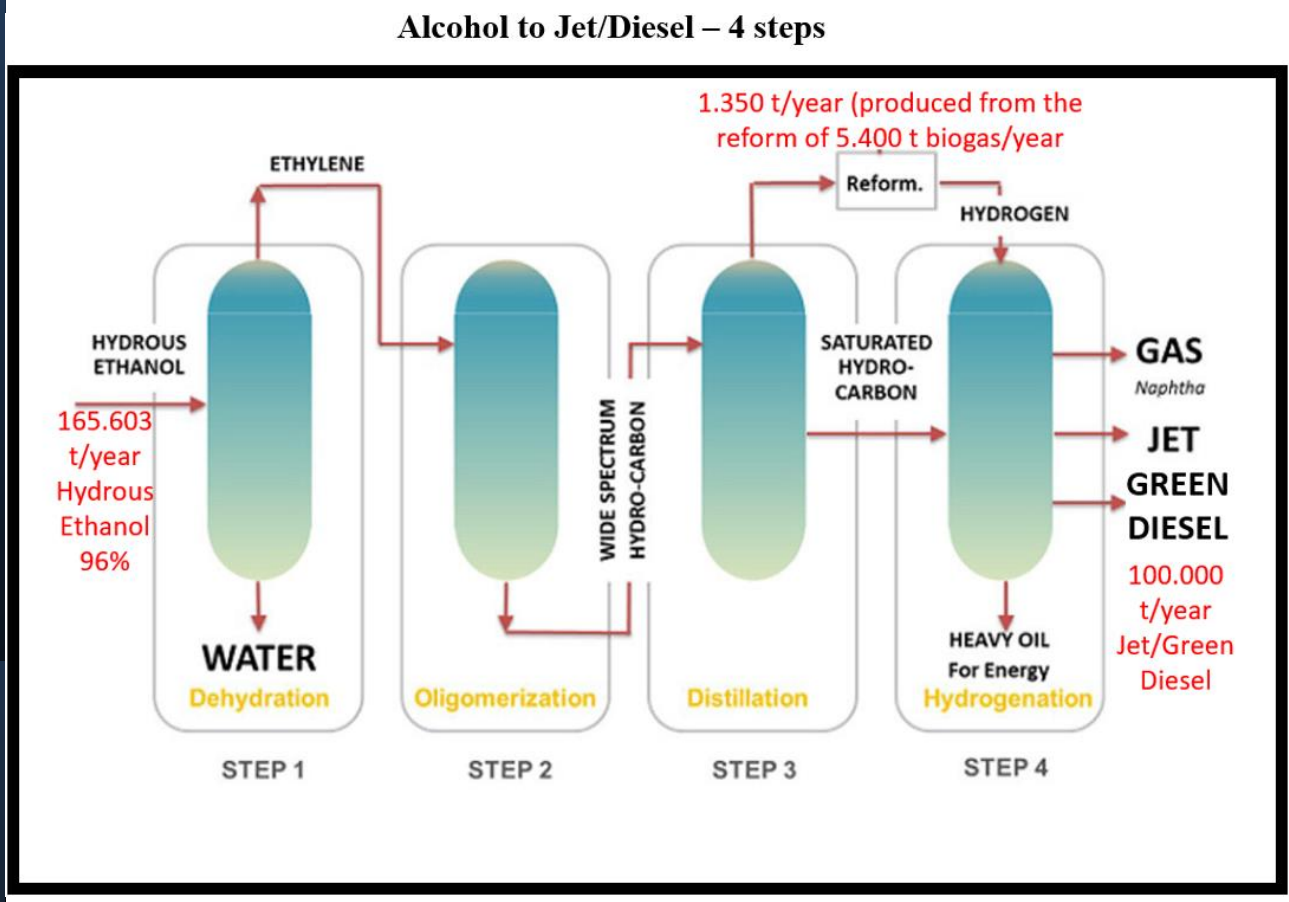
- **Source:https://doi.org/10.1002/cssc.201801690**

Gevo plant in Texas

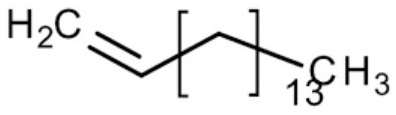
100,000 gal/year

# Alcohol-to jet (ATJ)

(technological options)




