Brazil’s Ethanol Experience & Accomplishments -- Towards the Geopolitics of Clean Energy

Dr. Plinio Nastari
DATAGRO

Governors Biofuels Coalition Meeting
The National Press Club
Washington, DC
February 22nd, 2010
The History of Ethanol Use Started in the US

Henry Ford and his automobile using pure ethanol as fuel, in 1896
In Brazil, regular ethanol use as a blend component (E5) dates back to 1931; First tests using higher blends, up to E100, were made in 1925.
Landmarks of Ethanol Development in Brazil

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• Brazil is the first country to completely ban tetra-ethyl lead use as component in gasoline, due to the country-wide use of anhydrous ethanol as a blend component, in 1983.
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- Neat-ethanol cars represent >88% of total car sales between 1983-88.
- **Hydrous ethanol (E100) is distributed in all fueling stations in a continental-size country.**
Landmarks of Ethanol Development in Brazil

- In 1988, 56.9% of all gasoline is substituted by ethanol! In 2009, this proportion is 50.11%, in gasoline equivalent, and continues to rise again.
% OF ETHANOL IN OTTO CYCLE FUEL DEMAND
(in % of gasoline equivalent)

Survey & Analysis: DATAGRO

Governors Biofuels Coalition, WDC
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- In 1988, 56.9% of all gasoline is substituted by ethanol. In 2009, this proportion is 50.11%, in gasoline equivalent, and continues to rise again.

- **Ethanol use enables drastic reduction of vehicle emissions.**
Carbon Monoxide Historic Emissions

Survey & Analysis: DATAGRO
Basic Data: CETESB
Hydrocarbon Historic Emissions

Light Duty Vehicles

Survey & Analysis: DATAGRO
Basic Data: CETESB

DATAGRO

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• In Jan/2008, consumption of ethanol overcomes (again) pure gasoline (A) in volume terms.
Gasoline A Vs. Ethanol Consumption - Brazil

Survey & Analysis: DATAGRO

Gasoline A (pure gasoline)  Ethanol (Hydrous + Unhydros)

January 2007 to July 2009

Billion Liters
## Total Fuels Consumption in Brazil

<table>
<thead>
<tr>
<th>Fuels</th>
<th>2008</th>
<th>2009</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel oil</td>
<td>11,825</td>
<td>11,702</td>
<td>-1.0%</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>297</td>
<td>413</td>
<td>39.1%</td>
</tr>
<tr>
<td>Gasohol</td>
<td>6,651</td>
<td>6,712</td>
<td>0.9%</td>
</tr>
<tr>
<td>Pure gasoline (A)</td>
<td>4,988</td>
<td>5,034</td>
<td>0.9%</td>
</tr>
<tr>
<td>Anhydrous ethanol fuel</td>
<td>1,663</td>
<td>1,678</td>
<td>0.9%</td>
</tr>
<tr>
<td>Hydrous ethanol fuel</td>
<td>3,511</td>
<td>4,351</td>
<td>23.9%</td>
</tr>
<tr>
<td>Total Ethanol fuel</td>
<td>5,174</td>
<td>6,029</td>
<td>16.5%</td>
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<tr>
<td>LPG</td>
<td>3,238</td>
<td>3,200</td>
<td>-1.2%</td>
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<tr>
<td>Fuel oil</td>
<td>1,366</td>
<td>1,322</td>
<td>-3.2%</td>
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<tr>
<td>Jet fuel</td>
<td>1,381</td>
<td>1,434</td>
<td>3.8%</td>
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<tr>
<td>Aviation gasoline</td>
<td>16</td>
<td>16</td>
<td>1.6%</td>
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<tr>
<td>Kerosene</td>
<td>6</td>
<td>4</td>
<td>-33.3%</td>
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<tr>
<td>Total liquid fuels</td>
<td>27,995</td>
<td>28,743</td>
<td>2.7%</td>
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<tr>
<td>CNG</td>
<td>1,752</td>
<td>1,666</td>
<td>-4.9%</td>
</tr>
</tbody>
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Survey & research: DATAGRO
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- Flex cars, capable of using any % of E100 and E25 are launched in Mar/2003.
- In Jan/2008, consumption of ethanol overcomes again gasoline in volume terms.
- 2009: flex cars represent 88.2% of total vehicle sales, and >35% of existing fleet. It is expected that by 2020, >90% of fleet will be flex.
Flex-Fuel Vehicles

- Allows use of any blends of hydrous ethanol (E100) and gasoline with anhydrous ethanol (E25).
- January 2010: sales of flex fuel cars accounted for 85.3% of total vehicle sales in the country.
- Consumers opt for E100 to E25 whenever price of E100 is <=70% price of E25.

