

History of Ethanol in Brazil:

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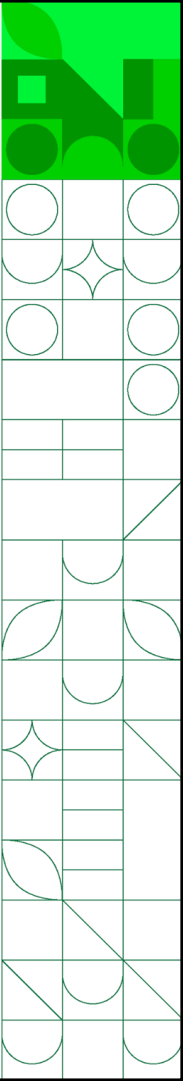
MINISTRY OF
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Main topics

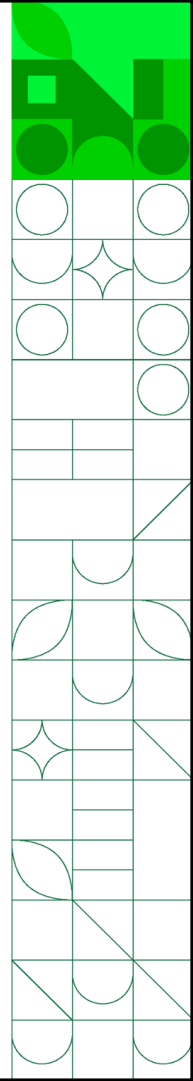
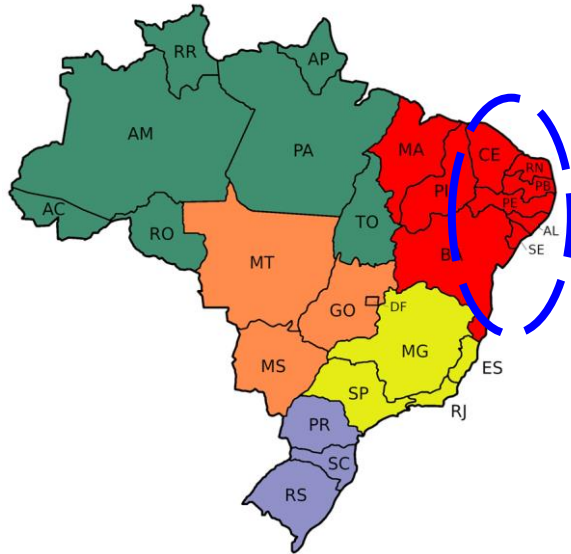
Brazilian success is a combination of many conditions

- 1. Sugarcane capabilities**
- 2. Climate**
- 3. Brazilian vocation to be an environmental powerhouse**
- 4. Entrepreneurship**
- 5. Historical conditions**
- 6. Public policies**
- 7. Research, innovation and technology development**



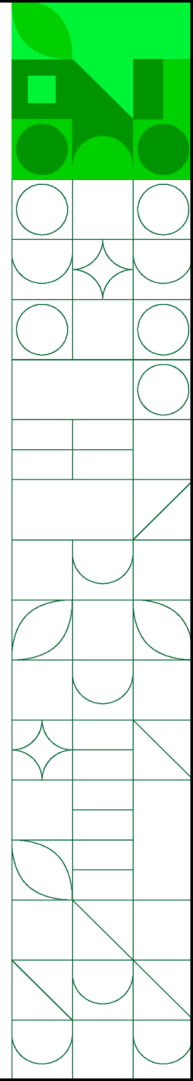
Historical perspective

- 1532 - Introduction of sugarcane from Madeira Island and Cabo Verde
- Northeast region of Brazil



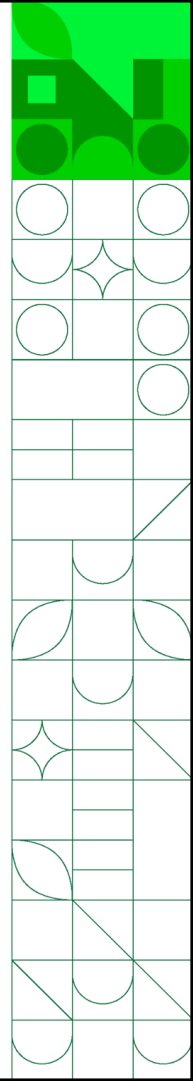
Historical perspective

- **1931 - Law-Decree 19.717 - Mandatory 5% ethanol addition to gasoline**
- **1933 - President Getulio Vargas creates Sugar and Ethanol Institute to guide, foster and control the production of sugar and ethanol-**
 - cause was a crisis in sugar prices
- **1942 - Law-Decree 4.722 - Declares ethanol industry as national strategic sector and sets minimum price for ethanol**



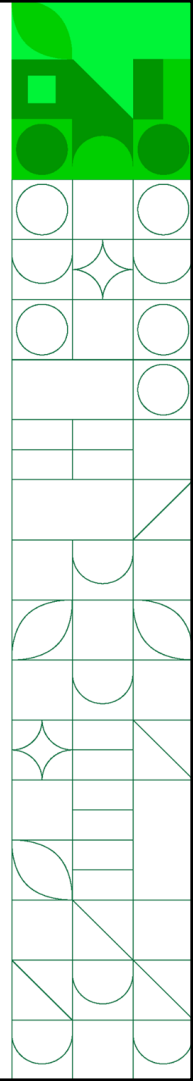
Historical perspective

- **1969 - CTC Copersucar Technology Center was created in Piracicaba**
 - Development of new sugarcane varieties
 - Main results:
 - Doubled productivity
 - Sugar levels in sugarcane increased
 - Jump in ethanol production per hectare 3x bigger
 - 66 % reduction in costs production
 - Adapted cuban and european technology with south-african and australian innovation creating brazilian know-how

