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# **Biofuel Carbon Capture & Storage, the Brazilian experience**

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DATAGRO

**FAPESP-NERC WORKSHOP ON SUSTAINABLE GAS FUTURE**

**February, 25<sup>th</sup> 2015**

FAPESP - Rua Pio XI, 1500 – Alto da Lapa

São Paulo Brazil

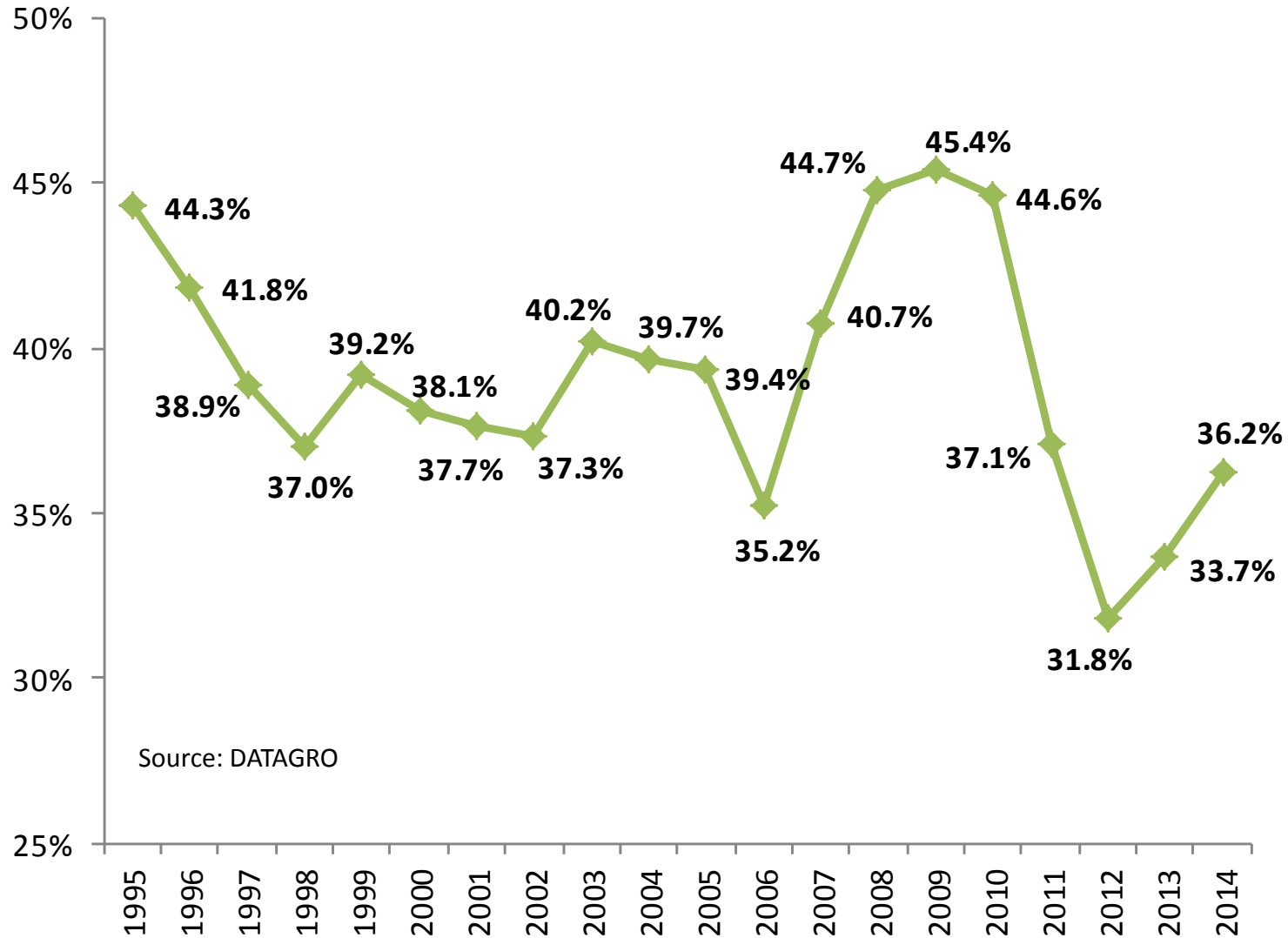
# Energy Consumption – Transport Sector

## 2013 in Brazil

<b>Energy Consumption - Transport Sector</b>		
Source	million tep	%
Diesel	38,433	46.2%
Biodiesel	2,005	2.4%
Gasoline (pure)	24,393	29.3%
Ethanol	11,889	14.3%
Anhydrous	5,172	6.2%
Hydrous	6,717	8.1%
Kerosene	3,608	4.3%
Fuel Oil	957	1.2%
Electricity	162	0.2%
CNG	1,647	2.0%
Others	59	0.1%
<b>Total</b>	<b>83,153</b>	<b>100.0%</b>

Source: BEN/MME

# ETHANOL SHARE IN OTTO CYCLE FUEL DEMAND (in gasoline equivalent)

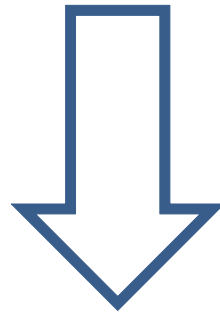


Source: DATAGRO

# Photosynthesis

Generates plants used as sources of biomass:

Cane	African palm	Eucaliptus
Soybeans	Cassava	Pinus
Castor	Palm	Other species



Conversion

Ethanol	Charcoal
Biodiesel	Hydrogen
Methanol	Biogas/biomethane

# Ethanol – Avoided Emissions

<b>Avoided emissions (kg CO2 eq/liter)</b>		
<b>Source</b>	<b>Industry Average</b>	<b>Best practices</b>
Anhydrous ethanol	2.564	2.716
Hydrous ethanol	1.722	1.867
Base case		
Gasoline (pure)	2.820	