All auto-makers installed in Brazil are producing / marketing Flex-Fuel models.
All major Auto-makers produce Flex Cars in Brazil
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• Regulation/deregulation phases:
  – 1931-1989: period of strong government intervention (production quotas, sales quotas, stock controls, state monopoly on exports of sugar, prices controlled by the government).
  – 1999 onwards: minimal government intervention (intervention left is definition of blend level in the range of 20-25%; import/export tariffs).
Ethanol Production in Brazil

**Million Gallons**

- Strong government intervention
- Deregulation period
- Minimal govt intervention

- Golden days of neat-ethanol cars sales (79-93)

Source: DATAGRO, in million gallons.

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Governors Biofuels Coalition, WDC
THE SUGAR & ETHANOL INDUSTRIES ARE FULLY INTEGRATED.

THIS SYNERGY ENABLED BRAZIL TO BECOME THE LEAST COST PRODUCER IN THE WORLD.
SUPPLY OF TOTAL SUGARS IN BRAZIL

Source: DATAGRO, in million tonnes of total reducing sugars equivalent.
IN BRAZIL, ETHANOL IS CURRENTLY 55.4% OF TOTAL SUGARS – BUT IT REACHED AS MUCH AS 72.7%, IN 89/90!

Governors Biofuels Coalition, WDC
% OF CANE GOING TO ETHANOL

Source: Datagro
BRAZIL BUILT UP NOT ONLY A FLEX FLEET BUT ALSO (UNDER SOME LIMITS) A FLEX INDUSTRY
In 10/11, each 1% change in mix represents 900 thousand tons of sugar or 135 million gallons of anhydrous ethanol.

This flexibility has brought the possibility for producers to arbitrate prices in the sugar and ethanol markets.
FLEXIBILITY HAS ENABLED PRODUCERS TO ARBITRATE MARKETS DEPENDING ON THE RELATIVE PRICES OF SUGAR & ETHANOL
DATAGRO Price Equivalencies

Center South Region – in USD cents/lb FOB Santos sugar equivalent

Source: DATAGRO

Governors Biofuels Coalition, WDC

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ETHANOL PRODUCTION CAN EXPAND IN A SUSTAINED WAY.

SUGAR CANE (FOR SUGAR & ETHANOL) OCCUPIES 7.2 MILLION HA OUT OF 65.0 MILLION HA POSSIBLE AFTER THE AGROECOLOGICAL ZONING.
Agroecological Zonning for Sugar Cane Growth in Brazil - 2009

Legend

<table>
<thead>
<tr>
<th>Suitability</th>
<th>Current occupation</th>
<th>Area (million ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Pasture</td>
<td>11,302,343</td>
</tr>
<tr>
<td>Medium</td>
<td>Pasture</td>
<td>22,863,866</td>
</tr>
<tr>
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</tr>
<tr>
<td>High</td>
<td>Cattle</td>
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<tr>
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<td>483,326</td>
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<tr>
<td>High</td>
<td>Agriculture</td>
<td>7,360,310</td>
</tr>
<tr>
<td>Medium</td>
<td>Agriculture</td>
<td>16,496,736</td>
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<tr>
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<td>Agriculture</td>
<td>731,077</td>
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Total Area in Brazil (H+M+L) 65,005,941

Source: MAPA, MCT, MME, MPOG, MMA, Casa Civil, Embrapa, Conab, IBGE, CPRM, INPE, UNICAMP, PNUD.

