ETHANOL BLENDING POLICY: STATUS & IMPLEMENTATION

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SUSTAINABLE MOBILITY: ETHANOL TALKS THAILAND

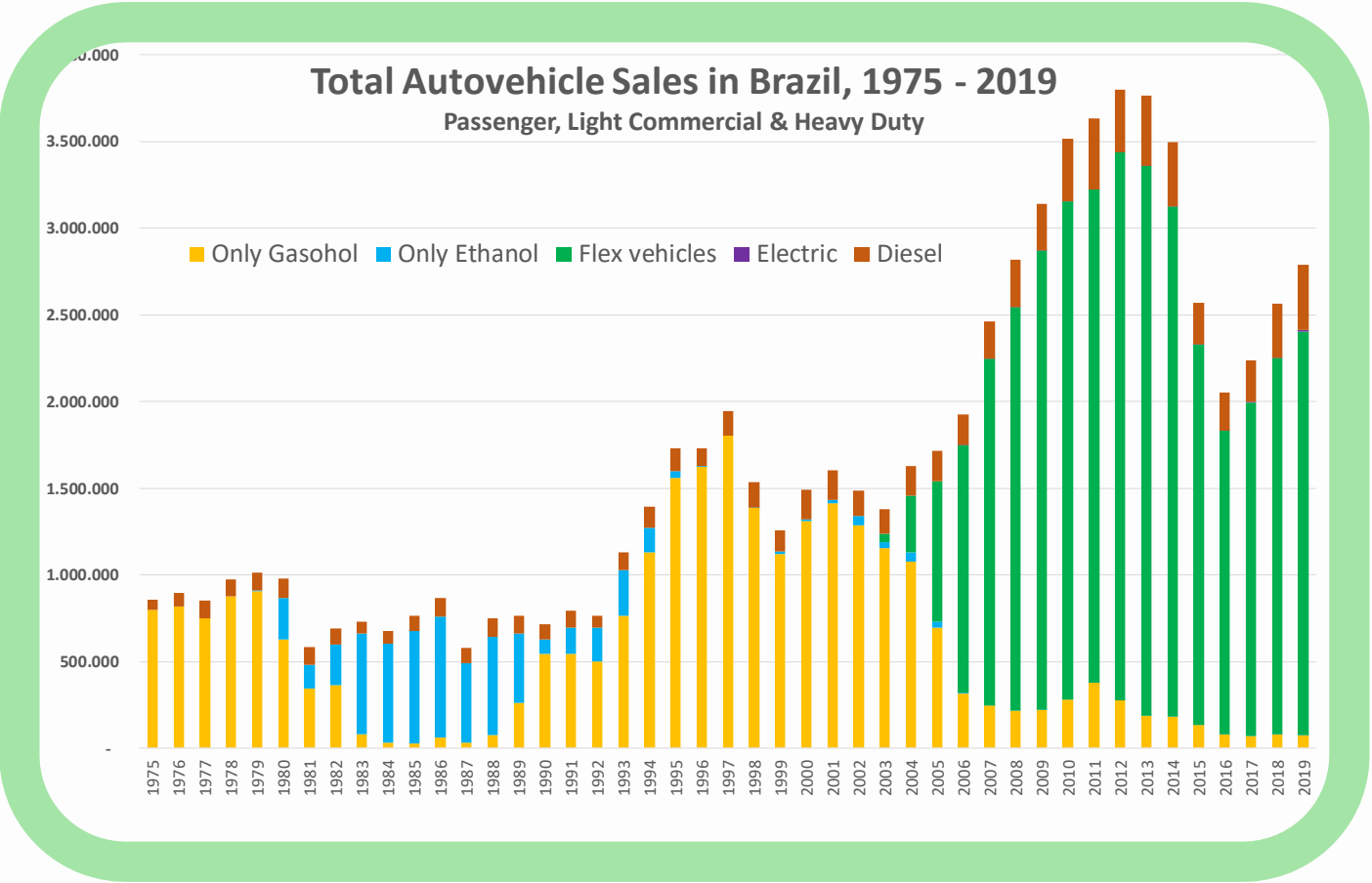
REASONS WHY ETHANOL POLICY WAS IMPLEMENTED IN BRAZIL

- After 1970's oil crises, to mitigate high dependence on oil imports (+81% of total demand in 1975)
- Negative impact on trade balance & the economy
- Take advantage of Brazil´s tradition in sugar cane cultivation
- Environmental & health benefits were found only much later