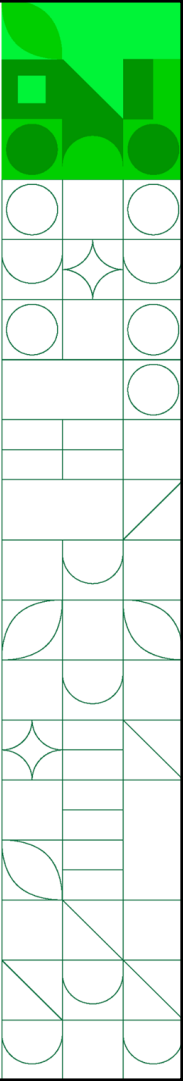


Proalcool

- **1973 - Oil crisis - OPEC**
- **Decree 76593 creates the Proalcool - National Ethanol Program**
 - Photosynthesis as a source for energy
 - Price parity: +35%
 - Multi Ministerial Program
 - Ministry of Finance;
 - Ministry of Agriculture;
 - Ministry of Industry and Commerce;
 - Ministry of Mines and Energy;
 - Ministry of the Interior;
 - Secretariat of Planning of the Presidency of the Republic.
 - Financing: reduced interest rates for investments in ethanol projects
 - Encourage the expansion of supply of raw materials by:
 - increasing agricultural production,
 - modernizing and expanding existing distilleries and
 - installing new production units, attached to mills or autonomous, and storage units.

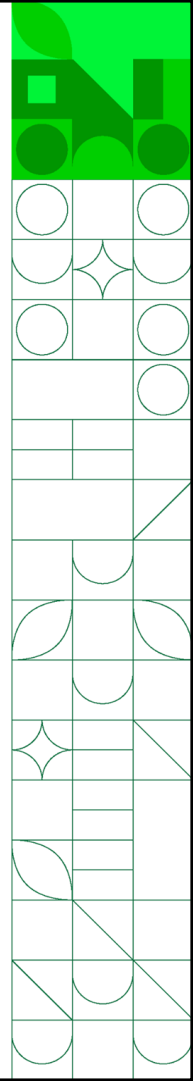


Proalcool



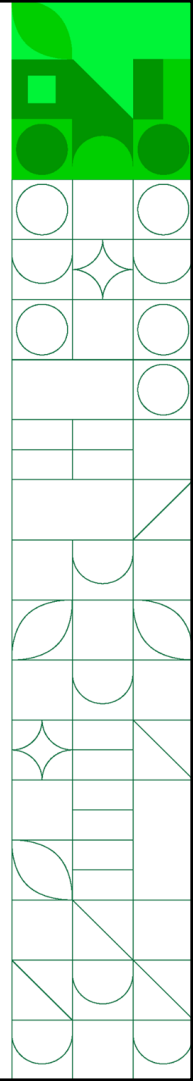
Proalcool

- 1979 - first ethanol exclusive car in Brazil (Fiat 147)
- 1987 - First bioelectricity contract between a mill and an electric distribution company
- 2000 - First factory of biodegradable plastic from sugarcane is installed
- 2003- First flex car starts to be sold



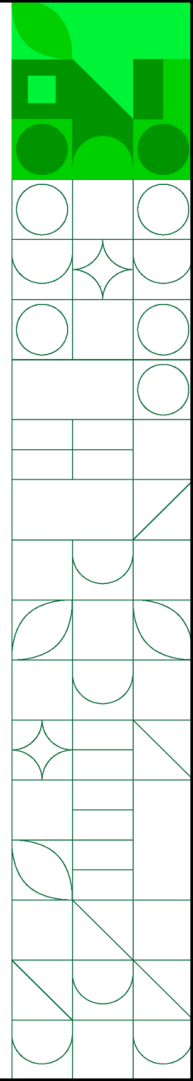
Flex Fuel

- **Technology allows vehicles to run with 100% ethanol, fossil fuels or any mixture of the two**
- **Give choice to consumers (70% of price)**
- **Empowers consumers to help reduce air pollution**
- **In Brazil, 98% of new cars sold are flex**
- **552 Millions Tons of CO₂eq avoided in the atmosphere (2003-2020)**
- **100 billion liters of fossil fuels saved**



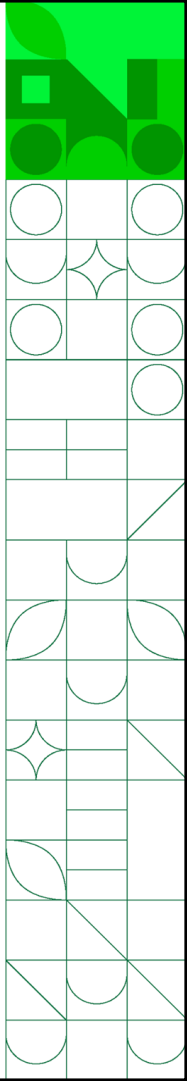
Proalcool

- **2004 - First plane fueled by ethanol starts to be sold by EMBRAER**
- **2009 - First flex (gasoline and ethanol) motorcycle starts to be sold by Honda**
- **2010 - Bioplastic gains scale - Braskem starts to produce bioplastic and sell to companies like Danone in USA, Germany, France and Belgium**
- **2011 - Scania starts to produce buses fueled by ethanol and they starts to be seen in streets of São Paulo**



