ABiogás

Associação Brasileira do Biogás e do Biometano

Brazilian Biogas and Biomethane Association

Biomethane Potential

A scalable, market-ready drop-in solution for immediate maritime defossilization

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IMO Headquarters, London

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STRATEGIC OBJECTIVE

POSITION BIOGAS AND BIOMETHANE AS A VECTOR OF ENERGY TRANSITION IN BRAZIL, VALUING THEIR ATTRIBUTES AND PROMOTING MARKET ACCESS.

ASSOCIATED COMPANIES

STRATEGIC OBJECTIVE

POSITION BIOGAS AND BIOMETHANE AS A VECTOR OF ENERGY TRANSITION IN BRAZIL, VALUING THEIR ATTRIBUTES AND PROMOTING MARKET ACCESS.

The United Biogas Alliance (UBA) is a coalition of leading biogas associations working together to grow biogas markets and the multiple benefits biogas systems provide.

United Biogas Alliance

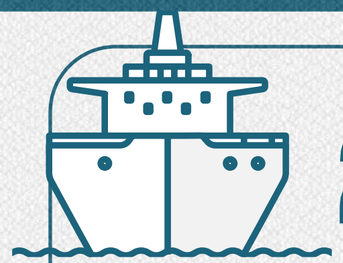
Why Coordination Is Necessary?

- Biogas systems are inherently decentralized. National coordination helps optimize supply chains and local policy to maximize organic residue recycling.
- International coordination elevates biogas markets, aligns carbon accounting principles, strengthens international recognition, and helps fuel marketers access buyers and sellers beyond borders, helping capital flow more predictably into these long-term infrastructure nodes.

Agenda

- Biomethane context
- Brazilian potential and global context
- Reduced emissions from biomethane
- Technology & market
- Closing

Biomethane context



2,400+

LNG-capable vessels globally[1]
(in operation or on order)

25.9 Mt/year
Bio-LNG potential from agro-industrial residues in Brazil[3]

8.4 Mt/year
Could already be supplied by Brazilian biomethane target production by 2030

The LNG fleet is **already compatible with bio-LNG** — the question is supply.

Up to
80%
WtW GHG Reduction[2]

Near-zero emissions
(negative emissions possible with avoided emissions)

56% of the global LNG market size by 2030[4]
Can be supplied by the Brazilian biomethane target production by 2030

+38% of global maritime low-GHG methane demand by 2040[1]
Can be supplied by Brazil's low-GHG bio-LNG

Source: [1] "Methane in shipping: LNG-fuelled ships and the switch to low-GHG methane" report from DNV, [2] "Life Cycle GHG Emission Study on the Use of LNG as Marine Fuel" report from Thinkstep on behalf of SEA-LNG, [3] ABiogás estimative, [4] "THE JOURNEY: A Decade Moving Towards A Cleaner Future" report from SEA-LNG