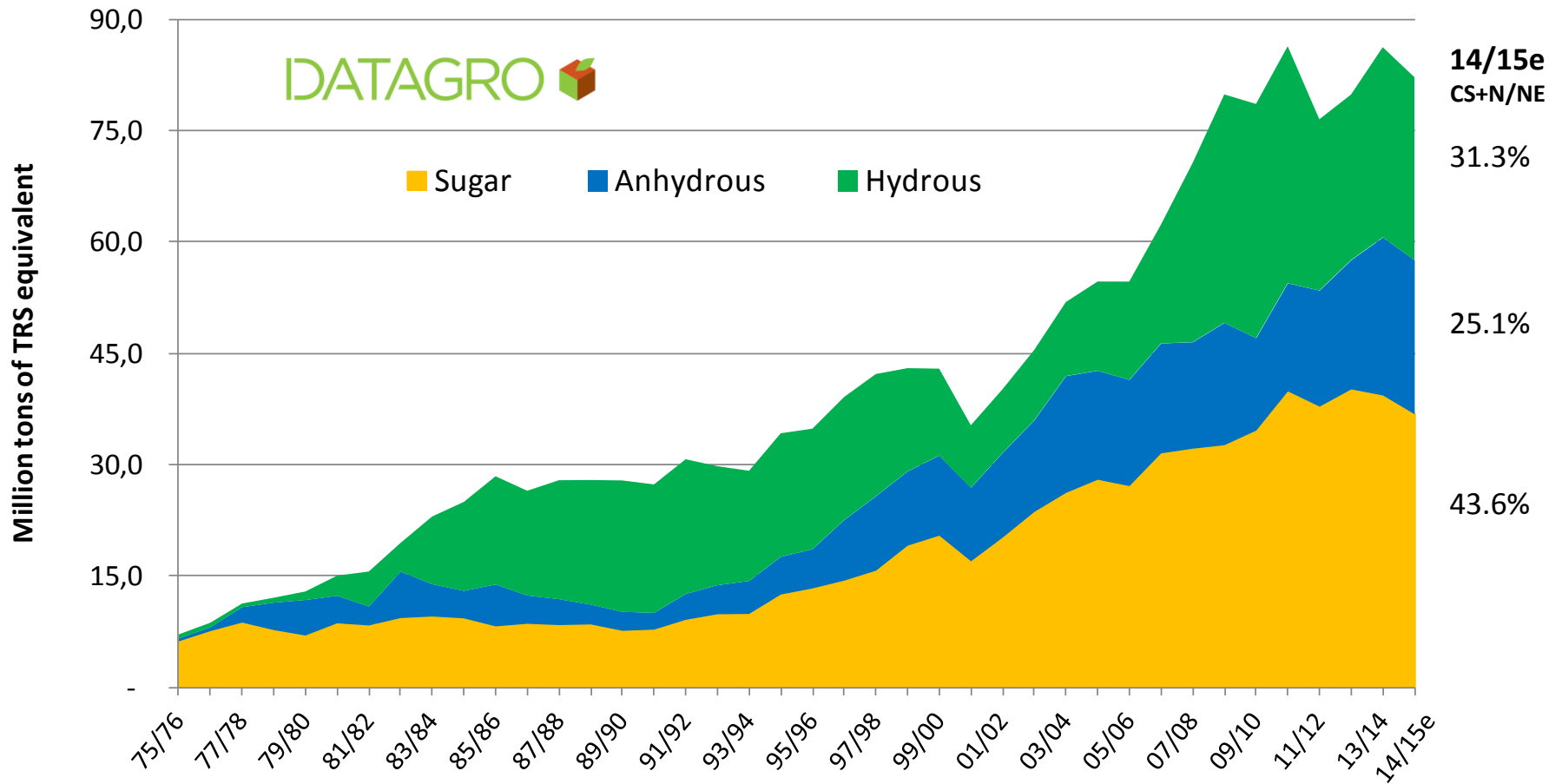
Source: Macedo et al. (2004).

# Biodiesel – Avoided Emissions

<b>Avoided emissions (kg CO2 eq/liter)</b>	
<b>Source</b>	<b>Industry Average</b>
Biodiesel (B100)	
Palm	2.760
Soy	2.530
Castor	1.760
Fossil Diesel	2.930

Source: EPE (2005).