- **Source: Own elaboration from WANG (2016).**

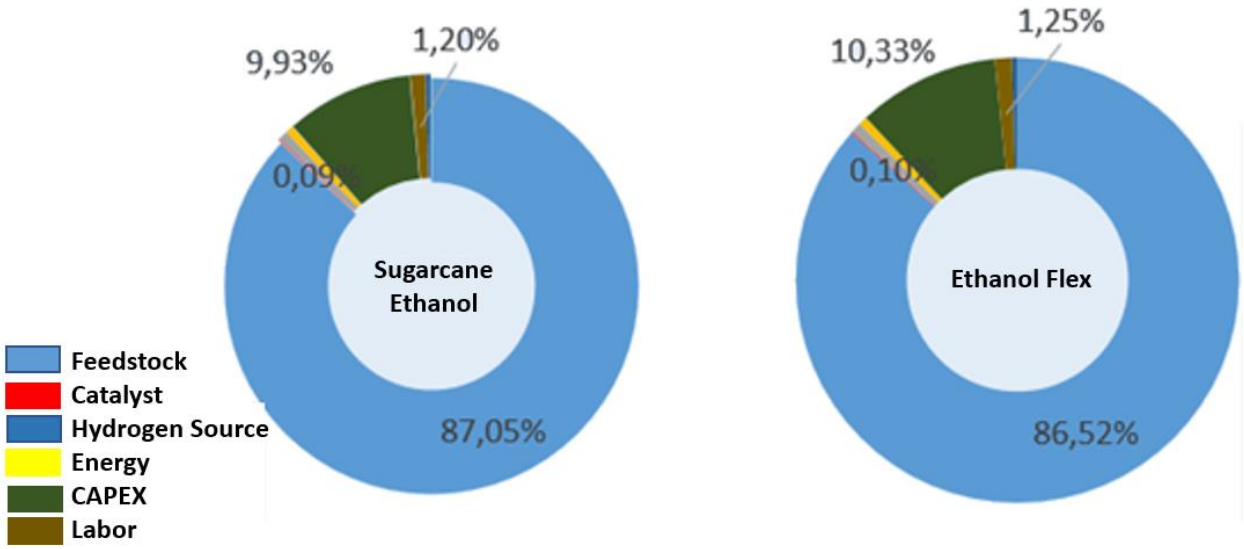


# Alcohol-to jet (ATJ)

| | Opex - proposed detailing | Expected products |
|---|---|---|
| s | For a plant with capacity 120 kt/y biojet, order of magnitude is a consumption of pure ethanol feed of around 238 kt/y. | Here below the yields, carbon basis, %wt:<br><br>Max naphtha mode:<br>Naphtha / jet/diesel :up to 90/10 /0<br><br>Max jet mode:<br>Naphtha / jet/diesel : up to 0/80/20 |

# Alcohol-to jet (ATJ) (costs)

## Distribution of cost in % ATJ variants



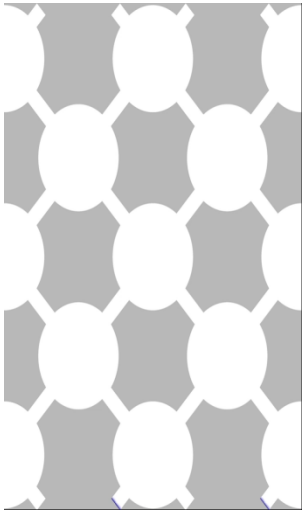

- **Source: TAPANES (2021).**

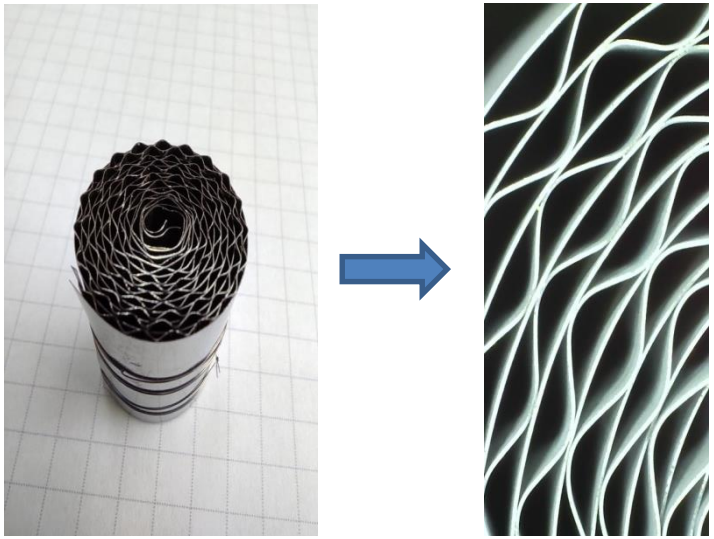
# LIPCAT/UFRJ

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÕES

PÁTRIA AMADA BRASIL GOVERNO FEDERAL

- ✓Microchannel reactors
- ✓Pilot plant 150 L/min  syngas
- ✓Also used for HVO, ATJ and Fischer-Tropsch