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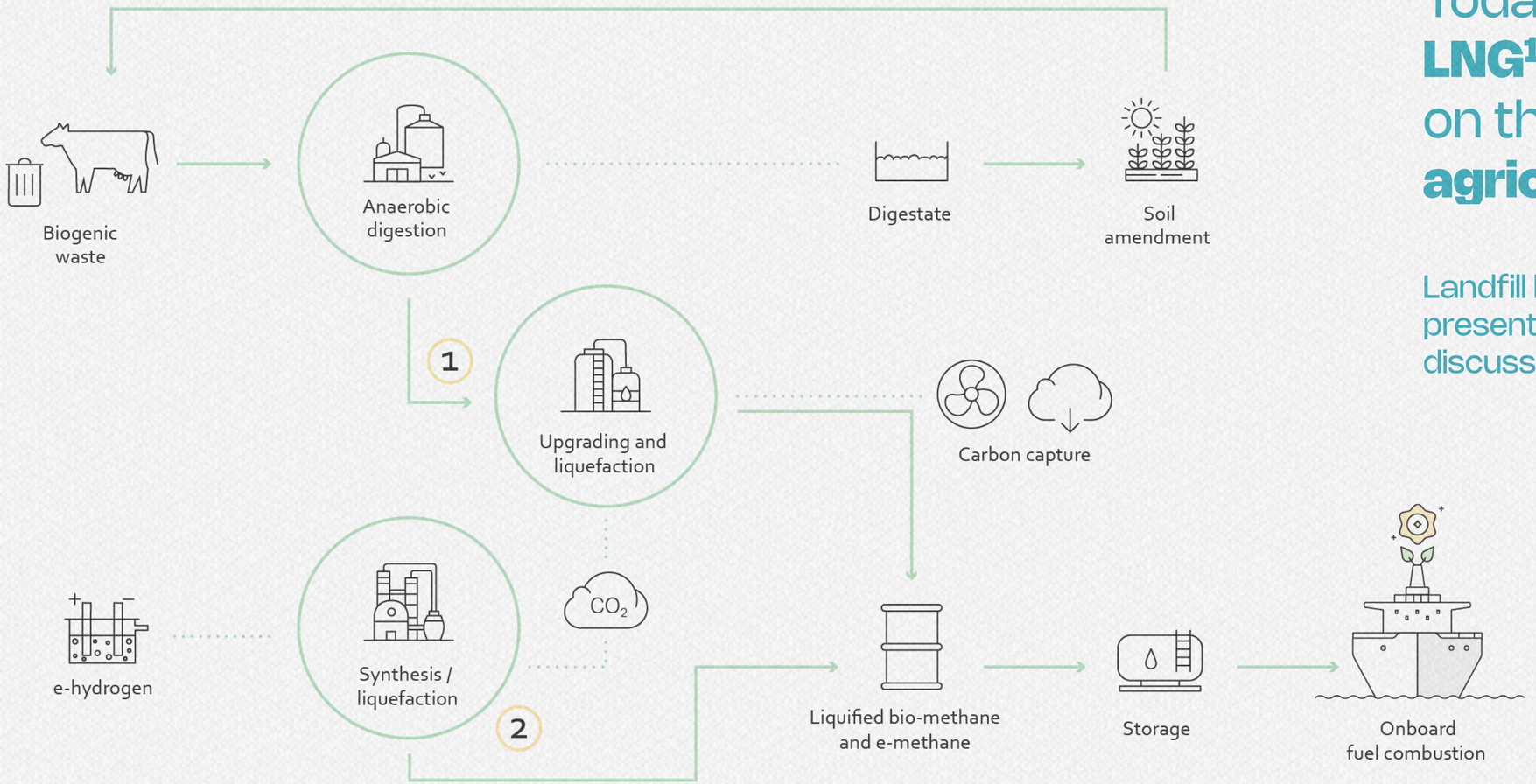

Today, we will focus on **bio-LNG[1]** – specifically, Route 1 on the left, produced from **agricultural residues.**

Landfill biogas is not covered in this presentation; only anaerobic digestion will be discussed.

[1]Also known as liquefied biomethane (LBM); in some places, biomethane is known as renewable natural gas (RNG)

Source: Adapted from "Biogas as a Source of Biofuels for Shipping: Biomass Availability" Report from Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS)

Brazilian potential and global context

SUGARCANE

Raw material

782 Mt

39% of world production

CORN

Raw material

132 Mt

10% of world production

LIVESTOCK

Heads

238 M bovine

15% of world production

44 M swine

5% of world production

MAIN RESIDUES

VINASSE, FILTER CAKE, BAGASSE, AND STRAW

STRAW

SLURRY/MANURE AND PROCESSING RESIDUES

OTHER AGROINDUSTRY WITH RELEVANT BIOGAS POTENTIAL INCLUDE COFFEE, SOY, AND CASSAVA

Source: Brazilian Institute of Geography and Statistics (Portuguese: Instituto Brasileiro de Geografia e Estatística, IBGE) – PPM (Municipal Livestock Production) and PAM (Municipal Agricultural Production) in 2023