# Brazilian Supply of Sugar+Ethanol (in TRS equivalent): with intense growth 2003-2010 period



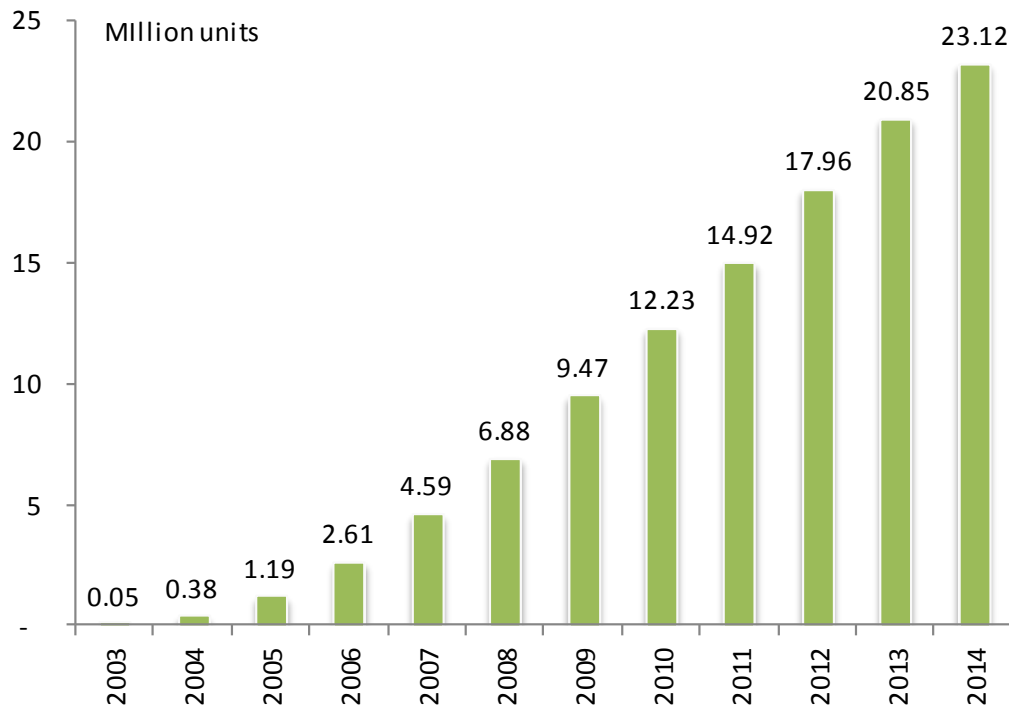
Source: DATAGRO

Note: TRS is Total Reducing Sugars, a common denominator for sugar and ethanol.