February 2010
Governors Biofuels Coalition, WDC
### Agroecological Zoning for Sugar Cane Growth in Brazil - 2009

#### Areas Considered Suitable for Sugar Cane

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## LAND USE IN BRAZIL - 2008

(MILLION HECTARES)

<table>
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<tr>
<th>Category</th>
<th>Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil's territory</td>
<td>851</td>
</tr>
<tr>
<td>Forests &amp; strategic biomas (Amazon, Atlantic, pantanal)</td>
<td>350</td>
</tr>
<tr>
<td>Cultivated Forests</td>
<td>5</td>
</tr>
<tr>
<td>Preservation areas</td>
<td>55</td>
</tr>
<tr>
<td>Cities, rivers, lakes, roads</td>
<td>20</td>
</tr>
<tr>
<td>Other areas (depleted, improper for agriculture)</td>
<td>38</td>
</tr>
<tr>
<td><strong>Current in use for agriculture &amp; livestock</strong></td>
<td></td>
</tr>
<tr>
<td>Annual crops</td>
<td>60.6</td>
</tr>
<tr>
<td>Soybeans</td>
<td>24.2</td>
</tr>
<tr>
<td>Corn</td>
<td>21.2</td>
</tr>
<tr>
<td>Permanent crops</td>
<td>16.1</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>7.2</td>
</tr>
<tr>
<td>Pastureland</td>
<td>220.0</td>
</tr>
<tr>
<td><strong>Expected to be released to agriculture</strong></td>
<td>70-90</td>
</tr>
<tr>
<td><strong>Without any current use</strong></td>
<td>86.3</td>
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Source: MAPA, Casa Civil, Datagro.
CATTLE RANCHING IS BECOMING INCREASINGLY EFFICIENT, THUS RELEASING LAND FOR AGRICULTURE.
The State of Sao Paulo accounts for 66.5% of all sugar cane grown in Brazil.

Between 1985 & 2008, while the cattle herd in SP grew 10.4%, pastureland reduced by 2.05 million hectares.
In 2006, there were 172.3 million hectares occupied with pastureland, by 169.9 million heads of cattle.
Fuel Distribution (2009)

- 457 sugar cane processing plants/mills;
- 198 fuel distributors;
- 37,627 fuel retailers.
  - All gasoline contains 20-25% anhydrous ethanol – gasohol.
  - Hydrous ethanol is sold in all of them.
The Industry is Becoming Rapidly Internationalized

Top 5 companies crush 21.6% of cane,
Top 25 companies crush 50.1% of cane,
4 out of Top 5 companies are multinationals.

Source: DATAGRO
Energy Companies and Agrindustrial Giants are the new investors
WHY ARE THESE COMPANIES INVESTING IN BRAZIL?
Likely reasons for investment...

• Even though already cost competitive with gasoline without any subsidy, its cost is not yet optimized.
Energy Contained in 1,000 tons of Sugar Cane
(in tons of oil equivalent)

- **Sucrose**: 51.11
- **Bagasse**: 55.05
- **Tops and Leaves**: 56.43

Only sucrose part is used efficiently today. Bagasse is used inefficiently and leaves are wasted.

Source: Nastari, Lisbon, 2000
Likely reasons for investment...

- Even though already cost competitive with gasoline without any subsidy, its cost is not yet optimized.
- Brazil has a growing domestic market.
- Good industrial base for supply of equipments.
- Dynamic agriculture research capacity.
- Minimal government intervention.
- Sugarcane ethanol has been proven to be efficient for GHG mitigation.
SUGAR CANE ETHANOL AS GHG Saver

   - Sugarcane ethanol met the 50% GHG reduction requirement for unspecified advanced biofuel: 61.2% savings over gasoline baseline.
   - This means that sugarcane ethanol qualifies as advanced biofuel for purposes of RFS2, in spite of land use change impact calculations.
   - Advanced biofuels target is 21 bi gallons by 2022 (79.5 bi liters), including cellulosic ethanol, biomass diesel, and other advanced biofuels (15.1 bi liters).

2. CARB in California had also concluded in favor of sugarcane ethanol for its environmental qualities.
HOWEVER, IN THE WORLD OF FUELS, ETHANOL IS STILL A DROP IN THE BUCKET!
HOWEVER, IN THE WORLD, ETHANOL IS STILL A DROP IN THE BUCKET (1)

>> Brazil stands out as the country where the use of biomass ethanol represents a large share of energy consumption:

- 50.11% (in gasoline equivalent) of the total consumption of Otto-cycle fuels in 2009 (this % reached 56.9% in 1988).

>> In the US, where ethanol production is larger in volume than in Brazil, ethanol represents ~7.8% of Otto-cycle fuel demand (2009).

>> In the world: biomass ethanol still represents only
  - 5.4% of consumption of gasoline, and
  - 1.3% of oil demand, which explains why it is considered an exotic fuel to many.
HOWEVER, IN THE WORLD, ETHANOL IS STILL A DROP IN THE BUCKET (2)

>> But, world fuels demand is expected to grow 40% until 2020.