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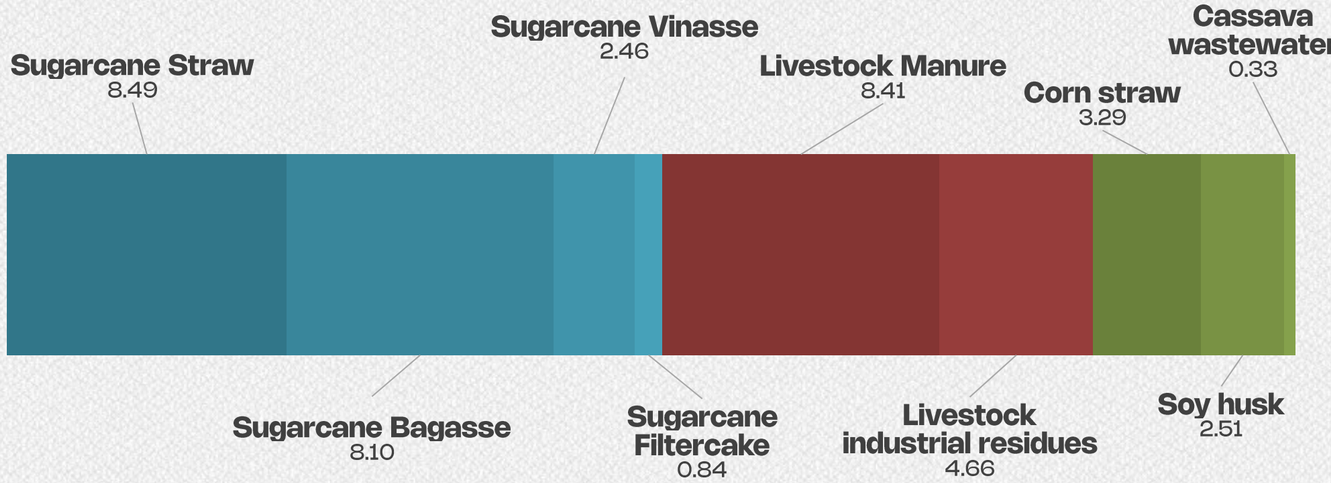
Brazil's **biomethane** potential[1] from different **agricultural residues.**

In billion Nm^3/year.