BRIEF CHRONOLOGY OF ETHANOL USE IN BRAZIL

- Ethanol blends have been in use in Brazil since 1924
  - 5% mandatory blend first approved in July 1931
  - Blend level rose to as much as 50% during II WW
- 1975: decision was taken to gradually raise mandatory blend in all gasoline sold & to develop technology for the use of pure (E100) ethanol use in cars
- 1976 onwards: gradual raising of mandatory blend
- 1979 (Aug): pure (E100) ethanol car launched (Fiat 147), for use of hydrous ethanol fuel (avg 95.5º. GL at 15º. C).
- 1984-87: pure (E100) ethanol cars are great success (92% to 96% of total sales)
- 1989: Ethanol supply crisis affects sales of pure ethanol cars
- 2003 (March): launching of flex-fuel cars
- 2004-2019: flex-fuel cars are great success (96.4% of total sales in 2019)
- 2017: RenovaBio legislation is approved in Congress with massive majority vote
- 2019 (Dec): flex-fuel cars account for +80% of the fleet
- 2020: RenovaBio is implemented

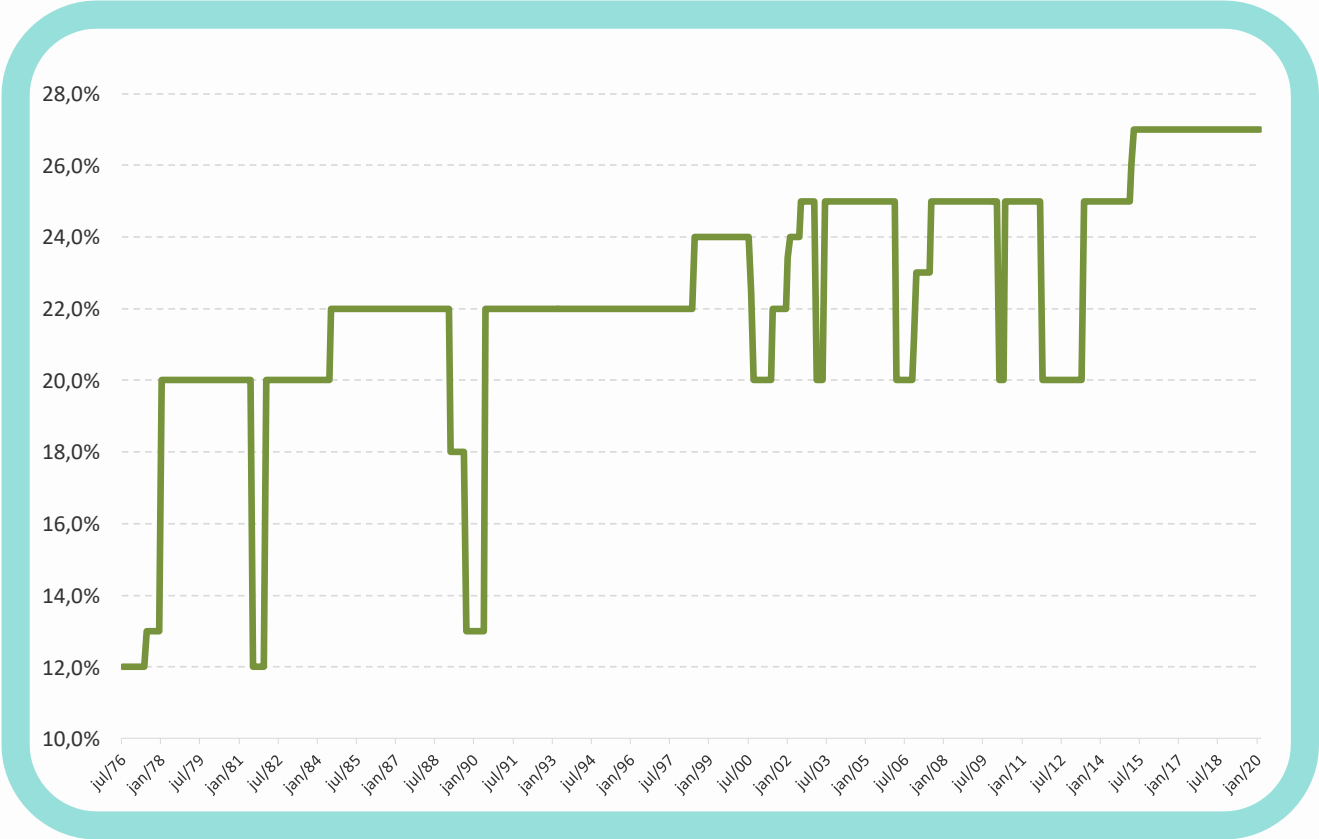
AUTOVEHICLE SALES IN BRAZIL ACCORDING TO FUEL USE



- 1984-87: neat etanol car sales were 92% to 96% of all car sales.
- 2019: Flex-cars are 96.4% of all car sales.
- In Dec/19, flex-fuel cars accounted for +80% of total light vehicle fleet.
- Since 2015, mandatory blend of 27% in all gasoline sold in the country.

