Bioenergy & Biotechnology for Future Fuels

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World Future Fuel Summit & Expo 2022
New Delhi, India
16-17 February 2022
Virtual Platform

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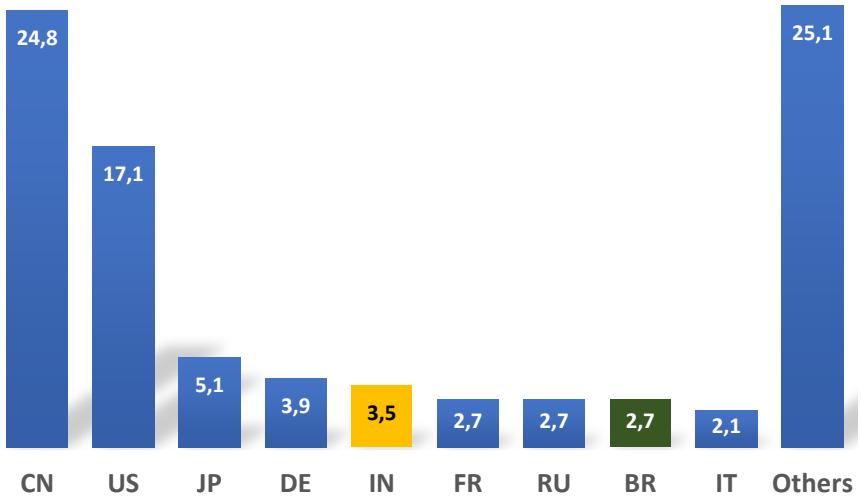
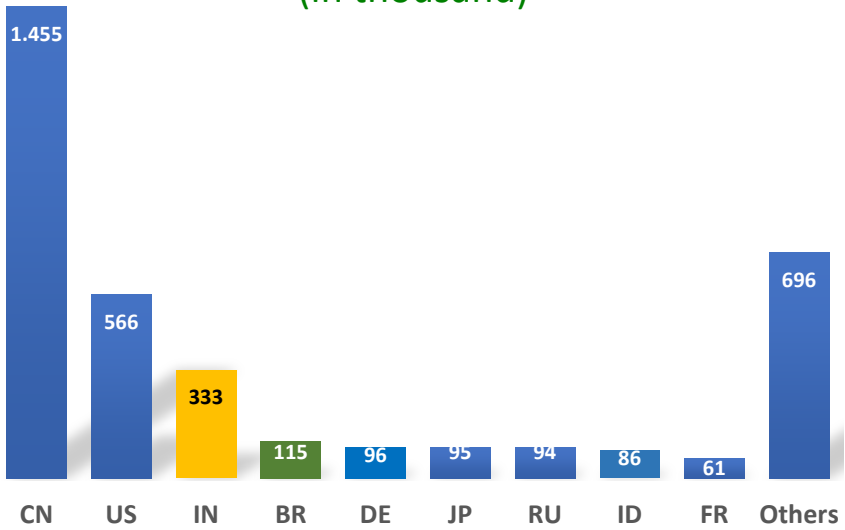
India is one of the world´s largest automotive markets

Light Vehicle Sales in 2019
(in million)



Heavy Vehicle Sales in 2019
(in thousand)



Source: IBIO

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Option of Technological Pathway
for **Fuel & Motorization** will depend on the method used to measure
Energy Efficiency & Environmental Impact

Tank-to-Wheel (TtW)

or

Well-to-Wheel (WtW)

Or

Cradle-to-Grave (CtG)