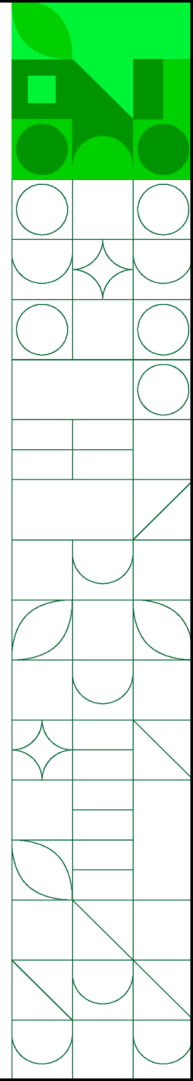
Proalcool

- 2015 - E27 in Brazil - addition of 27,5% of ethanol in gasoline
- 2017 - Renovabio
- 2019 - Toyota launches first hybrid-flex vehicle (Corolla)
- Recently, hydrogen cell cars from ethanol are starting to be tested by University of São Paulo

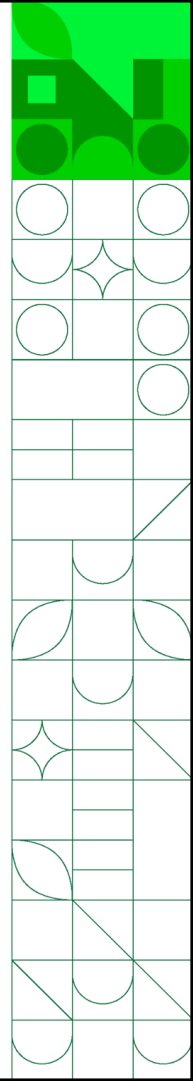
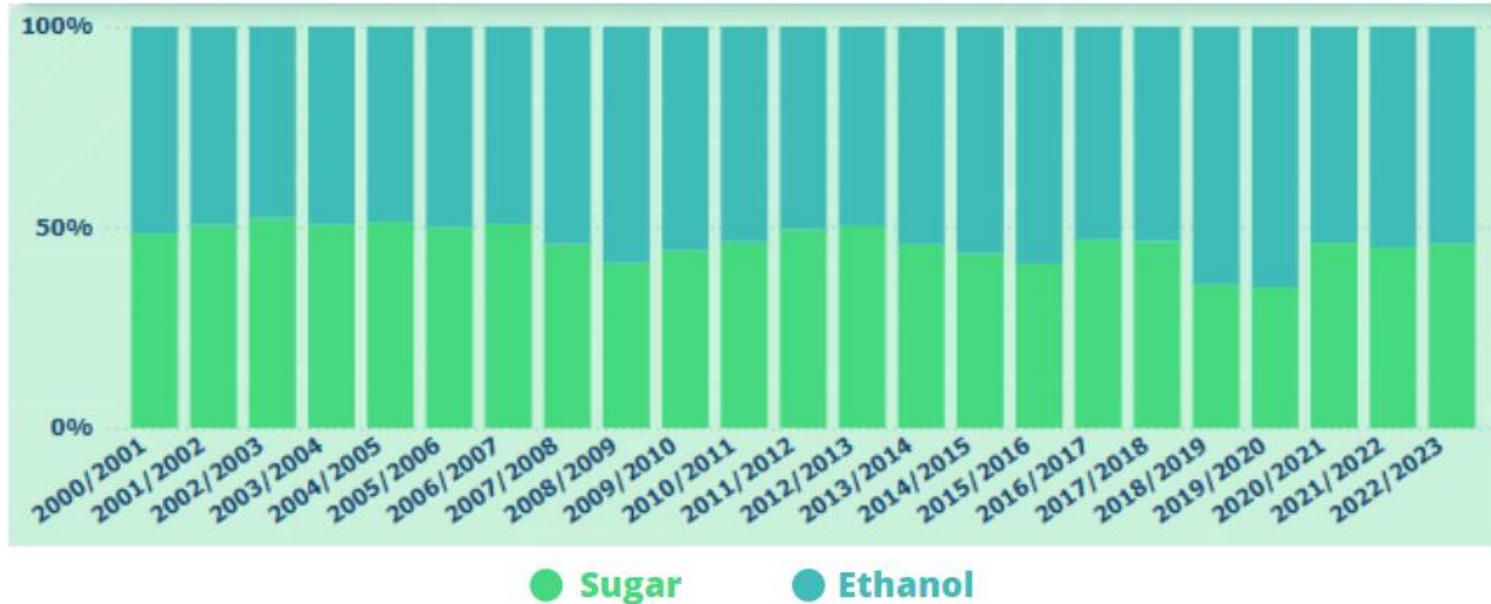


Proalcool

- **Phase 1**
 - Oil crisis 1973
 - Plants idleness due to renovation and centralization
 - Drop on sugar prices acentuada nos preços do produto.
- **Phase 2**
 - New oil crisis in 1979
 - Installation of autonomous ethanol mills
 - Strongest phase of Proalcool with implementation of subsidies and financial mechanisms
- **Phase 3**
 - Super production of ethanol in 1999/2000
 - Low prices of oil international markets
 - Dismantlement of state support and intervention on production of sugar and ethanol
 - Demand maintained somehow with anhydrous ethanol for cars. However production surpassed consumption.
 - Low prices
- **Phase 4**
 - Renewal of Proalcool through corporative actions, integrating more economic sectors
 - Liberalization of ethanol prices
 - Better international oil prices
 - Better prices for ethanol.
 - Introduction of flex fuels cars
 - Ends at 1990