Source: ANFAVEA, Brazil´s Automanufacturers Association, prepared by DATAGRO.

EVOLUTION OF ETHANOL BLEND MANDATE IN BRAZIL 1976-2020



- Mandatory blend of anhydrous etanol, min 99.5º. GL at 15º. C, as % in volume.
- Since Jan/1978, 20%
- Since Jul/1984, 22%
- Since Jun/1998, 24%
- Since Jul/2002, 25%
- Since Mar/2015, 27%
- Applies to all gasoline sold in the country

Source: DATAGRO, based on regulations published in Brazil´s Official Gazette.

BENEFITS GENERATED FROM ETHANOL POLICY

- Over 3.15 billion barrels of gasoline substituted between 1975-2019 (Brazil´s total proven petroleum reserves are 15.4 billion barrels in Dec/19)
- Economy from gasoline imports: US$ 540.6 billion, including service on foregone foreign debt (Brazil´s international reserves are US$ 368.4 billion on Feb 13, 2020).
  - 2019: 449,514 b/d of gasoline saved, with savings of US$ 13.03 billion in imports
- 870,000 direct jobs + 2 million indirect jobs
- Sustainability + longevity for the use of petroleum derivates
- Strenghtening & support to local auto industry
- Ethanol is equivalent to Hydrogen distribution infrastructure (“hydrogen-on-the-bucket”)
- Per capita GDP rise of US$ 1098 in cities where ethanol is produced
- Biofuels are central for Brazil´s low carbon emission strategy