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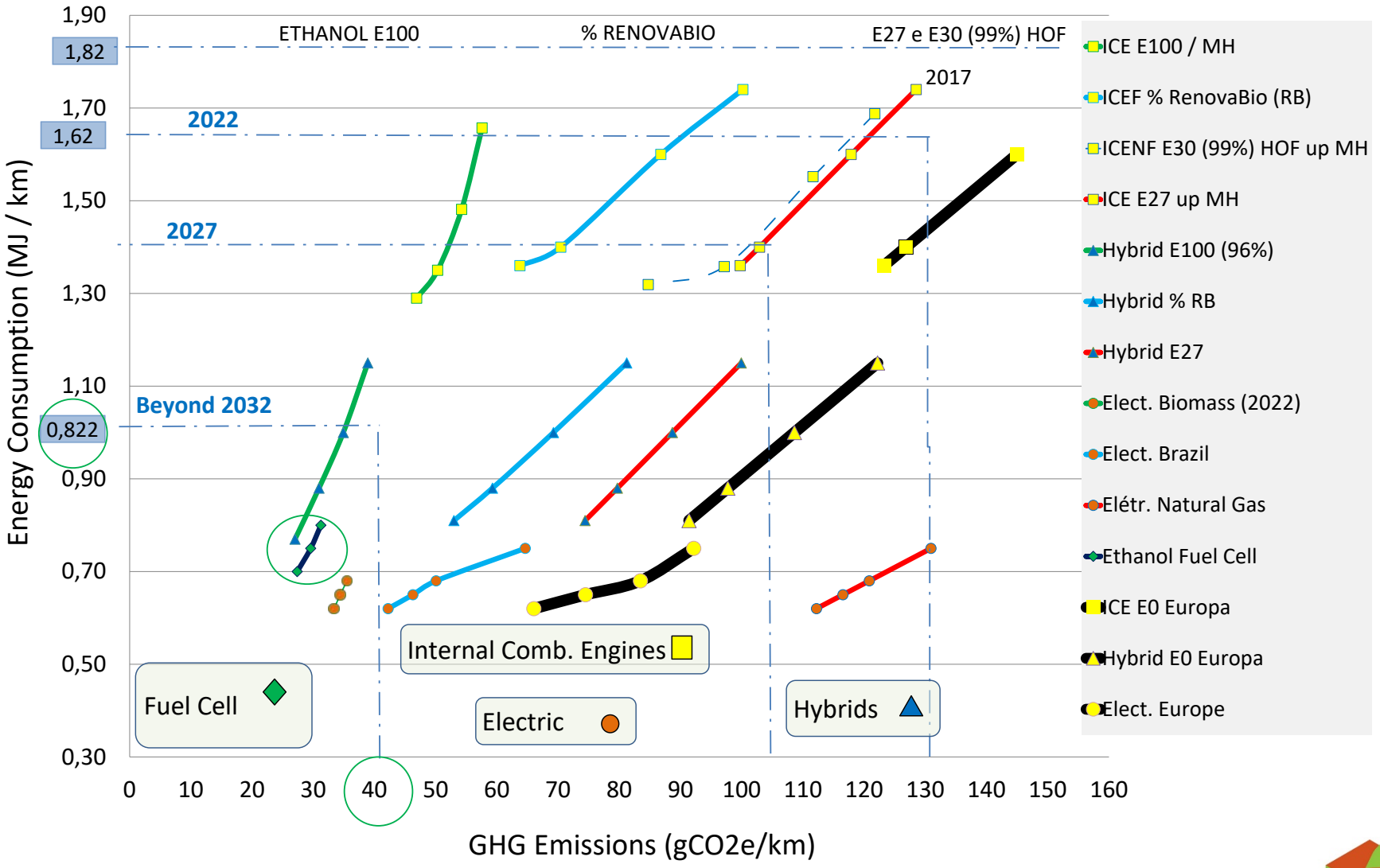
Comparison of Fuel & Motorization under WtW