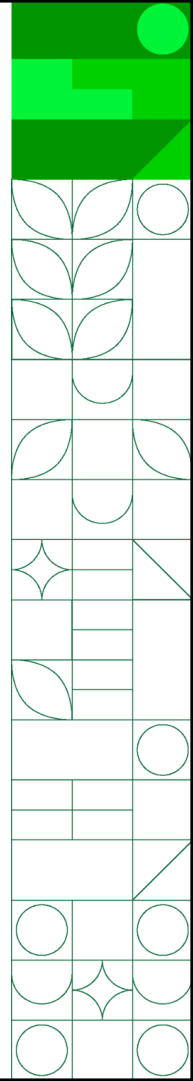


Mix of production for ethanol and sugar

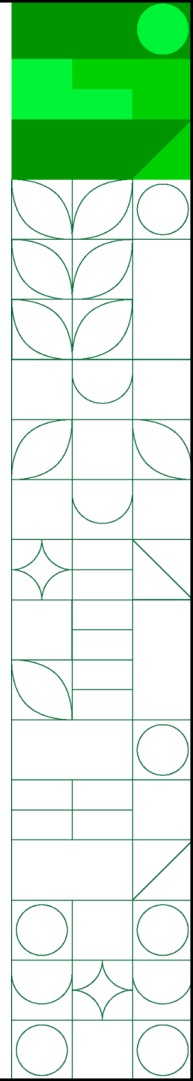


Historical production (2000 - 2023)

Harvest	Crushing (tons)	Sugar (tons)	Ethanol Anhydrous (m3)	Ethanol hydrous (m3)	Ethanol Total (m3)
2022/2023	607,413.483	36,953.181	13,512.630	17,680.491	31,193.121
2021/2022	578,054.029	34,992.247	11,936.082	17,845.807	29,781.889
2020/2021	657,653.300	41,483.184	10,655.227	21,870.187	32,525.414
2019/2020	642,529.058	29,614.055	10,878.469	24,708.953	35,587.422
2018/2019	621,217.310	29,048.419	9,918.410	23,205.605	33,124.015
2017/2018	640,934.722	38,600.350	11,364.620	16,482.957	27,847.577
2016/2017	651,840.683	38,734.075	11,586.252	15,667.647	27,253.899
2015/2016	667,116.425	33,837.339	11,660.541	18,571.894	30,232.435
2014/2015	633,927.436	35,571.119	12,079.000	16,401.378	28,480.378
2013/2014	653,210.558	37,683.133	12,217.154	15,335.850	27,553.004
2012/2013	589,784.413	38,284.154	9,860.910	13,401.840	23,262.750
2011/2012	557,953.809	35,878.224	8,576.800	14,058.260	22,635.060
2010/2011	615,260.213	37,849.401	8,285.882	18,884.050	27,169.932
2009/2010	602,193.192	32,956.359	7,065.247	18,625.671	25,690.918
2008/2009	569,215.975	31,047.382	9,336.343	18,189.621	27,525.964
2007/2008	492,381.586	30,719.385	8,362.882	14,059.124	22,422.006
2006/2007	425,415.606	29,798.433	8,292.451	9,418.036	17,710.487
2005/2006	387,345.224	25,948.223	7,826.628	8,116.313	15,942.941
2004/2005	386,090.118	26,621.215	8,304.450	7,112.218	15,416.668
2003/2004	358,939.690	24,925.793	8,911.957	5,883.679	14,795.636
2002/2003	320,650.076	22,567.260	7,015.466	5,607.759	12,623.225
2001/2002	293,050.543	19,218.011	6,465.098	5,070.936	11,536.034
2000/2001	257,622.017	16,256.105	5,620.964	4,972.071	10,593.035



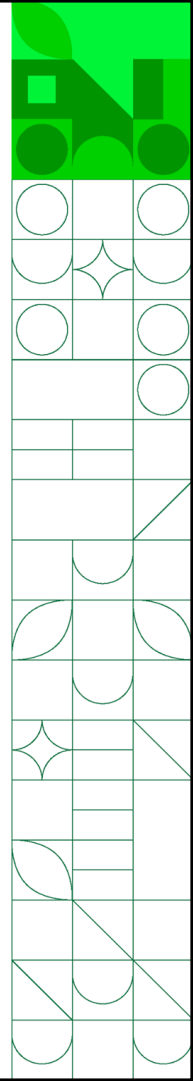
1.2% of the Brazilian territory is used for the cultivation of sugarcane, with 0.9% destined for ethanol production (sugarcane and corn).



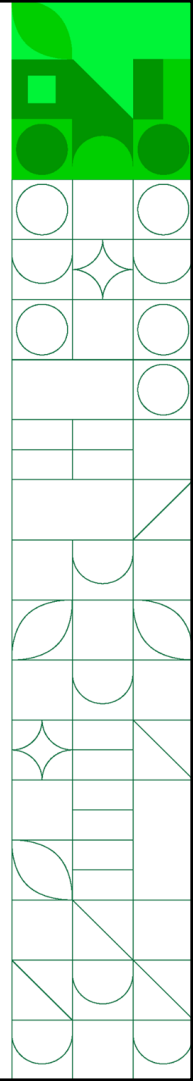
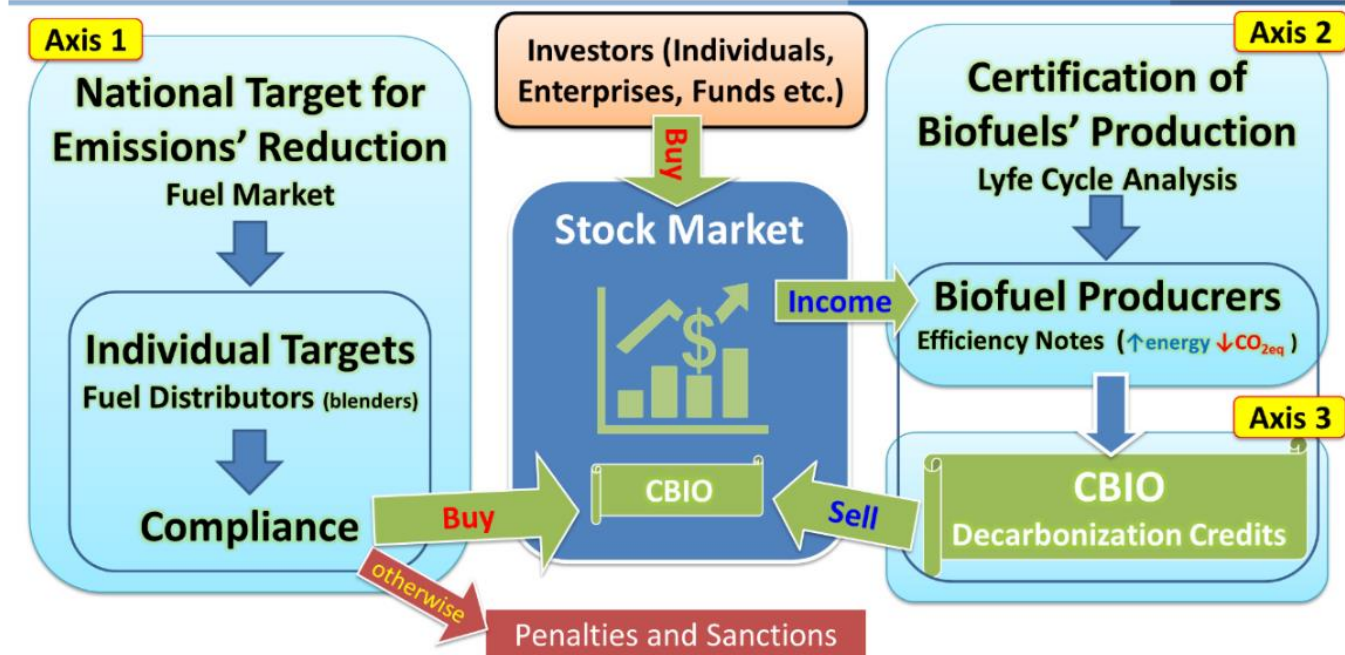