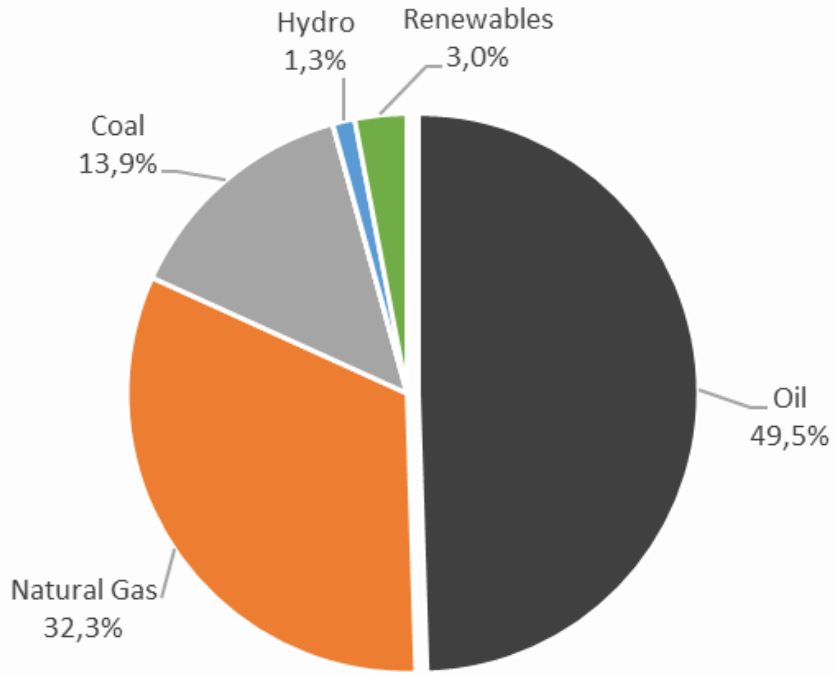
COMPARISON OF GDP & CO2 EMISSIONS

Largest World Economies

2018					
Rank	Country	GDP - Billion USD	Total CO2 emissions (Mt of CO2)	CO2 emissions per capita	CO2 emissions per USD (tons CO2/M USD)
1º	United States	20.544,3	4.896,0	14,9	238,3
2º	China	13.608,2	9.302,0	6,7	683,6
3º	Japan	4.971,3	1.098,0	8,7	220,9
4º	Germany	3.947,6	683,0	8,2	173,0
5º	United Kingdom	2.855,3	353,0	5,3	123,6
6º	France	2.777,5	293,0	4,4	105,5
7º	India	2.718,7	2.162,0	1,6	795,2
8º	Italy	2.083,9	314,0	5,2	150,7
9º	Brazil	1.868,6	428,0	2,0	229,0
10º	Canada	1.713,3	573,0	15,5	334,4
25º	Thailand	505,0	244,0	3,5	483,2
		Source: World Bank	Source: IEA - International Energy Agency		Source: Elaborated by DATAGRO