Source: MAHLE

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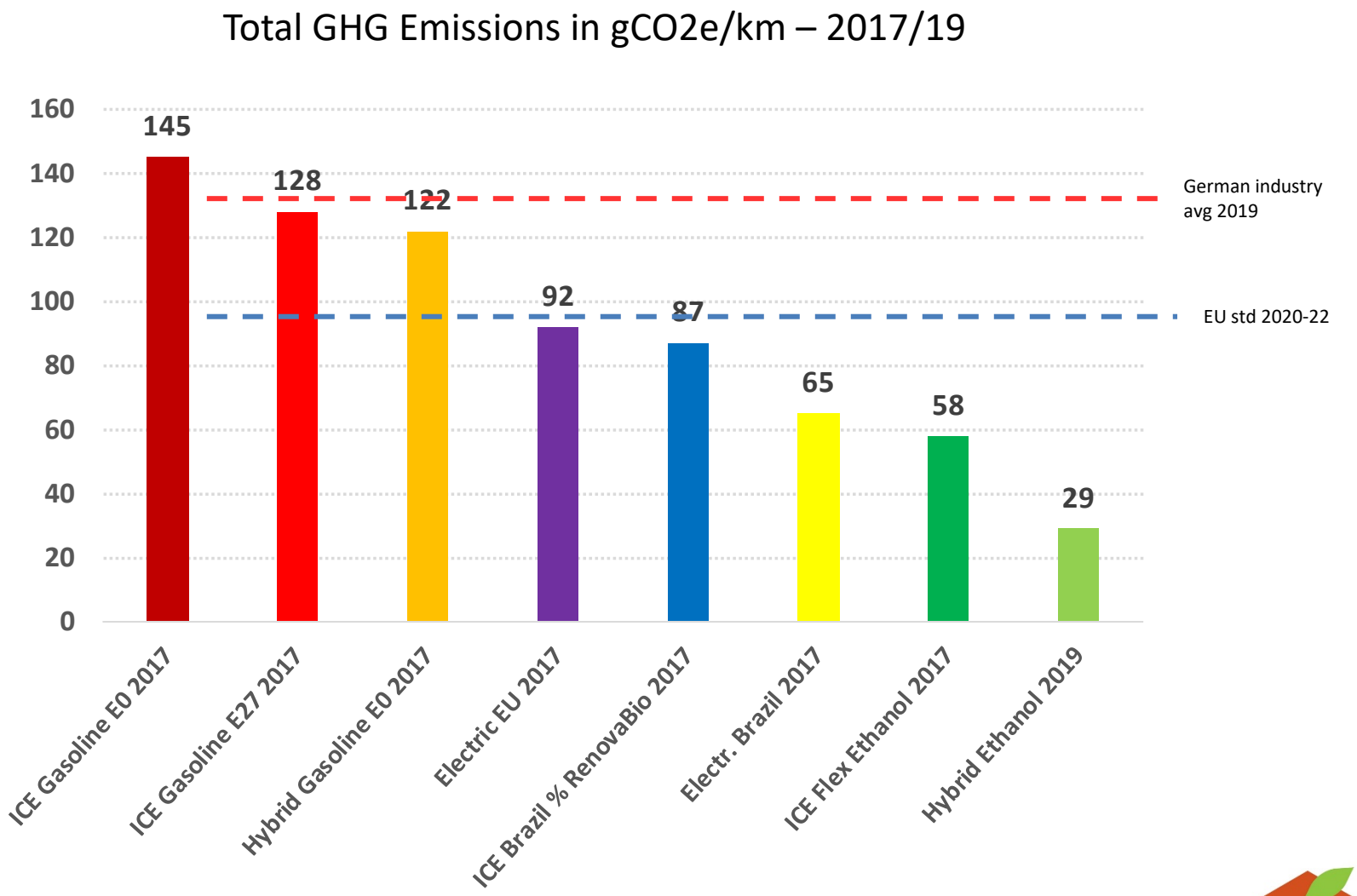
Comparison of GHG Emissions under WtW – 2017/19