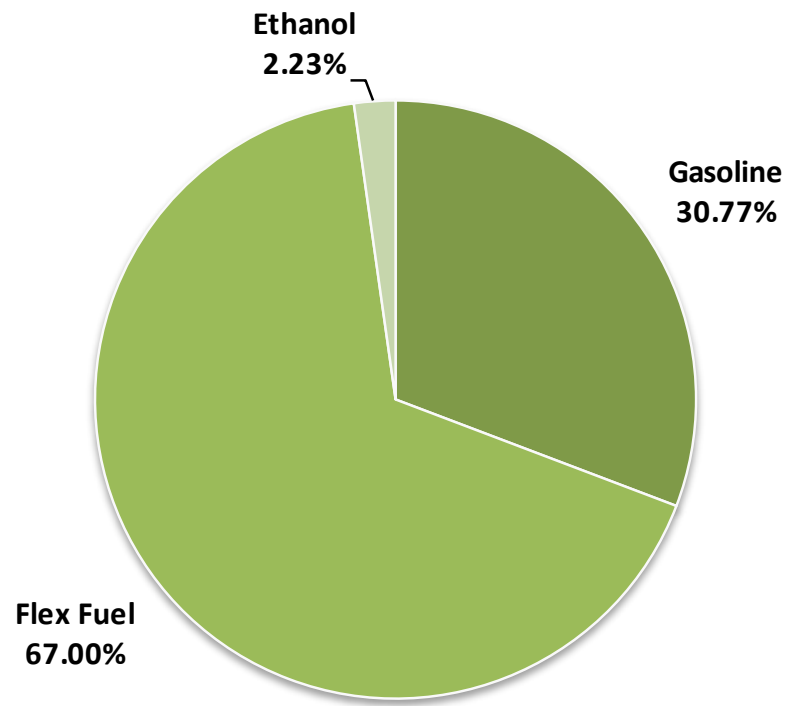


# SIZE OF THE DOMESTIC FLEET (OTTO CYCLE)

## Flex-Fuel Vehicle Fleet



## Vehicle Fleet by Type of Fuel (2014)

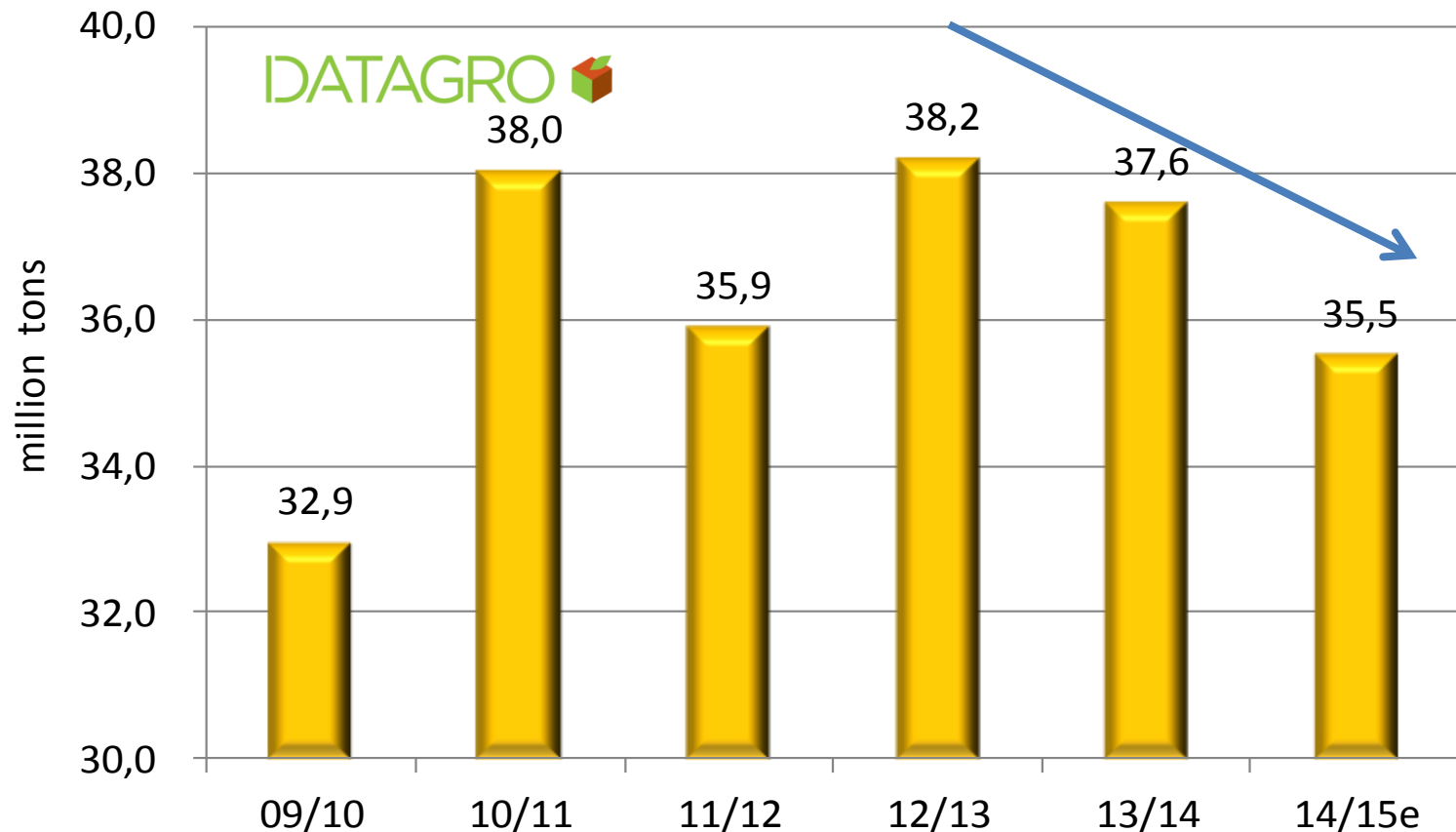