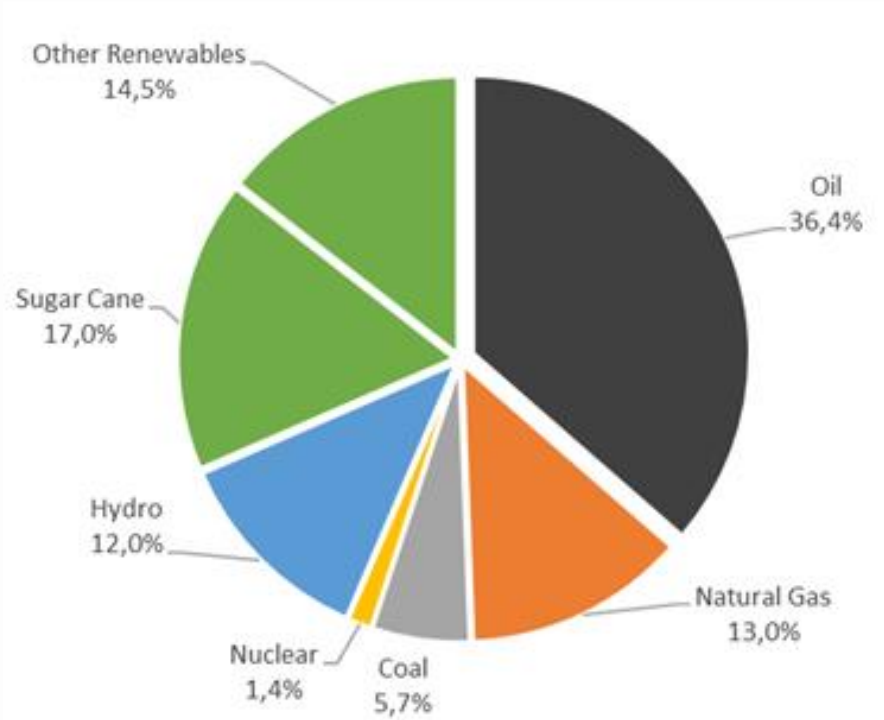
THAILAND & BRAZIL ENERGY MATRIX

Thailand´s Energy Matrix



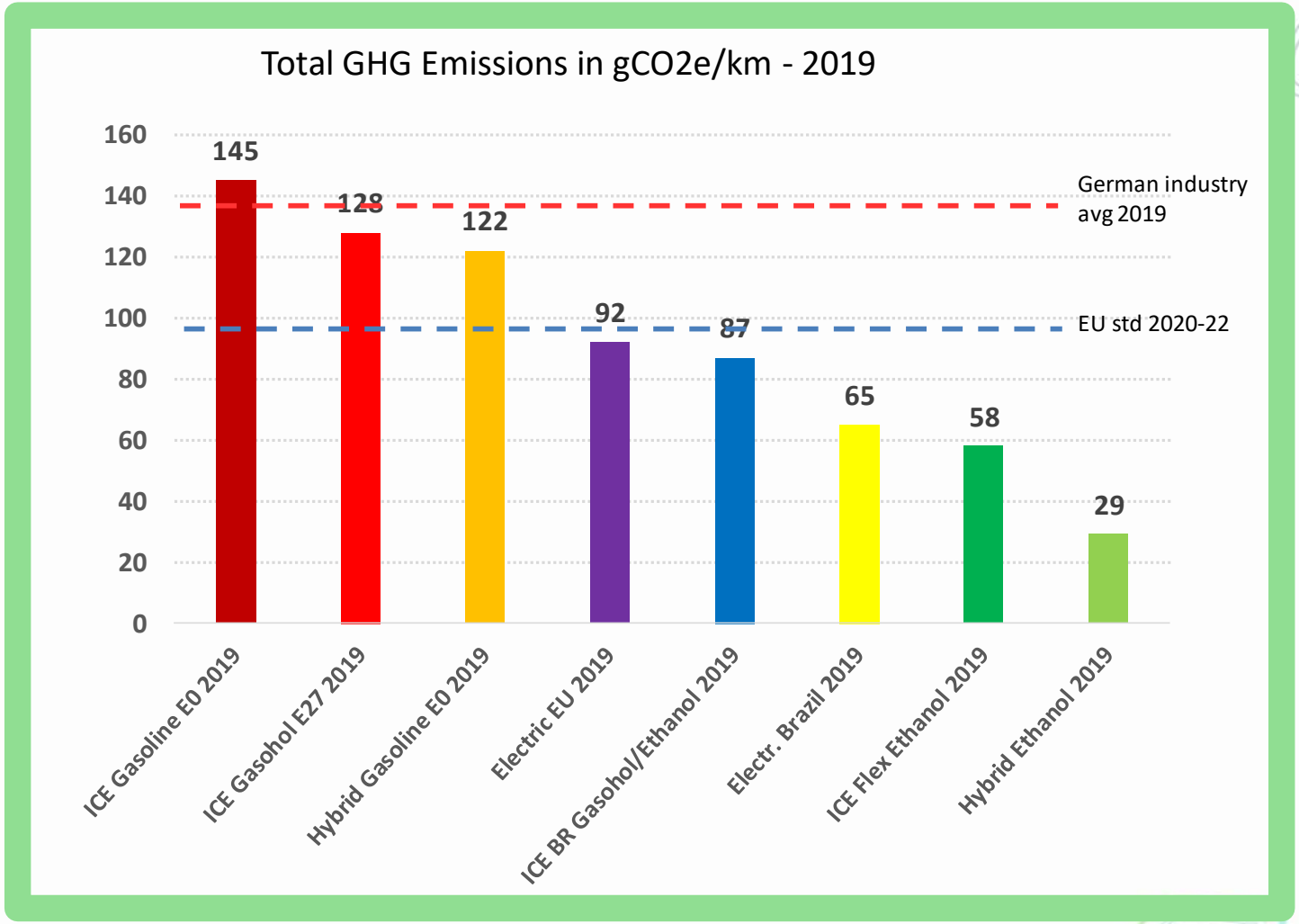
Source: Thailand`s Ministry of Energy, elaborated by DATAGRO

Brazil´s Energy Matrix



Source: Ministry of Mines and Energy of Brazil elaborated by DATAGRO

CARBON EMISSIONS FROM ETHANOL USE ARE THE LOWEST AMONGST ALL POWERTRAINS



AQI (as $MP_{2.5}$) FOR MOST POLLUTED CITIES

Most Polluted Cities in the World - Unit: µg/m³ - 2018							
Rankig	City	Country	2018 AVG	Rankig	City	Country	2018 AVG
1	Gurugram		135,8	26	Mandi Gobindgarh		78,6
2	Ghaziabad		135,2	27	Xingtai Shi		76,7
3	Faisalabad		130,4	28	Shijiazhuang		76,7
4	Faridabad		129,1	29	Ahmedabad		76,1
5	Bhiwadi		125,4	30	Aksu		74,1
6	Noida		123,6	31	Handan		74
7	Patna		119,7	32	Anyang		72,9
8	Hotan		116	33	Baoding		70,7
9	Lucknow		115,7	34	Linfen		68,2
10	Lahore		114,9	35	Wujiaqu		67,8
11	Delhi		113,5	36	Xianyang		67,8
12	Jodhpur		113,4	37	Jaipur		67,6
13	Muzaffarpur		110,3	38	Jiaozuo		66,9
14	Varanasi		105,3	39	Hengshui Shi		65,7
15	Moradabad		104,9	40	Xuzhou		65,5
16	Agra		104,8	41	Cangzhou Shi		65,2
17	Dhaka		97,1	42	Pingdingshan		65,1
18	Gaya		96,6	43	Kaifeng		64,6
19	Kashgar		95,7	44	Asansol		64,4
20	Jind		91,6	45	Howrah		64,2
21	Kanpur		88,2	46	Xuchang		64,2
22	Singrauli		86,8	47	Zhengzhou		64,1
23	Kolkata		85,4	48	Tangshan		63,5
24	Pali		82,3	49	Puyang		63,5
25	Rohtak		81,6	50	Luohe		62,6

