Mission Innovation - Integrated Biorefineries Mission

Webinar on Biorefineries Efficiency Improvement

R&D for Advanced Biorefineries

Sustainable Aviation Fuel Technologies

Mateus Ferreira Chagas

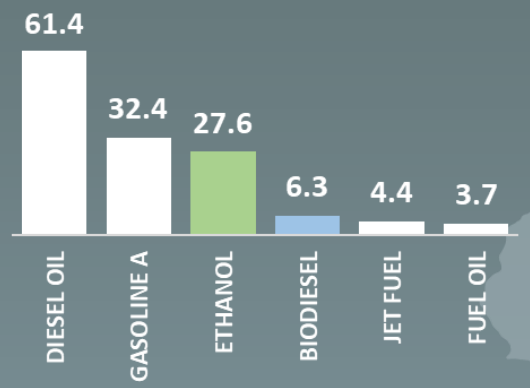
Brazilian Biorenewables National Laboratory (LNBR)

Brazilian Center for Research in Energy and Materials (CNPEM)

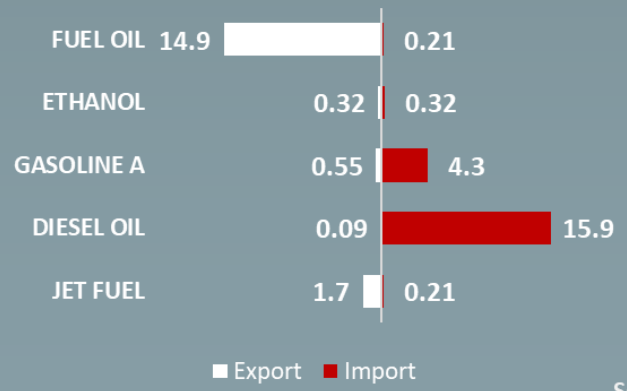
July 13th, 2023

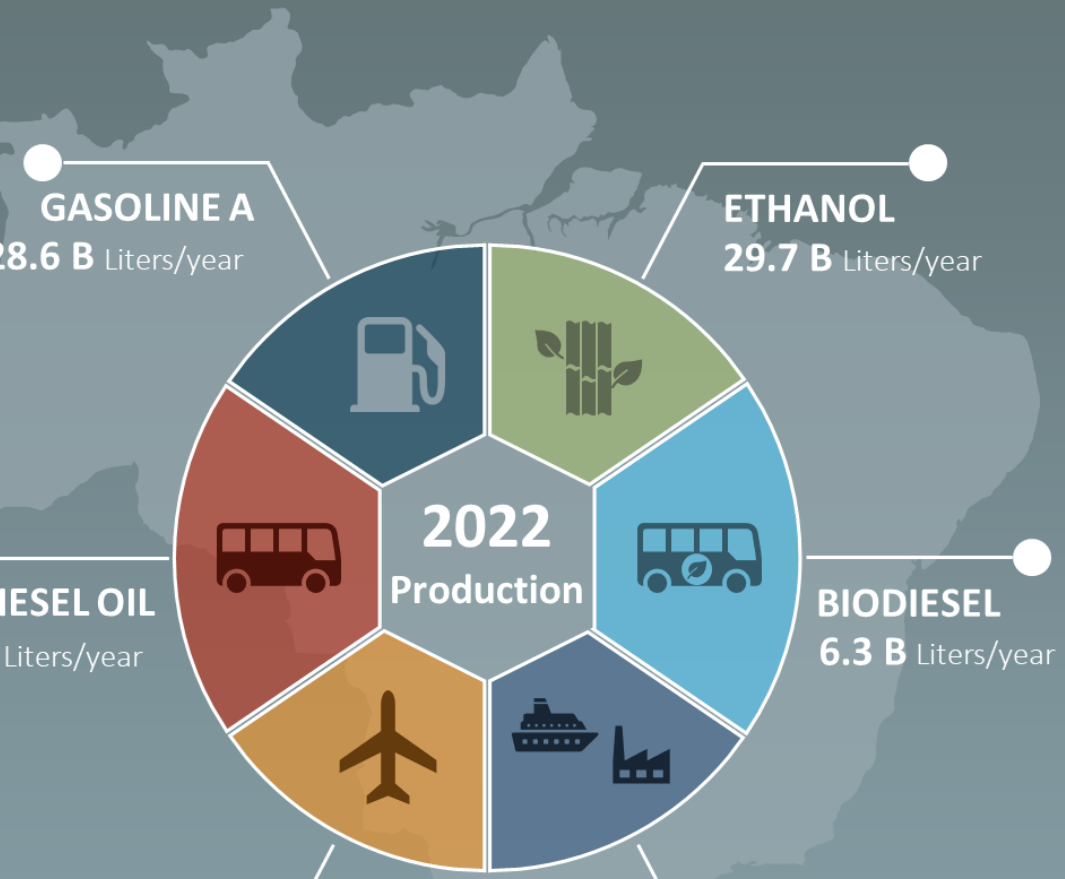
Overview of Liquid Fuels in Brazil in 2022