Source: DATAGRO

Source: DATAGRO

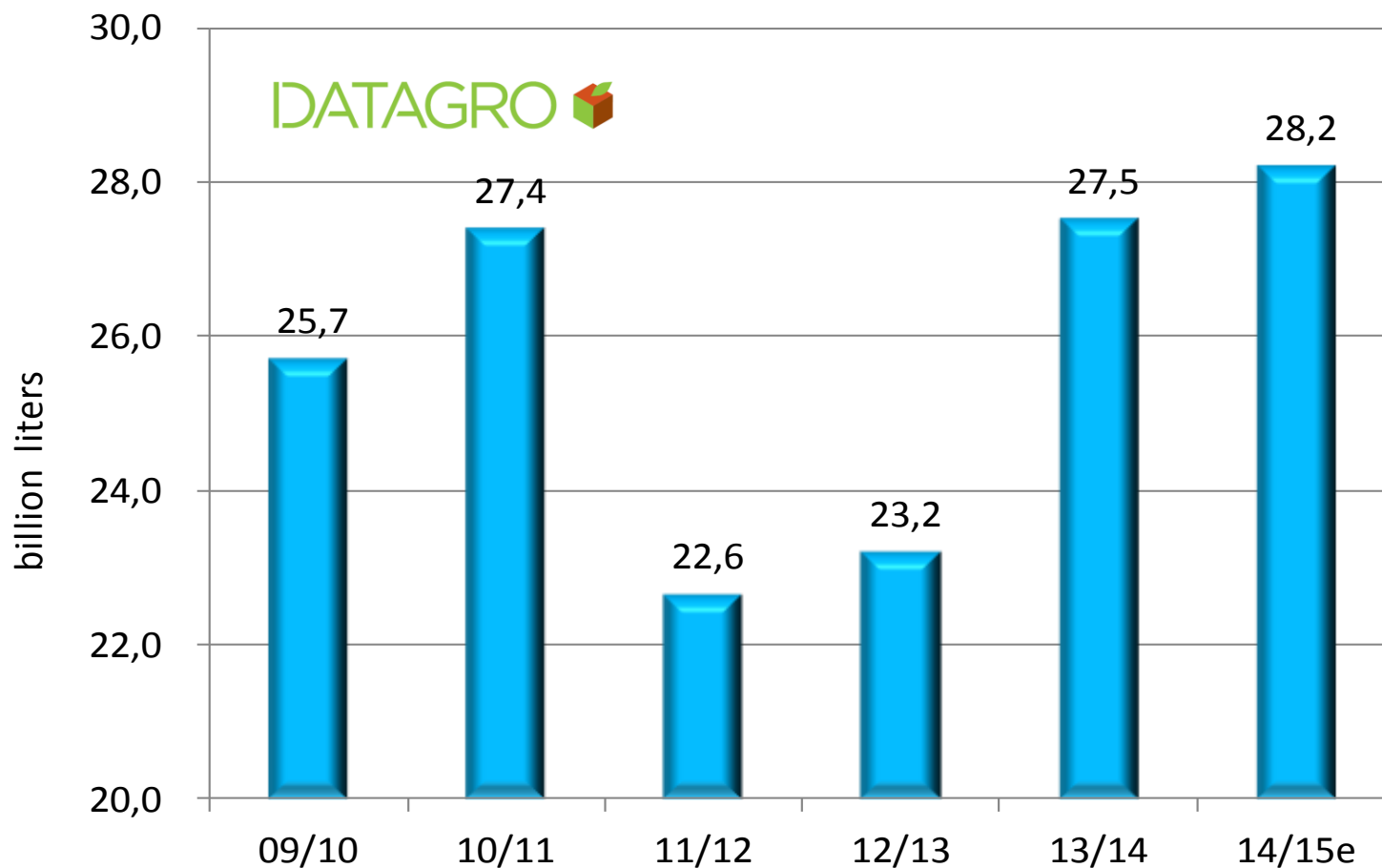
- Flex cars were responsible for 67.0% of total light vehicle fleet. This proportion is rising every year:
  - ✓ 2013: 63.12%
  - ✓ 2012: 58.02%
  - ✓ 2011: 52.07%

# Brazil: production of sugar has fallen since 2012



Source: Elaborated by DATAGRO, from data obtained with Syndicates of Producers.