Of the 50 most polluted cities in the world:

- 25 in India
- 22 in China
- 2 in Pakistan
- 1 in Bangladesh

Bangkok is **498º**. in the ranking

AVG in 2018 – **25.2** µg / m³

São Paulo is **879º**. in the ranking

AVG in 2018 - **16.2** µg / m³

MAIN ELEMENTS OF BRAZIL'S ETHANOL POLICY

- **Long-term approach:** main policy goals & instruments must be maintained overtime
- **Blend mandate,** not simple authorization
- **Support to innovation** in automobile technology adapted for ethanol use, through fiscal incentives to automaker´s improvements in efficiency
- **Legal framework to support private investment in expansion** of distillation capacity
- **Price parity** between ethanol & sugar
- Legislation regulating **disposal of vinasse** – valuable resource for fertirrigation, provided disposed in proper way.

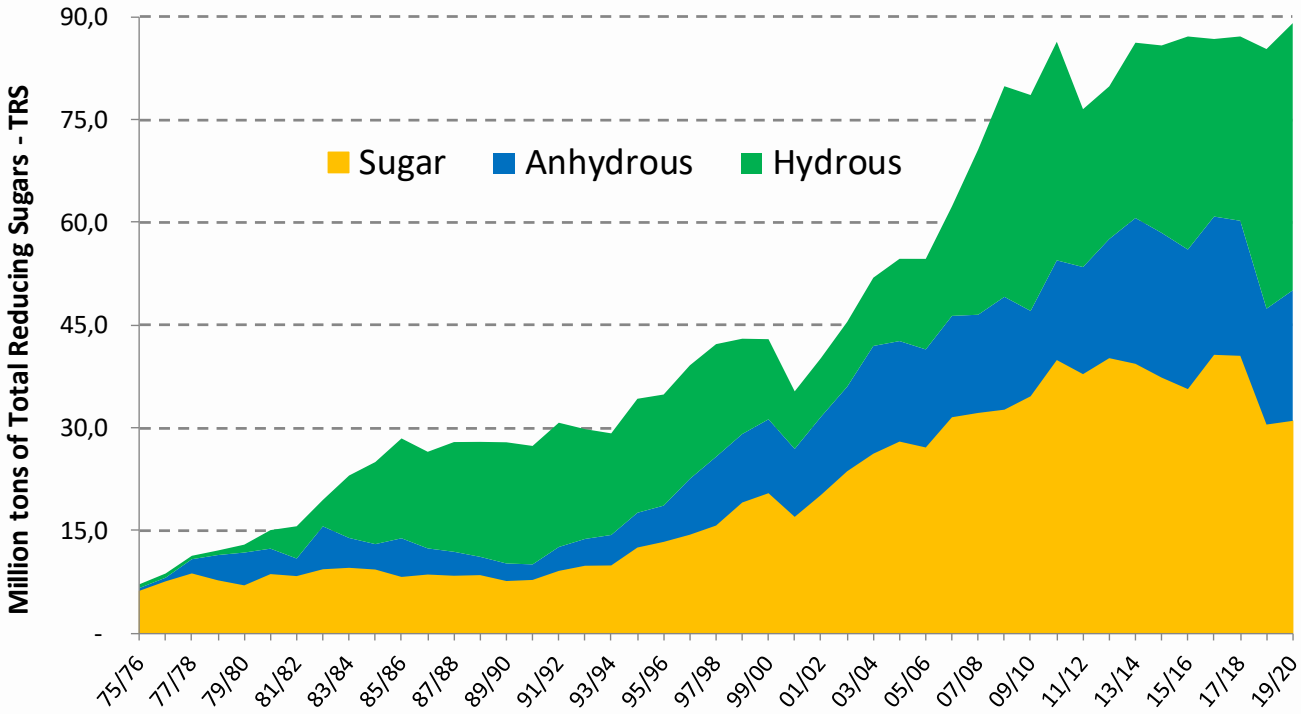
MAIN ELEMENTS OF BRAZIL'S ETHANOL POLICY

- **RenovaBio:** new legislation that places innovation and efficiency in fuel production and use is at center of Brazil´s strategy for the use of low carbon sources of energy.
- RenovaBio is **not subsidy, nor carbon tax**
- System of **voluntary certification** of biofuel producers for their **energy-environmental efficiency**, based on life-cycle assessment (LCA), which will determine ability to request issuance of Decarbonization Credits (CBios)
- **Market-driven carbon pricing mechanism** (endogenous, not exogenous determination), rewarding achievement of individual efficiency, not a common or equal coverage.
- **Unleashes market forces** to implement and drive innovation for increased competitiveness in biofuel/bioenergy production.

HOW IT ALL HAPPENED

- Blend **mandate was raised overtime**, as production allowed.
- **Obligatory contracts for sale of ethanol** to be blended in gasoline between producers and oil company(ies)
  - Contracts are valid for 12 months, and must be renewed every year to meet projected demand of ethanol to be blended in order to guarantee supplies & meet mandate
  - Contracts can be used as colateral to finance expansion of distillation capacity (PPA´s)
- Until 1999, price of ethanol at producer level was determined by govt in **parity with sugar.** After market scale was achieved, prices were liberalized
- Since 1999, prices of gasoline and ethanol at producer level are freely determined. Prices at retail for E27 and E100 are also freely determined
- Consumers make the choice of fuel use at the pump
- Regulation on **fuel specification confers legal security to automobile & autopart manufacturers and fuel distributors**
- **Provinces are free to set state-level incentives** for ethanol production & use of ethanol as fuel, recognizing its positive externalities