Fonte:
Turbulence in Microlfuidics: microfabrication, carachterization and application, 2019, Sousa Lima, Rç
https://www.net4co2.pt/p137-netmix-en


LIPCAT
Laboratório de Intensificação de Processos e Catálise

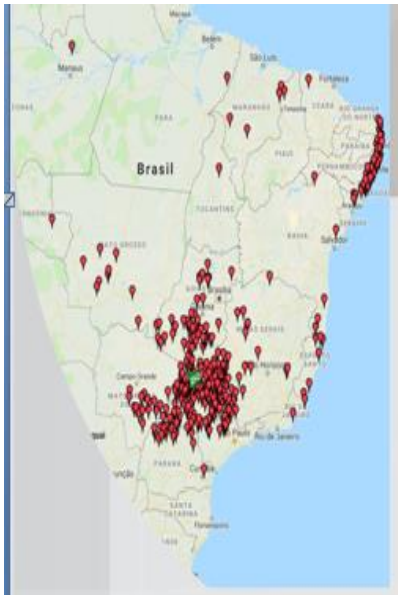
PROCAT
UNIDADE PROTÓTIPO DE CATALISADORES


LIPCAT
Laboratório de Intensificação de Processos e Catálise

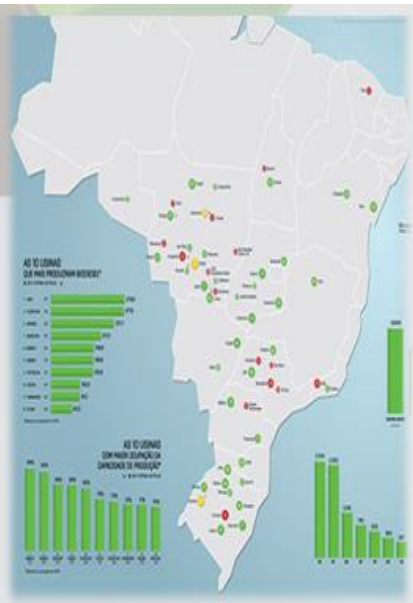
PROCAT
UNIDADE PROTÓTIPO DE CATALISADORES

# PROCAT


# PATHWAYS FOR SAF

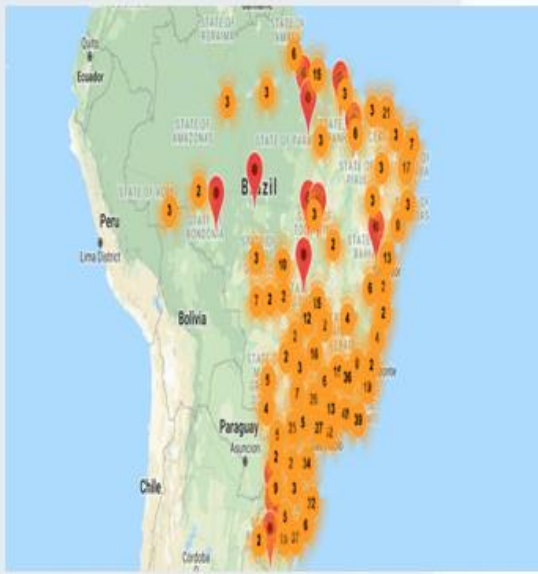



ETHANOL



BIODIESEL


WIND




SOLAR

LIPCAT
Laboratório de Intensificação de Processos e Catálise

PROCAT
UNIDADE PROTÓTIPO DE CATALISADORES

UFRJ
UNIVERSIDADE FEDERAL DO RIO DE JANEIRO

Ubrabio

**8 pós-docs, 9 M. Sc e D. Sc.**

Petrogal Brasil, S.A.
Joint Venture
Galp Energia | Sinopec

CNPq

FAPERJ

SINOCHEM

Rm 8.28 “Todas as coisas cooperam para o bem daqueles que amam a Deus”