Total potential

39.1

billion Nm^3/year

This **biomethane** can be liquefied into

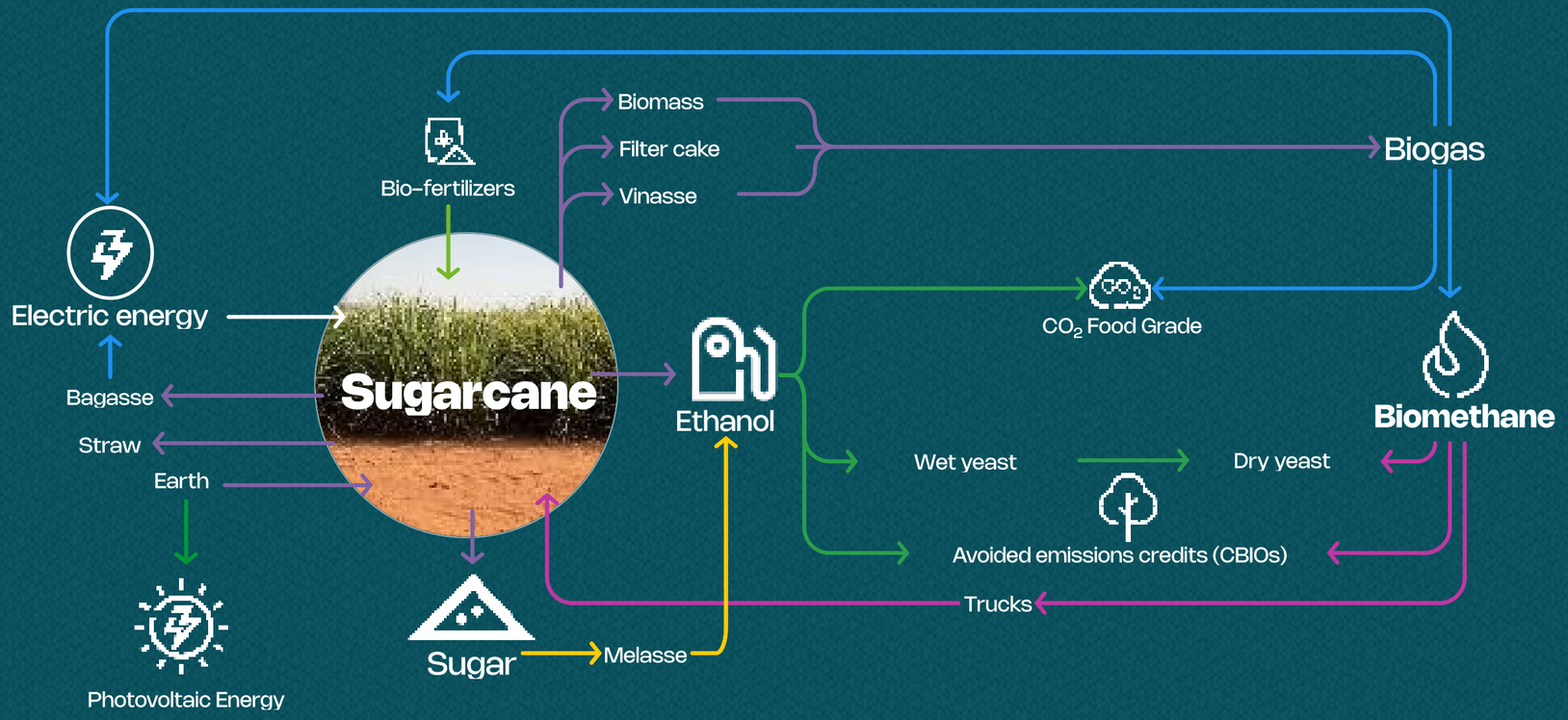
25.9 Mt of bio-LNG

per year.

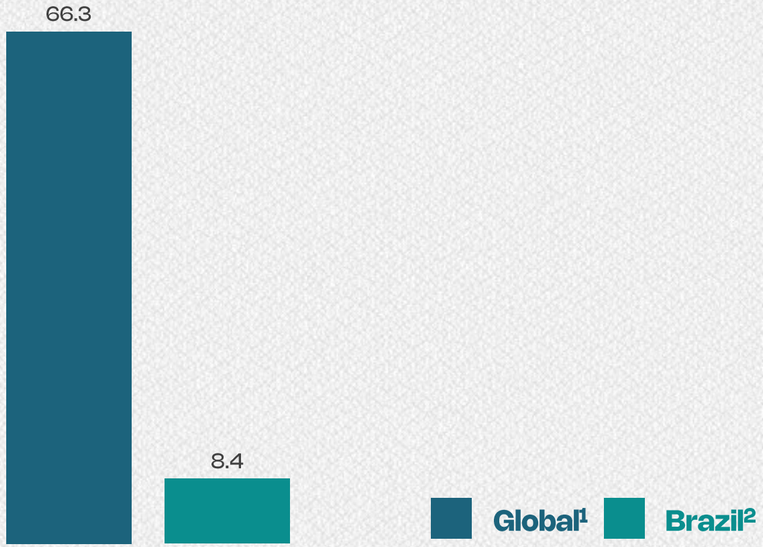
More than 50% of the global maritime low-GHG methane demand by 2040 – estimated at 40 to 95 million tonnes per year[2] – could be supplied by Brazilian bio-LNG from existing residues, with no need for additional cropland.

Source: [1]ABiogás estimative, [2]"Methane in shipping: LNG-fuelled ships and the switch to low-GHG methane" report from DNV

Sugarcane industry example



The sugarcane industry represents one of the largest biogas potential sectors, enabling **circular economy solutions** through efficient carbon capture, integrated logistics, and nutrient recycling.



Biomethane **production target** by 2030

in Mt/year of bio-LNG

The Brazilian biomethane production target for 2030 can supply up to **8.4 Mt/year** of bio-LNG.

This is 32% of Brazil's bio-LNG potential, which can be unlocked through **regulatory incentives**.

Brazil's Fuel of the Future Law

Starting in 2026, the natural gas industry is required to purchase biomethane[3] corresponding to a percentage of its production.

By 2036, the regulated market alone will require more than 2.7 Mt/year of bio-LNG equivalent.

Maritime

The maritime sector could enable the scale-up of the biomethane projects, securing long-term contracts with bio-LNG that is cost-competitive with the European market.

[3]The mandate can be fulfilled with physical biomethane with CGOB, the Brazilian government biomethane certificate of origin, or only the CGOB. It is an internationally fungible certificate, validated by the Brazilian National Agency for Petroleum, Natural Gas, and Biofuels (ANP).