EVOLUTION OF PRODUCTION OF SUGAR & ETHANOL IN BRAZIL



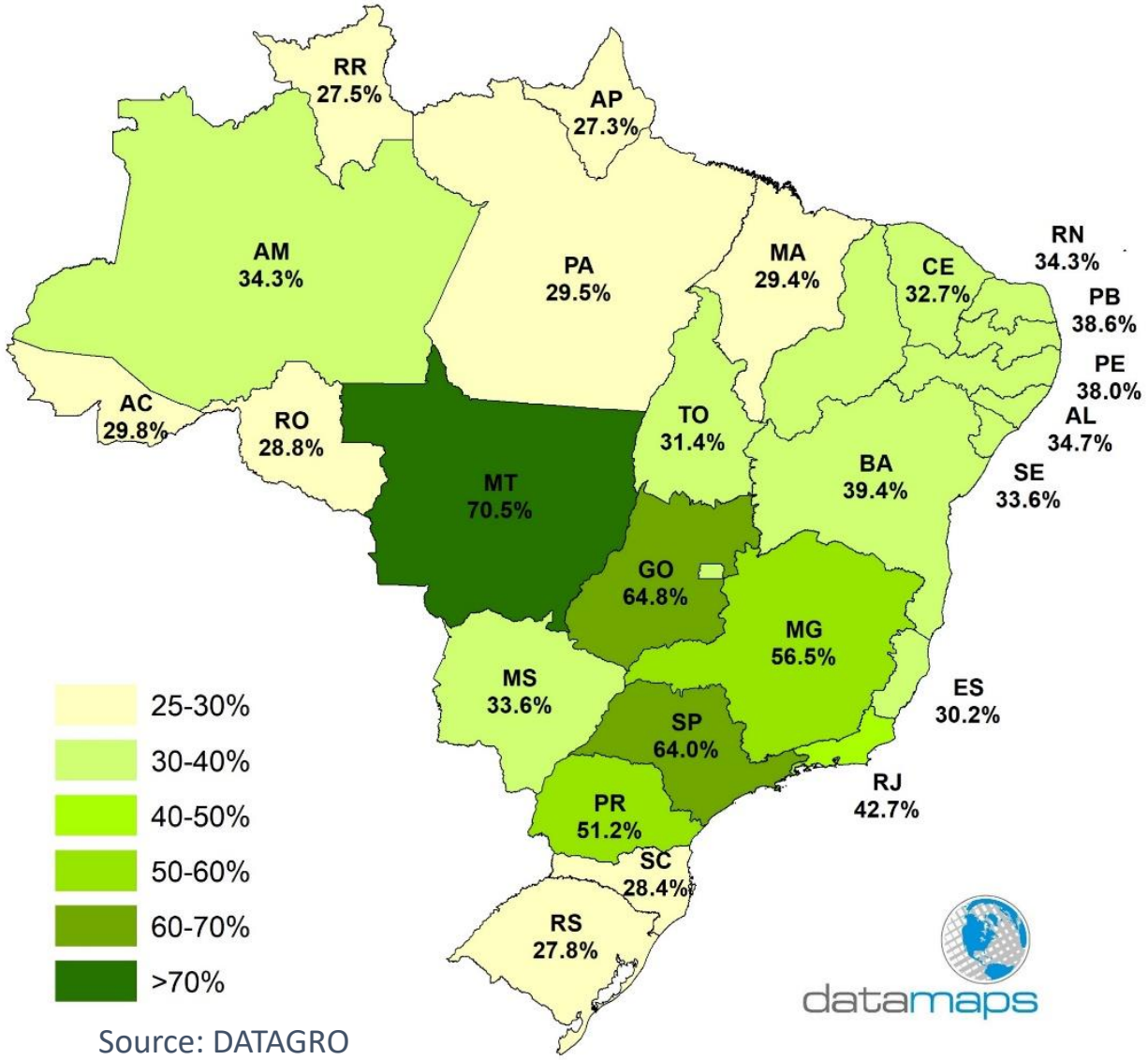
Source: DATAGRO

- Diversification towards ethanol enabled production of sugar & ethanol to rise from 7.1 mmt of Total Reducing Sugars (TRS) in 1975/76, to 89.1 mmt in 2019/20.
- % of TRS going to ethanol rose from 13.2% in 1975/76 to 65.2% in 2019/20.
- Industrial flexibility allowed industry to adapt more efficiently to changing market conditions.
- Sugar exports of 19.3 mmt in 2019/20 account for only 22.6% of TRS supply.

SHARE OF ETHANOL IN OTTO CYCLE FUEL CONSUMPTION

BY STATE IN BRAZIL (2019)

(in % of gasoline equivalent)



Source: DATAGRO

ADVANTAGES OF ETHANOL FOR ENERGY POLICY

- **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**
- **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**

BASIS FOR ADOPTION OF ETHANOL USE REGULATION

- Vision that **it is possible to enlarge the use of high-density low-carbon liquid fuels**, stimulating **higher energy efficiency and lower environmental footprint**
- **Using** largely **available biomass feedstocks** without compromising food security
- **Complementing** in a virtuous way **renewable and traditional fuels**
- **Using** the **existing infrastructure**, and
- **Promoting local technologies in fuel production and** in **automobile technology**
- Enabling simultaneous **social, economic, environmental & health benefits**

OUR VISION FOR SUSTAINABLE MOBILITY

- Various forms of motorization will cohexist in the pursuit of higher ENERGY EFFICIENCY & LOWER CARBON EMISSIONS
- Battery Electric Vehicles (BEVs) are clean only if the source of energy is clean
- Batteries have low energy density
- ELECTRIFICATION WITH ETHANOL (Hybrids & SOFCs) is the path:
  - Affordable to consumers
  - Uses a high-density liquid fuel with low carbon footprint
- Desired evolution:
  - Otimization of ICEs using Ethanol (higher blends in gasoline)
  - Hybrids
  - Fuel Cell Vehicles using Ethanol

WE ARE MOVING TOWARDS THE AGE OF HYDROGEN

Not Hydrogen captured and stored in
high-pressure, costly and risky Titanium tanks,
but **Hydrogen** represented by
high-density - low carbon footprint
sustainably produced **Advanced Biofuels**
such as **Ethanol, Biogas & Biomethane**

SUSTAINABLE MOBILITY: ETHANOL TALKS THAILAND

REALIZATION:

Thai Sugar Millers

BRAZIL
Sugarcane Bioenergy Solution

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