Source: MAHLE

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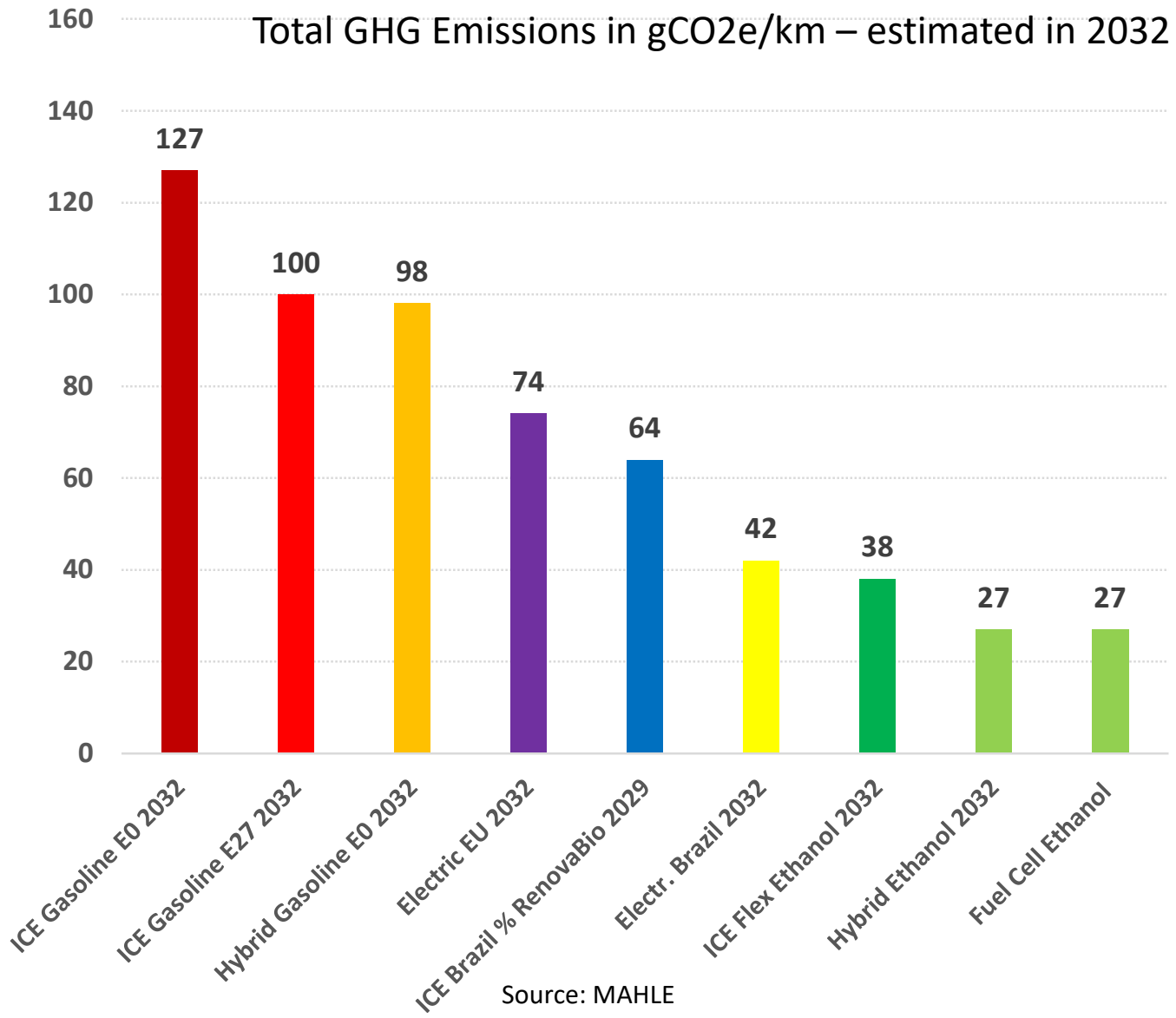
Comparison of GHG Emissions under WtW - 2032