>>Considering that E10 is technically feasible (World Fuels Chart) in world´s gasoline today, potential market taking into account only E10 is:
   • = 117 billion liters
   • = 202 million tons of sugar
   • = 123% of current world sugar demand.

>>Where most of gasoline is consumed today:
   • US accounts for 46% of world´s demand for gasoline: 540 billion liters, or 9.2 million barrels/day, or 46% of world demand, of 20.1 million b/d.
THE EXPLOSIVE EXPANSION IN THE US

2009
Production of ~42.0 billion liters, from 6.5 billion liters in 2000.
By 2013, all gasoline used in the US should be E10.

New Targets for Renewables in the US

Pres. Bush (State of Union 2006)
• Called for 20% gasoline substitution by 2017 =132 billion liters of renewables (AFS).

US Congress approved RFS2 (HR6) defining target of 136 billion liters by 2022.

“America is addicted to oil, which is often imported from unstable parts of the world.”

President Bush’s State of the Union Address—January 31, 2006
DEMAND FOR RENEWABLE FUELS - RFS1 & RFS2

(IN BILLION LITERS)

Source: Datagro

Governors Biofuels Coalition, WDC

February 2010
DEMAND OF RENEWABLE FUELS – RFS2 (HR 6)

Nota: Em tons de verde são indicados os "Advanced biofuels" (cell biofuel, und advanced biofuel, biomass diesel).

DATAGRO

February 2010
Governors Biofuels Coalition, WDC
THE POTENTIAL IS ENORMOUS, BUT ETHANOL MARKET EXPANSION DEPENDS FUNDAMENTALLY ON:

• COMPETITIVENESS WITH GASOLINE

• OVERCOMING THE BLEND WALL

• IMPROVING LOGISTICS

• A MORE OPEN MARKET
Learning Curve – Anhydrous Ethanol

Source: Nastari, P.M. "Competitividade da Produção de Etanol de Cana-de-açúcar no Brasil: as três ondas de desenvolvimento", V Conferência Internacional da Datagro sobre Açúcar e Álcool, Grand Hyatt São Paulo, 20 de setembro de 2005, São Paulo, SP.
THE BLEND WALL

• In the US, expansion of ethanol demand is currently limited by the 10% blend wall, mostly due to the small engines issue.
• In Brazil, small engines (boats, lawn-mowers) have been using E20-25 since 1978 without any problem.
• In 2008, Honda launched in Brazil **flex motorcycles** (125 cc) capable of using E100 - E25.
Ethanol use can go beyond E10

- Increasing blend level above 10%.
- Flex fuel fleet, Brazilian style, in tropical and sub-tropical countries.
- Flex fuel fleet in the US, lacking distribution network for E85.
- Production of bio-plastics and substitutes for other petrochemical products.
- Fuel cells
  - Ethanol is preferred liquid fuel.
Logistics

• In Brazil, ethanol has been transported in multi-product pipelines without pigs, for over 30 years.

• Brazilian logistics experts do not understand why there is still controversy over this issue in the US.

• Ethanol absorbs and dries out all condensation water in the system, maintaining it water-free afterwards.
IN THIS DECADE, ETHANOL HAS GROWN MUCH FASTER THAN SUGAR.
World Sugar Production
(raw sugar equivalent)

99/00 to 09/10 - CGAR 2.1%

Survey & Analysis: DATAGRO
Basic Data: DATAGRO / ISO

DATAGRO
World Ethanol Production

Survey & Analysis: DATAGRO

99/00 to 09/10 – CGAR 11.4%

Governors Biofuels Coalition, WDC
World Sugar & Ethanol Production
(raw sugar equivalent)

Survey & Analysis: DATAGRO
Basic Data: DATAGRO / ISO

World Ethanol Production
World Sugar Production
Potential Market is Very Large!

New Trends

- The world of fuels and petrochemical applications is MUCH larger than the world of sugar.

- Biofuels and renewable feedstocks can become raw material for polyethylene, PET, textile fibers, bio-derived gasoline and diesel.
PRODUCTION IS STILL MUCH CONCENTRATED IN THE US AND BRAZIL
>> In 2009, world ethanol production was 85.15 billion liters, or 151.2 million tons of raw sugar equivalent.