Source: [1]"Global Biomethane Market – 2025 Assessment" report from CEDIGAZ, [2]ABiogás estimative

Reduced emissions from biomethane

WELL-TO-TANK (WtT)

UPSTREAM

Residues carry **no cultivation emissions**

Those are attributed entirely to the primary product and coproducts (sugar, ethanol, meat)

AVOIDING METHANE EMISSIONS

Controlled digestion **prevents uncontrolled methane release**

Depending on the framework, avoided emissions can lead to negative WtT carbon intensity values

TANK-TO-WAKE (TtW)

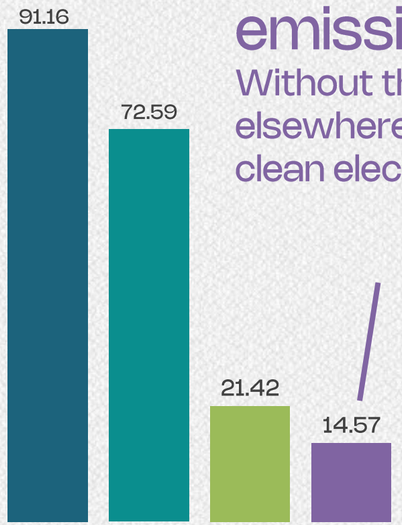
BIOGENIC CO_2

Carbon dioxide released during combustion is **biogenic**

Counted near zero in the WtW balance under multiple LCA guidelines

The Brazilian **bio-LNG** have **32% less** WtW emissions.

Without the carbon penalty seen elsewhere, thanks to its uniquely clean electricity grid.



WtW **emission factor**

in g CO_{2-eq}/MJ

HFO[1] **LNG[2]** **bio-LNG[3]** **BR bio-LNG[4]**

Fossil LNG has a lower carbon intensity (CI) than Heavy Fuel Oil (HFO), which can already help meet current **emission reduction targets.**

As emission reduction targets tighten and bio-LNG supply grows, it can be blended with LNG – **up to 100% bio-LNG – to achieve negative emissions.**

No ILUC emissions concerns when using residues.

Source: [1] "Biogas as a Source of Biofuels for Shipping: Biomass Availability" Report from Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS), [2] "Methane in shipping: LNG-fuelled ships and the switch to low-GHG methane" report from DNV.
[3] The value of 21.42 g CO_2-eq/MJ reflects a conservative estimate for WtW emissions associated with low-carbon methane in 2-stroke high-pressure dual-fuel (2-S HPDF) engines, as reported by DNV in "Methane in shipping: LNG-fuelled ships and the switch to low-GHG methane" . For the same HPDF technology, the NZF scenario defines a range starting from a "Low" estimate of -18.58 g CO_2-eq/MJ highlighting the significant decarbonization potential of waste-based biomethane. [4] The WtT emission factor is based on the Brazilian Renovabio carbon intensity for biomethane from agricultural residues and includes the liquefaction emissions based on the Brazilian energy matrix. Other assumptions are based on 3.

Start with 100% Fossil LNG

100% Fossil LNG

WtW Emissions Reduced by up to

23%

compared to conventional oil-based fuels

The 20% "Drop-In" Blend

80% Fossil LNG + **20% bio-LNG**

Zero engine modifications required

12 to 18%

further WtW decarbonization

Scaling to 100% bio-LNG

100% bio-LNG

WtW Emissions Reduced by

64 to 92%

depending on engine technology

Achieving Negative Emissions[a]

Reaches

-190%

GHG INTENSITY

By capturing methane that would otherwise enter the atmosphere

Blending bio-LNG with fossil LNG progressively **lowers the overall carbon intensity of the fuel on a full life-cycle (Well-to-Wake) basis.**

Using LNG and bio-LNG blends allows shipowners to leverage existing investments while extending their compliance window as maritime regulations tighten.

[a] Only if avoided emissions or emissions credits are considered in the framework.

Source: "Life Cycle GHG Emission Study on the Use of LNG as Marine Fuel" report from Thinkstep on behalf of SEA-LNG

Technology & market

PRODUCTION

Anaerobic digestion and upgrading are mature, bankable technologies with thousands of plants globally.[1]

Methane liquefaction is a proven technology; once impurities are removed from biomethane, the process is even simpler than for natural gas.[2]

Fossil LNG infrastructure can be fully leveraged; bio-LNG is fully drop-in compatible with LNG, so no changes to the infrastructure are needed.[3]

Brazilian Electricity Matrix is more than 90% renewable; high-energy steps like liquefaction can be low-carbon and advantageous for the final carbon intensity of the bio-LNG, compared with other international producers.