INTERNAL DEMAND
(B Liters/year)



EXPORT vs. IMPORT
(B Liters/year)





BIOFUELS PARTICIPATION

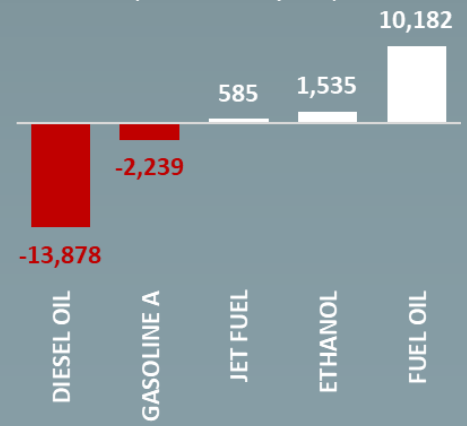
Volumetric Basis

25 %

Energy Basis

19 %

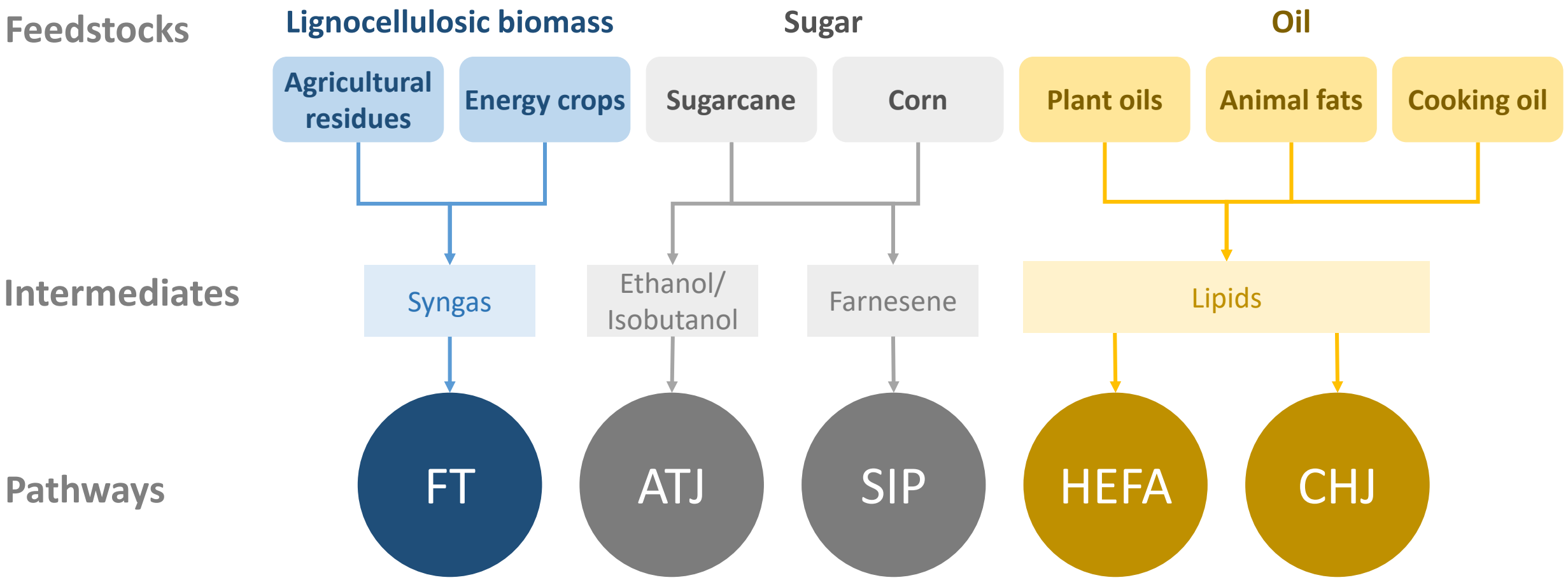
TRADE BALANCE
(MM USD/year)