Still much concentrated in the US & Brazil

WORLD ETHANOL PRODUCTION
2009 - 85.15 BILLION LITERS
Sugarcane Ethanol can increase income from agriculture in many other countries

- Price of sugars in molasses are, in general, much below the ruling price of sugar in each market.
- This is why sugar producers tend to extract from molasses as much sugars as they can: 1st, 2nd & 3rd strike sugars.
Ethanol: increasing income from agriculture

- In this decade, world price of molasses with 55% sugars has varied in the range of:
  - $65-180 / ton FOB, or
  - $120 to 330 / ton of sugar equivalent.

- Price of white sugar has varied from $ 250 to 830 / ton!
Price of Blackstrap Molasses
US$ / metric ton of molasses FOB - US ports

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan/95</th>
<th>Jul/95</th>
<th>Jan/96</th>
<th>Jul/96</th>
<th>Jan/97</th>
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Price of White Sugar vs. Price of Sugars in Molasses

Molasses Basis New Orleans - in US$/ metric ton of sugar

DATAGRO

SUGAR (LN 5)  NEW ORLEANS

February 2010
Governors Biofuels Coalition, WDC
Ethanol: increasing income from agriculture

• Molasses to ethanol: Brazilian producers were able to value almost all sucrose for a price nearly equivalent to that of sugar.
• Great edge against its competitors.
• Enabled capital accumulation, applied in the modernization of industrial and agricultural processes.
• Explains average increase in agrindustrial productivity of 3.7% per year, during the past 35 years.
General Positive Impacts

- Sugar cane ethanol has proven to be one of the few effective sustainable development strategies to:
  - Generate jobs with low investment costs, and mitigate poverty in developing countries
  - Address the 2 main problems faced by the developed world:
    - the need to find a viable replacement to oil
    - control urban pollution and mitigate greenhouse gas emissions.
Ethanol can be long term solution

- Brazil’s self-sufficiency:
  - Substituted 1.87 billion barrels of gasoline, in 35 years = 13.8% of Brazil’s current proven crude oil and condensate reserves.

- Savings of over $78 billion, in constant dollars of 2009, measuring substituted gasoline for the price in the world market, in each year.
  - $241 billion savings, when foregone interests on foreign debt are considered.
  - Brazil’s total foreign reserves in Dec/09: $239.5 billion.
Extending its use is attainable

- Ethanol occupies in Brazil only 4.0 million hectares of sugarcane (2009), enough to substitute >50% of its gasoline.

- World consumption of gasoline is currently 20.07 million barrels/day: only 19.9 million hectares in sugar cane would be required to substitute 10% of world’s gasoline use.

- This land mass is available in many regions: in Central and South America, Africa and Southeast Asia.
MOU US-Brazil on Ethanol

• March 09, 2007: Memorandum of Understanding (MOU) to promote greater cooperation on ethanol and other biofuels in the Western Hemisphere.

• Americas Summit (Miami, 1994): pledge to ban MTBE and substitute it with ethanol.

• Obama Administration has historical chance to develop further policy on ethanol and biofuels in general.
Towards Geopolitics of Clean Energy

• Biomass ethanol, mostly from sugarcane, can play a major role at a moment many poor nations are in need of finding alternative uses and markets for their traditional agricultural production, reduce energy dependence, and find new sources of income.

• For more developed countries, there is a new option ahead:
  – Promote freer trade for clean, sustainably-produced ethanol, while at same time providing safeguards to domestic producers, and
  – Open new markets for its products and services, as fresh income is irrigated to clean-energy-producing less-developed countries.
Towards Geopolitics of Clean Energy

• Brazil is part of Mercosur, where there is a intra-zone tariff (0%) and an external tariff for ethanol imports (20%), establishing a preference for intra-zone trade.
• Brazil is considering lowering the external tariff also to 0%: decision has been postponed to June/10.
• Efforts continue to promote ethanol production and use in other countries.
• It is unmistakable that the strategy is to transform clean energy into the new major platform of trade!
19th May 2010
4th ISO / DATAGRO New York Sugar & Ethanol Conference
The Waldorf=Astoria, Starlight Roof - New York Sugar Dinner.
www.isodatagrony.com

18th - 19th October 2010
X International DATAGRO Sugar & Ethanol Conference
Grand Hyatt São Paulo, Brazil.
www.conferencia.datagro.com.br
IV ISO DATAGRO NEW YORK SUGAR CONFERENCE 2010

May 19th, 2010
The Waldorf Astoria
301 Park Avenue - New York

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