Source: MAHLE

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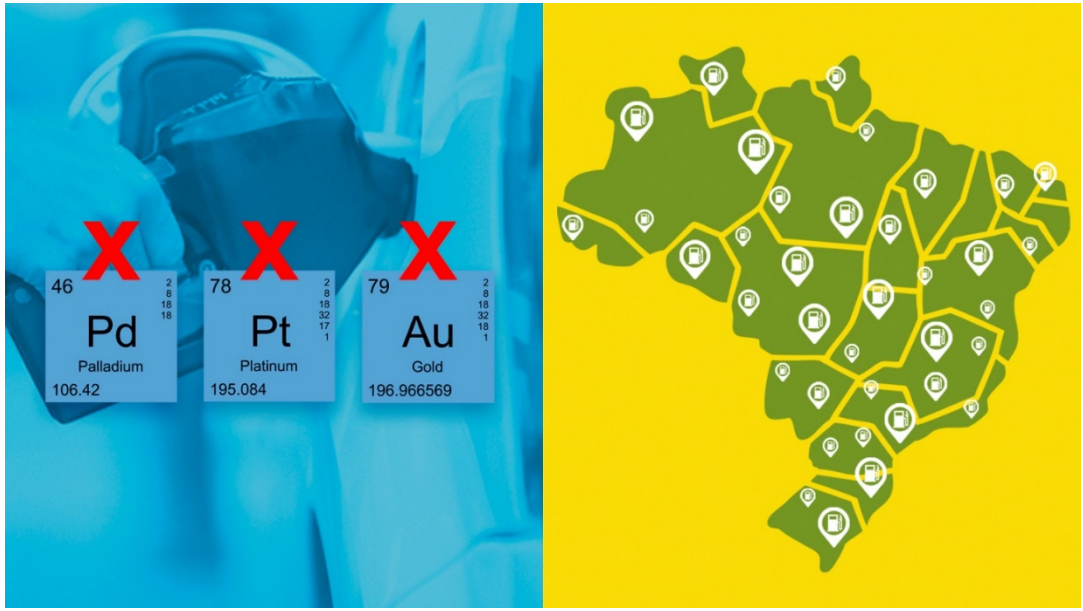
Automotive Technology

- Electrification with Ethanol
  - "With the current ethanol distribution infrastructure, Brazil has already solved the Hydrogen distribution hurdle" (Nissan, June 2016).
  - Electrification with ethanol does not require use of rare metals.
  - Distribution of ethanol, as a sole or blended fuel in gasoline, is equivalent to a network of Hydrogen already in place.



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Energy Equivalency

1 ton of sugarcane **=** **1.2 barrels of oil**

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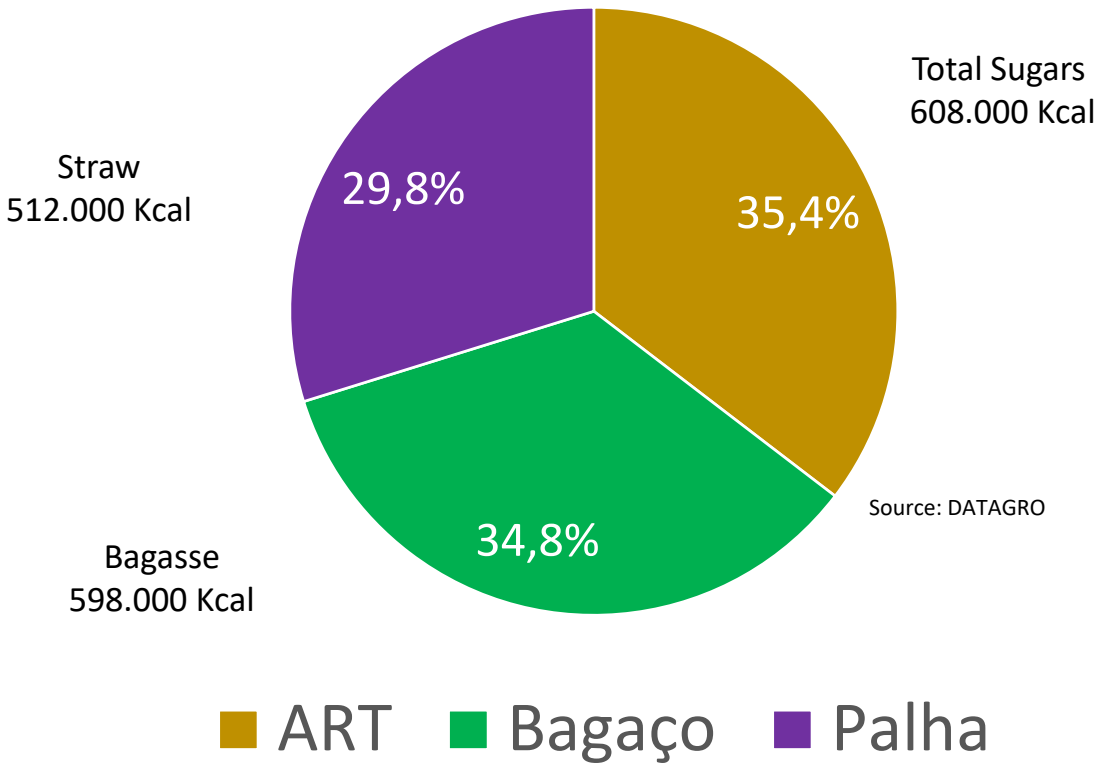
Energy in 1 ton of cane