Source: [1]"Global Biomethane Market – 2025 Assessment" report from CEDIGAZ, [2]"PNBB – Programa Nacional de Biogás e Biometano" report from ABiogás, [3] "Biometano: combustível verde" from GEF Biogás Brasil

VESSEL SIDE

No retrofits required for existing LNG dual-fuel fleets.[1, 2] Same tanks, same engines, same bunkering infrastructure.

Methane slip has been reduced by up to 90% over the past few decades[2, 3, 4] through improvements in engine design and electronic controls.

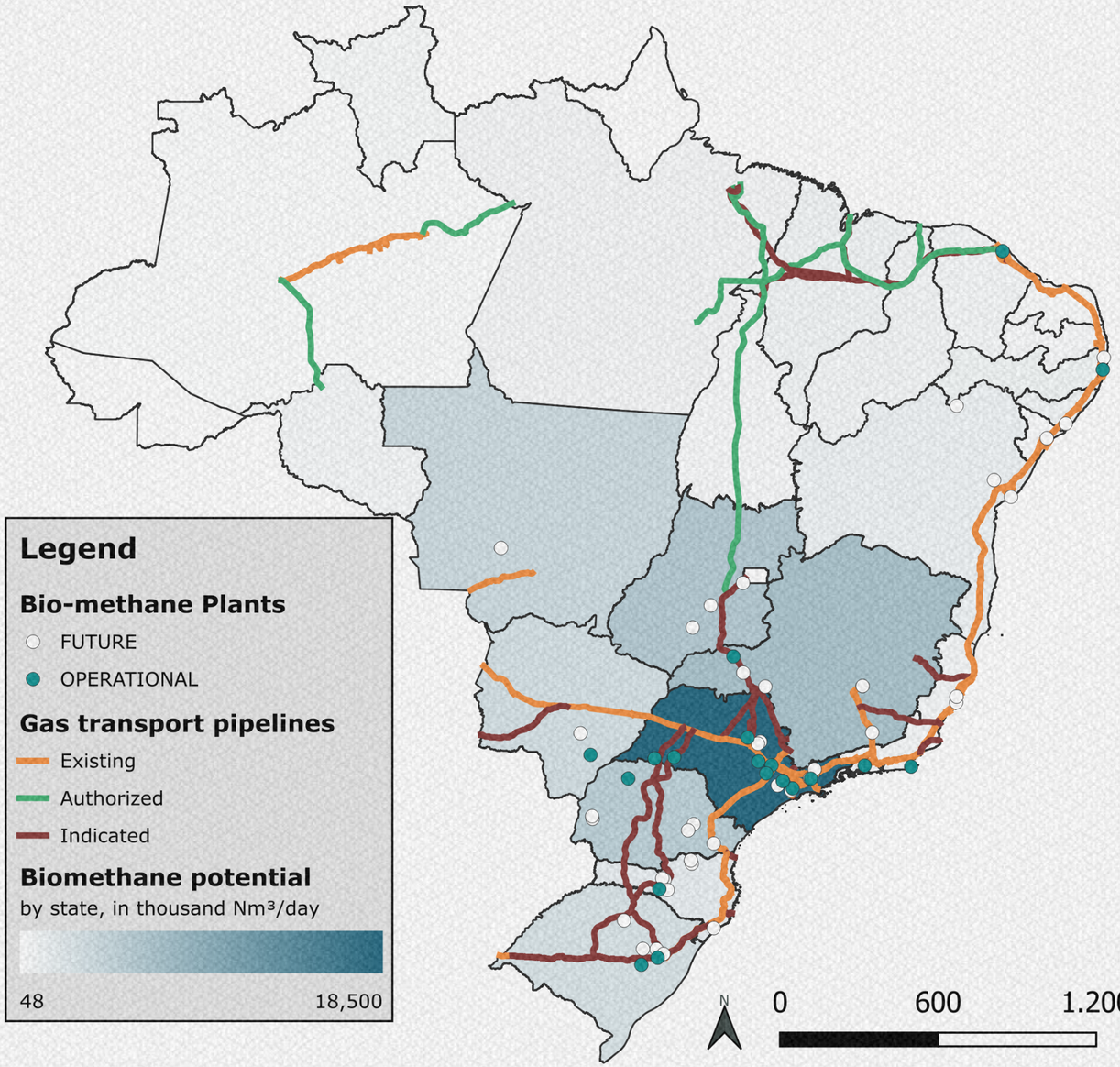
Off-gas post-treatment technologies are under development; catalysts oxidize methane, reducing methane slip by up to 98%.[5]

Boil-off gas (BOG)[a] is used as fuel, reliquefied, and/or flared; avoids methane slip and increases efficiency.