- **Implemented in 2017 - recognizes the strategic role of biofuels in the Brazilian energy matrix**
- **Aims to reduce the carbon emissions of Brazilian transportation systems**
- **Creates a carbon credit market to offset emissions of GHG from fossil fuels**

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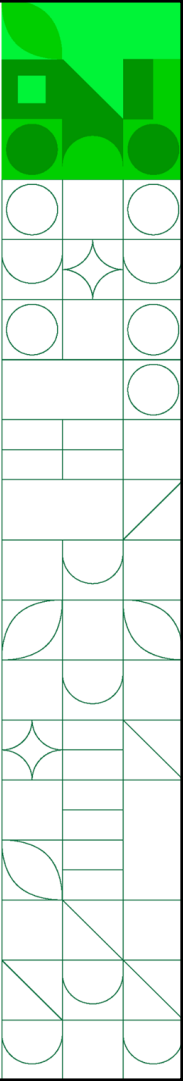


RenovaBio Concept



Ethanol from Corn

- From 37 million liters to 4.4 billion liters in 10 years
- 15% of ethanol produced in harvest year 21/22
- Co-generation of dried distilled grains



Bioelectricity

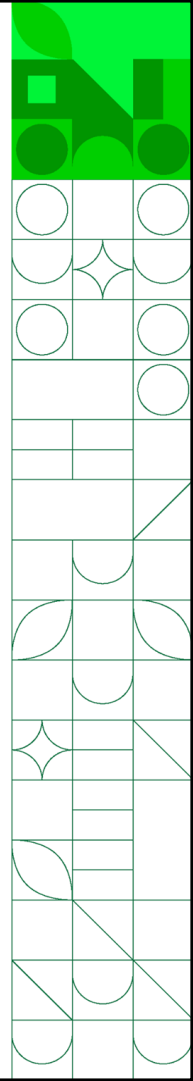


Juice | The sweet liquid inside the sugarcane stalk contains sucrose, which is used to produce sugar and ethanol.

Bagasse | The dry, fibrous residue left after sugarcane is crushed. One ton of cane produces about 250 kilos of bagasse (50% moisture)*. Source: CTC (2015).

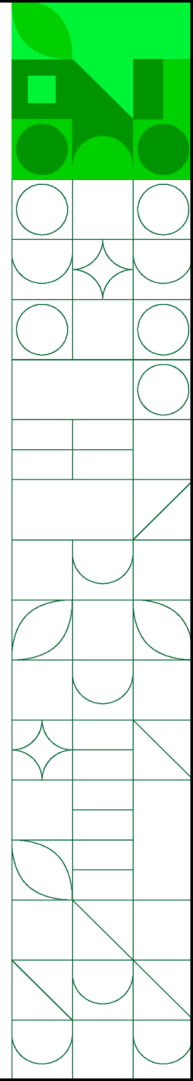
Straw | The tops and leaves of sugarcane stalks.

- Brazilian sugarcane mills learned to harness the energy stored in biomass by burning it in high-efficiency boilers to produce bioelectricity. As a result, these mills are energy self-sufficient, producing more than enough electricity to cover their own needs.
- All Brazilian mills are electric self-sufficient in and export the surplus to the National Electrical Grid
- Thanks to sugarcane bioelectricity, in 2020, sugarcane mills supplied more than 22,600 GWh to the grid, or 5% of Brazil's electricity requirements.



Bioelectricity

- Using only 15% of their potential, Brazilian sugarcane mills are the fourth most important electricity suppliers in Brazil's electricity mix.
- Experts estimate that with full use of sugarcane residues, bioelectricity could reach 148,000 GWh to the grid. That would be enough energy to power a country the size of Argentina or Norway.