Source: Brazilian Biorenewables National Laboratory LNBR/CNPEM – with data from ANP (2023)

The challenge to produce Sustainable Aviation Fuels (SAF)

Global routes approved by ASTM



How to move from oxygenated feedstocks to hydrocarbons (fuels)?

What ICAO points for new SAF technologies

- Coprocessing of biocrudes, with early energy-densification processes
- Use of recalcitrant waste streams
- Hybrid (bio- and thermochemical) or multi-technology conversions
- Hydrocarbon fuels from hydrogen and carbon dioxide

ICAO Environmental Report 2022 – New Sustainable Aviation Fuels (SAF) technology pathways under development.

Brazil-EU cooperation for advanced biofuels

Integrated bio- and thermochemical routes for SAF

BioValue

Coordinated by LNBR/CNPEM

- 04 Companies
- 11 Research Institutions
- 04 State Funding Agencies

BECOOL

Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels

Coordinated by University of Bologna

- 13 partners
- 07 EU countries
- Horizon 2020 funding

- Collection of literature, lab and pilot plant scale data
- Techno-economic and environmental assessment of different biorefinery configurations

MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION

BRAZILIAN GOVERNMENT BRASIL UNITING AND REBUILDING

CORSIA Eligible Sustainable Aviation Fuels

- Country-specific data for iLUC
- GLO routes based on residues: opportunities for collaborations between MI countries

Source: ICAO (2022) - CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels, 3rd Edition (June 2022)

Front-End Development of Innovative Technologies

There is no large-scale production of SAF in the world yet

At the moment, we must explore all possibilities

As an illustration:

Can **Biotechnology** be applied to promote feedstocks deoxygenation and produce SAF with lower environmental impact?

PNAS

Dimer-assisted mechanism of (un)saturated fatty acid decarboxylation for alkene production