[a] Boil-off gas (BOG) is the methane vapor that naturally occurs since the bio-LNG/LNG is stored at -162 °C and the heat exchange with the environment makes the liquid evaporate continuously.

Source: [1] "LNG PATHWAY: Mid-year Market Review" report from SEA-LNG, [2] "BioLNG in Transport Making Climate Neutrality a Reality" report from SEA-LNG, [3] "Methane in shipping: LNG-fuelled ships and the switch to low-GHG methane" report from DNV, [4] "Tackling Methane Slip in Shipping: Insights into options for regulation and quantification" report from Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS), [5] "THE JOURNEY: A Decade Moving Towards A Cleaner Future" report from SEA-LNG.

Brazilian biomethane pipeline



19 biomethane plants operational

1.2 million Nm^3 biomethane/day – 0.3 Mt bio-LNG/year

Major players (Raízen, Cocal, São Martinho, and Geo) already use sugarcane processing residues for biomethane production.

+48 additional biomethane projects

Once operational, these projects will double the daily capacity

The map includes only plants that have already applied for authorization from the Brazilian National Agency of Petroleum, Natural Gas and Biofuels (ANP)

Brazil offers a geopolitically stable, diversified supply base for maritime bio-LNG.

Source: Data from the Brazilian National Agency of Petroleum, Natural Gas and Biofuels (ANP) SIMP Product Movement System; and Brazilian Energy Research Office (EPE)

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INVESTMENT CATALYST

The Brazilian regulatory scenario has changed in recent years for biomethane, enabling new investments and ensuring **financial guarantees** with new assets.

The two main assets are CGOB[1] and CBIO[2], which can provide revenues of up to 0.30 USD per Nm^3 of biomethane.

This regulatory framework supports **guaranteed demand and long-term offtake agreements**, enabling bankable biogas project financing.

This scenario ensures an internal market and allows investments now that can be used soon to supply the maritime sector.

1. CGOB: the Brazilian government biomethane certificate of origin, its purchase is mandatory for natural gas importers and producers.
2. CBIO, the Brazilian government emissions credit, is obligatory for the transport sector

Source: ABiogás estimation

Brazil's biomethane potential enables an **unparalleled scale of production globally**. At this scale, competitive pricing becomes achievable alongside large bio-LNG volumes.

Compared with Europe plants,[1] Brazilian biomethane facilities[2] are, on average, 5x larger.

Considering the cost of non-compliance with the regulated market (such as FuelEU Maritime) **bio-LNG is the lowest-cost alternative fuel** through 2040 (cheaper than methanol, ammonia, and e-fuels).

Blending bio-LNG in an LNG fleet can save up to 17 million USD per year.

The **price of bio-LNG** as of 2030 is expected to be:

- Molecule (LNG): $ 8 – 13 per MMBtu
- Premium (regulated markets): $ 10 – 25 per MMBtu
- **Bio-LNG 100%: $ 18 – 38 per MMBtu**
- **Bio-LNG 20%/80% Fossil LNG: $ 10 – 18 per MMBtu or $ 560 – 1020 per ton of blending**

Source: [1]"EBA Statistical Report 2025" from European Biogas Association (EBA), [2] Data from the Brazilian National Agency of Petroleum, Natural Gas and Biofuels (ANP) SIMP Product Movement System

CERTIFICATION

Biomethane certification enables blending with fossil LNG in a **sustainable** and fully **traceable** manner.

Brazil's CGOB is being aligned with international fungibility standards.

Within fungible certificates, mass balance and book & claim are also a possibility.

Brazil already has biomethane plants that are **ISCC and RSB certified**.

Closing

20% of **Bio-LNG can already be cheaper** than bunker.

Brazil is uniquely capable of delivering **large-scale, low-cost bio-LNG** and low CI form agricultural residues, with **immediate compatibility with the global LNG fleet.**

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