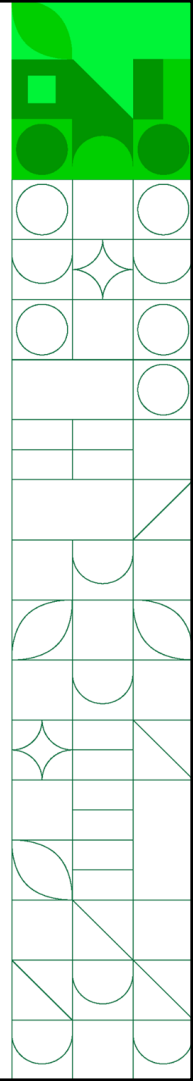


Brazilian Power Installed Capacity

Fuel	MW	%MW Total
Hydro	109,76	57%
Wind	24,581	13%
Natural Gas	18,244	10%
Sugar-cane Biomass	12,269	6%
Other biomass	4,791	2%
Other fossil fuels	8,873	5%
Coal	3,466	2%
Solar	7,71	4%
Nuclear	1,99	1%
Total	191,684	100%

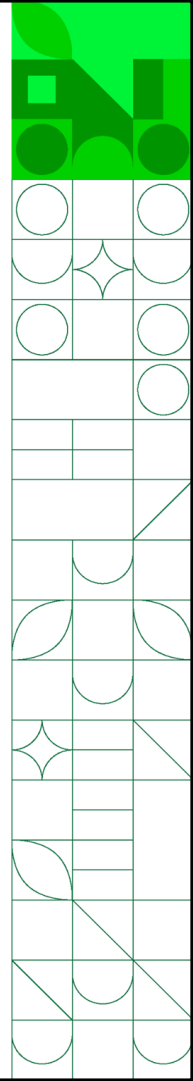
BIOELECTRICITY BENEFITS

- **Low environmental impact**
- **Reduces GHG emissions**
- **Producers can obtain carbon credits**
- **Highly complementary to hydroelectricity (Brazil)**
- **Reduces energy transmission loss**
- **Generated closer to consumers, avoiding the need of investment in transmission centers**



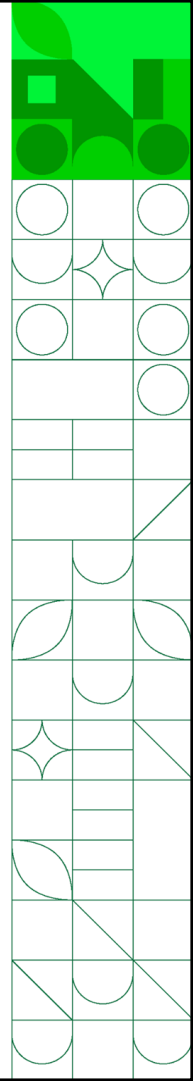
Facts

Brazil is the world's largest sugarcane ethanol producer and a pioneer in using ethanol as a motor fuel. In 2019-20, Brazilian ethanol production reached 32.5 billion liters. Most of this production is absorbed by the domestic market where it is sold as either pure ethanol fuel (E100) or blended with gasoline (E27).

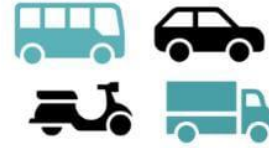


ETHANOL BENEFITS

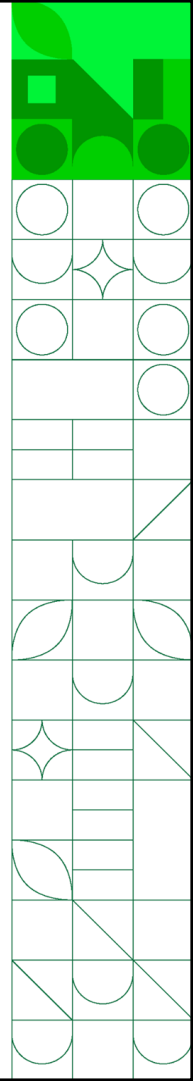
- Ethanol adds oxygen to gasoline which helps reduce air pollution and harmful tailpipe emissions. Ethanol also reduces Greenhouse Gas (GHG) emissions by up to 90% when compared to fossil fuels, performing better than any other liquid biofuel produced today on a commercial scale.
- Beyond its positive environmental impact, ethanol can also enhance a vehicle's performance. It is a high-octane fuel that generates more power in higher compression engines.
- Available now, ethanol helps to reduce global dependence on fossil fuels and can be used to diversify a country's energy matrix.



Sao Paulo and Ethanol



UNICA

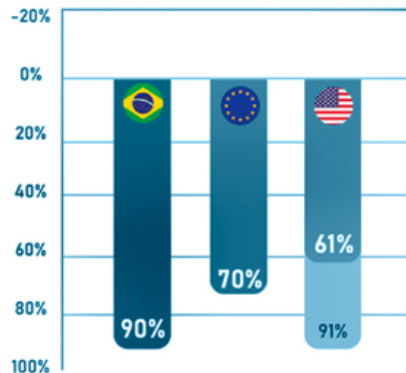


ETHANOL Brings Blues Skies Back

Ethanol reduced almost 50% of pollution and improved air quality in São Paulo, a City of 12 million people that now benefit from cleaner air thanks to the major uptake of ethanol in transportation.

Besides that, ethanol emits 90% less CO₂ than fossil fuels. The biofuel has saved, since 2003, about 600 million tons of CO₂ emissions to the Brazilian skies.