Source: DATAGRO

Routes of Diversification in Cane

- From sugar to
- Ethanol
- Bioelectricity
- 2G Ethanol
- Biogas and Biomethane
- Bagasse pellets
- Integration with corn ethanol
- Fermentation yeast (food and feed grade)
- Biochemistry (SAF, aviation biofuel and other products)
- CO2 capture from fermentation for production of a whole line of green chemicals

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Relevance of the distribution system

- Brazil can take advantage of its fuel distribution system for:
  - Hydrous Ethanol used as sole fuel, in fleet which is already 86% flex (Dec/2021) and growing,
  - Anhydrous Ethanol blended at 27% v/v in all gasoline nationwide (E27) – Brazil has been using "mid-level blends" for a long time,
  - Biodiesel blended in all fossil-based diesel Nationwide (B10), going to B15 in March/23.

- **Biofuel is SOLAR ENERGY captured, stored and distributed in an efficient, economical & safe manner.**

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Advantages of Ethanol

- **Drop-in** solution for mid-level blends: **does not require built-up of new fleet or infrastructure**
- Enables **immediate implementation & results**
- **Replicable:** no technical barrier for implementation
- **Scalable:** can grow overtime using available feedstocks, including organic residues for cellulosic conversion into ethanol
- Very effective and proven **environment & health benefits**
- Does **not** require use of **rare metals**
- **Affordable** in price to consumers
- Promotes **jobs & local income** to farmers
- Ethanol´s high octane **complements gasoline** well & **enables use of lower cost blend feedstocks**
- Provides **sustainability & longevity for the use of traditional sources of energy**
- Enables **automakers to meet** the most restrictive **emission targets**

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The concept of Ethanol as Green Hydrogen

- Ethanol & Biomethane are very rich in Hydrogen
- Ethanol: C_2H_5OH – has a H:C ratio of 3:1;
- Biomethane: CH_4 – has a H:C ratio of 4:1;
- Gasoline (indolene): has average H:C ratio of 1.62 :1.
- Ethanol and Biomethane are a **practical, easy, safe, efficient and economic way of capturing, storing and distributing Hydrogen** ("Hydrogen one can carry in a bucket").

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We are moving towards the Age of Hydrogen

Green Hydrogen from wind & solar power for large scale on-site industrial applications and for Mobility

Green Hydrogen represented by high-density, low carbon footprint, sustainably produced Advanced Biofuels such as Ethanol, Biogas & Biomethane

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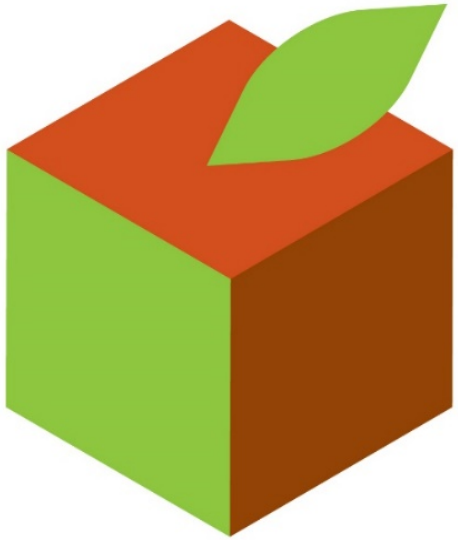

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