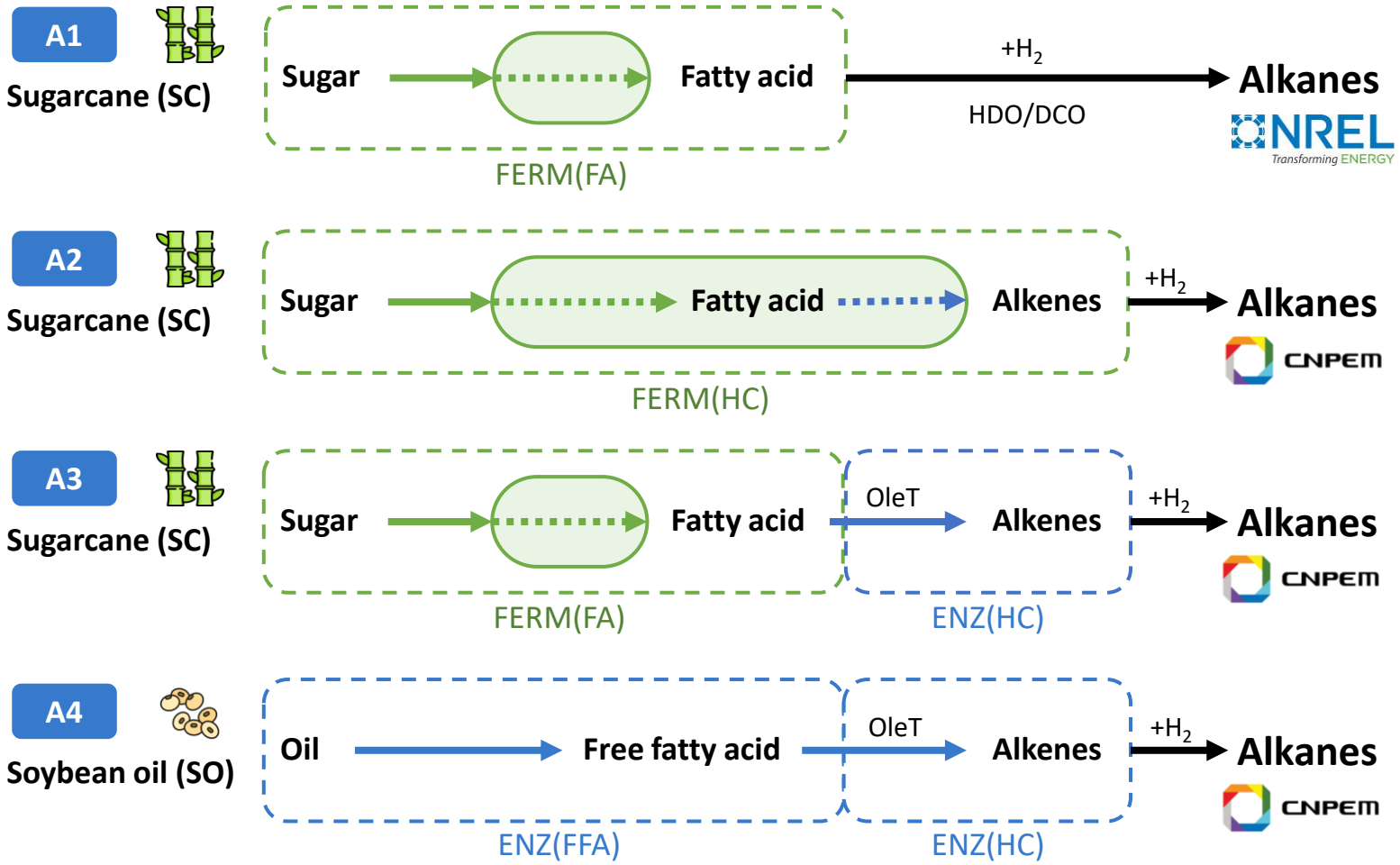
https://doi.org/10.1073/pnas.2221483120

From enzyme to cell-factory: Economic and environmental assessment of biobased pathways to unlock the potential of long-haul transportation biofuels

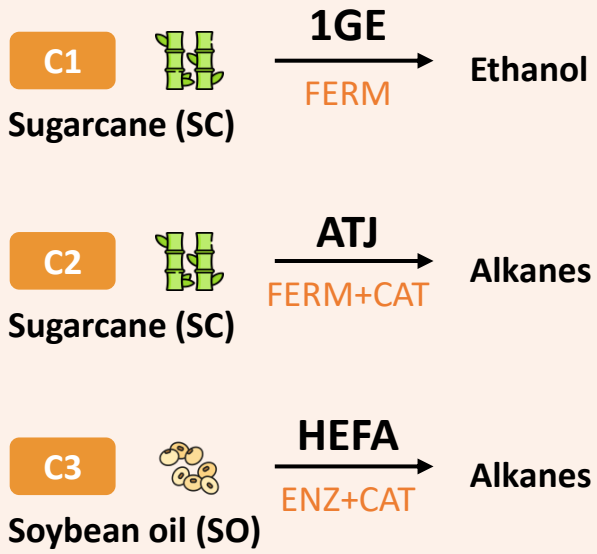
https://doi.org/10.1016/j.cej.2023.143878

SAF Biological Routes:

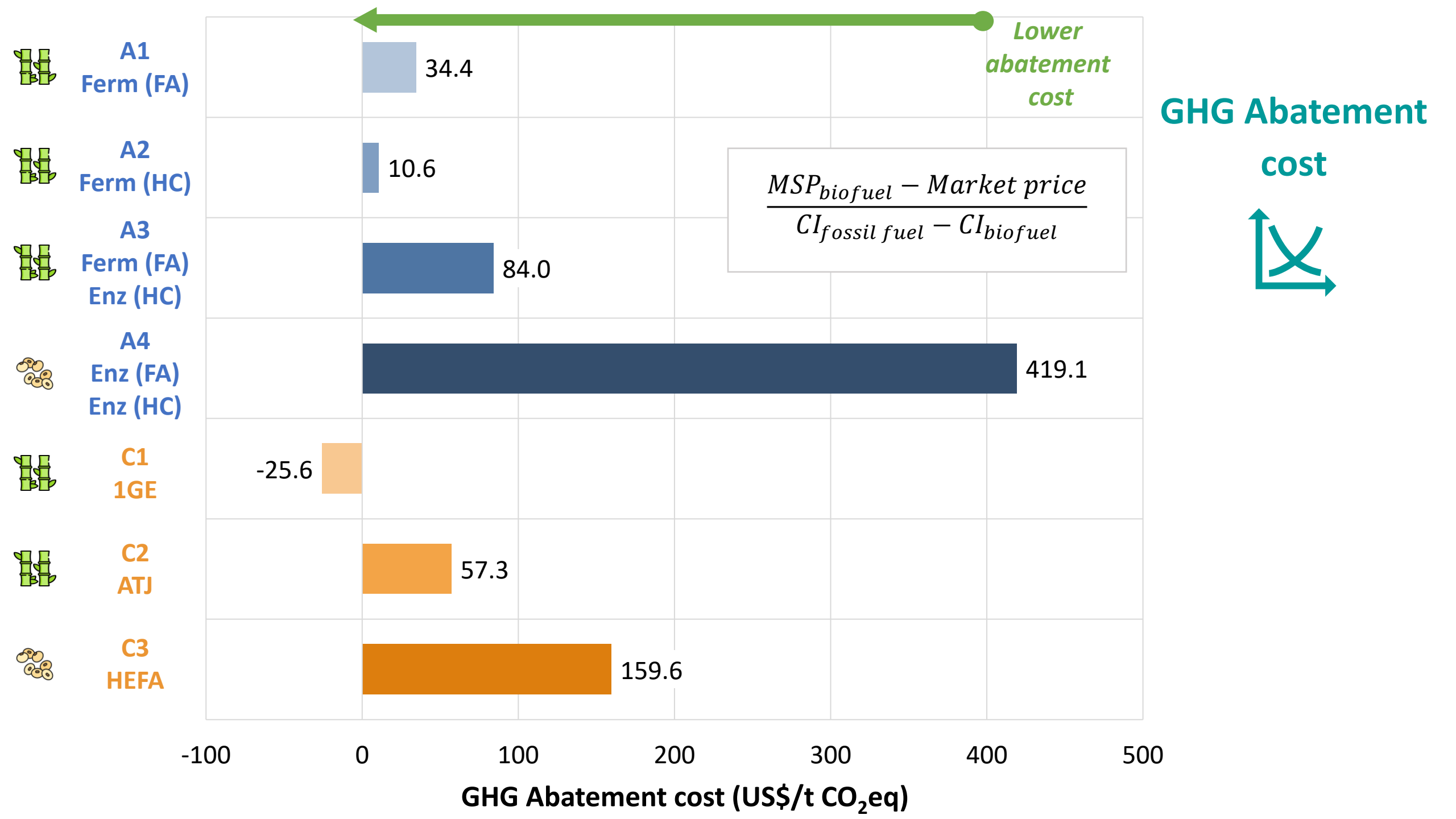
An illustration of novel routes



Comparison with Conventional Technologies:



- *Scenarios A2 - A4 have coproduction of hydroxy-fatty acids*
- *Sugarcane-based scenarios coproduce electricity*


A1
Ferm (FA)
34.4
A2
Ferm (HC)
10.6
A3
Ferm (FA)
Enz (HC)
84.0
A4
Enz (FA)
Enz (HC)
419.1
C1
1GE
-25.6
C2
ATJ
57.3
C3
HEFA
159.6
Lower abatement cost
$\frac{MSP_{biofuel} - Market\ price}{CI_{fossil\ fuel} - CI_{biofuel}}$
GHG Abatement cost
-100
0
100
200
300
400
500
GHG Abatement cost (US$/t CO_2eq)

Take-home messages

- There is no large-scale production of SAF – **room for innovation**
- **Integrated value chains** and disruptive technologies may improve sustainability performance
- Sustainability assessment is essential, even in early R&D stages, and **common global metrics** must be defined

Thank you!

Mateus Ferreira Chagas
mateus.chagas@lnbr.cnpem.br
+55 (19) 3517-5031

cnpem.br

Brazilian Center for Research in Energy and Materials

MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION

BRAZILIAN GOVERNMENT
BRASIL
UNITING AND REBUILDING