Ethanol helped to restore air quality in BraZilian big cities and can do the same for other major cities in the world



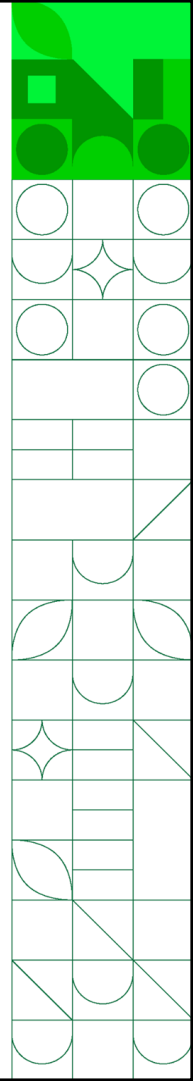
CLEAN AIR

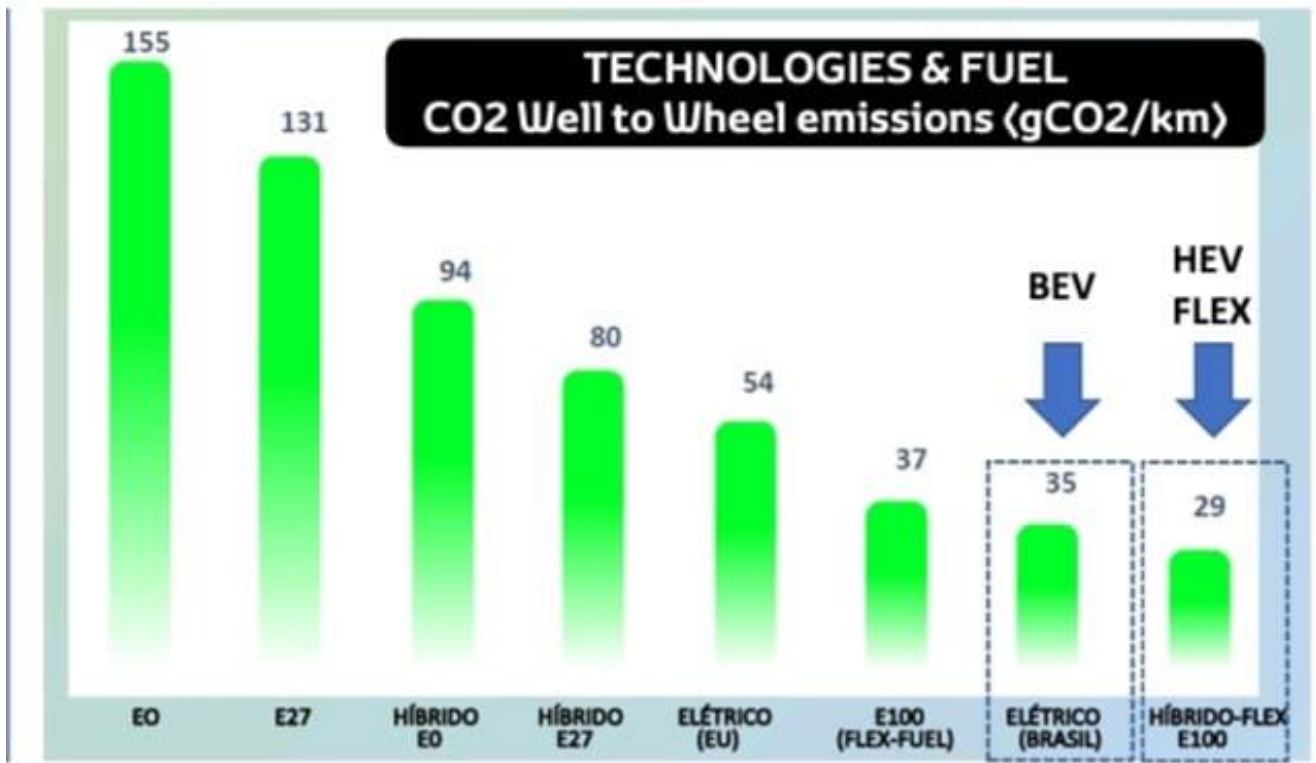
90% less greenhouse gas emission

98% reduction of inhalable particles

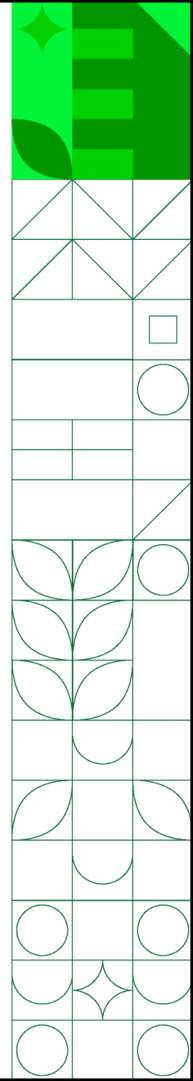
90% less Sulphur oxide and other toxic substances when compared to gasoline and diesel

EMISSIONS SAVINGS OF SUGARCANE ETHANOL COMPARED TO PETROL/GASOLINE





(source MME-2022)

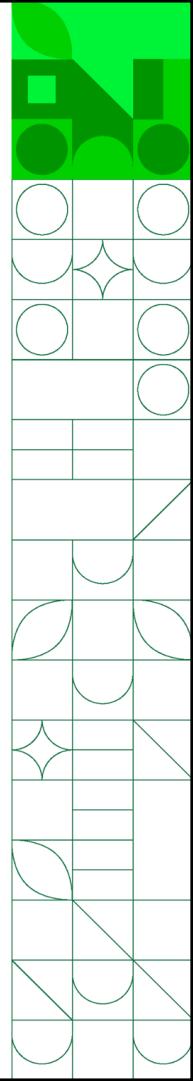


ETHANOL BENEFITS

Per capita GDP rise of USD 1,098 in Brazilian cities where ethanol is produced

Ethanol helped to restore air quality in Brazilian big cities and can do the same for other major cities in the world

OVER 3.20 bi barrels of gasoline substituted between 1975 and 2020 in Brazil



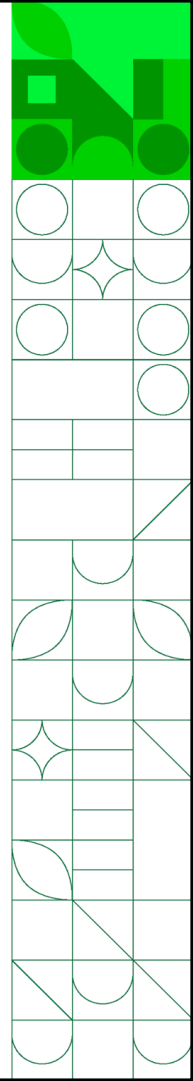
Ethanol 2G

Sugarcane ethanol today is made from the sucrose found in sugarcane juice and molasses. This current process taps only one-third of the energy sugarcane can offer. The other two-thirds remains locked in leftover cane fiber (called bagasse) and straw. While some of this energy is converted to bioelectricity in Brazil, scientists have discovered new techniques to produce ethanol – known as cellulosic ethanol – from leftover plant material.

This complex process involves hydrolysis and gasification technologies to break down lignocellulose – the structural material found in plant matter – into sugar, in the case of sugarcane. While cellulosic ethanol can be made from abundant and diverse raw materials, its production requires a greater amount of processing than mainstream sugarcane ethanol, making it relatively more expensive.

Once engineers and technical experts perfect commercial-scale manufacturing, production prices should come down, and cellulosic ethanol could potentially double the volume of fuel produced on the same amount of land.

There are currently two commercial plants producing cellulosic ethanol in Brazil: one from [GranBio](#) group and the other one from [Raízen](#).



ETHANOL 2G PRODUCTION PROCESS



Transport



Pre-treatment

The raw material is fed into the reactor, where its structure is broken up into cellulose and hemicellulose fibers



Fermentation

Sugars are fermented into ethanol using yeast



Enzymatic hydrolysis

Enzymes act as catalysts to deconstruct the cellulose fibers



Distillation

Ethanol goes through a purification process making it suitable for use



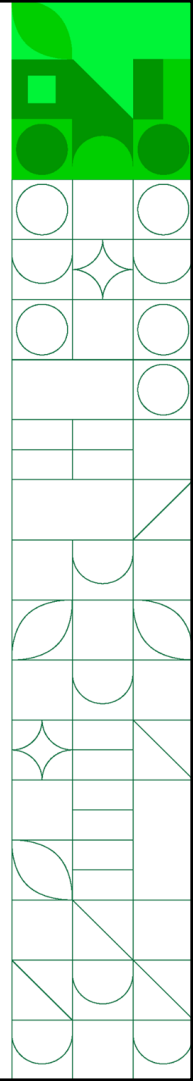
Distribution

The cellulosic ethanol is transported from the production plant to the gas station



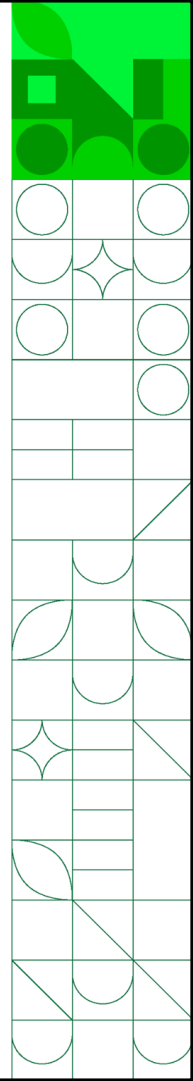
Lignin

Not used in the production of ethanol, but can be used to generate energy



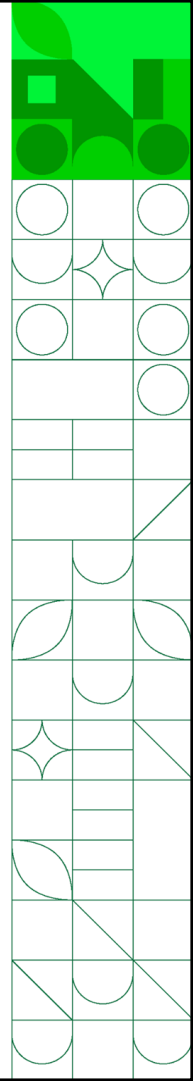
Some facts

- There are 360 active production mills in the country today.
- The gross value generated by the sugarcane and energy chain exceeds US\$ 100 billion, with a GDP of approximately US\$ 40 billion (equivalent to about 2% of the Brazilian GDP).
- Brazil is the world's largest producer of sugarcane, with around 607 million tons processed in the last harvest (2022/2023).
- The Center-South region accounts for 90% of this quantity, while the remaining 10% belongs to the states in the North-Northeast region.

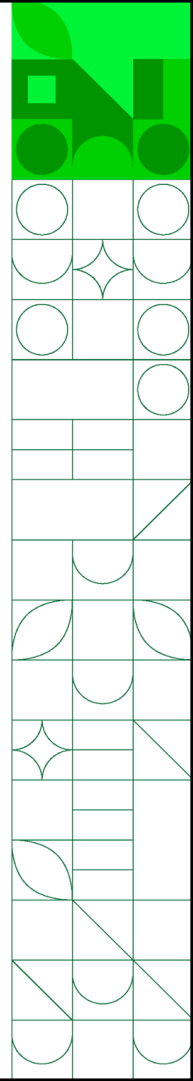


ETHANOL BENEFITS - Social Impacts

- **Over 705,000 formal jobs in the sector.**
- **Indirect jobs of approximately 2.1 million people.**
- **The existence of an ethanol plant in a municipality increases the average per capita GDP in the year of the plant's installation by \$1,098, while the 15 nearest cities experience an average increase of \$458.**



- **The consumption of hydrous ethanol by flex-fuel cars, combined with the current mandatory blend of 27% anhydrous ethanol in gasoline, has reduced greenhouse gas emissions (GHG) by more than 630 million tons of CO₂eq since March 2003 (the launch date of flex-fuel vehicles in Brazil) until March 2022.**
- **This amount is equivalent to the total emissions of South Korea.**



Terima Kasih!

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