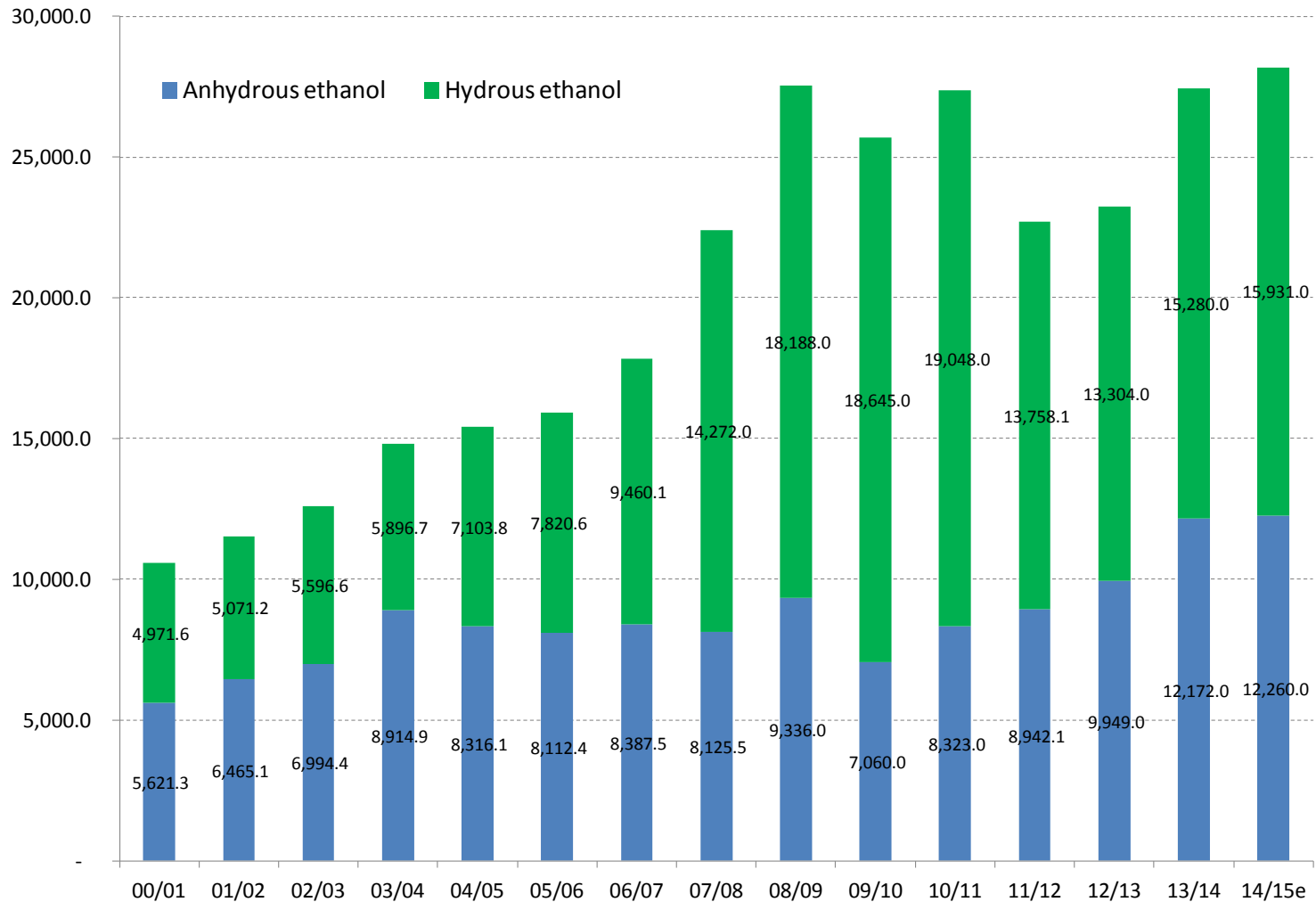
# Brazil: a new record production of ethanol achieved in 2014/15



Source: Elaborated by DATAGRO, from data obtained with Syndicates of Producers.

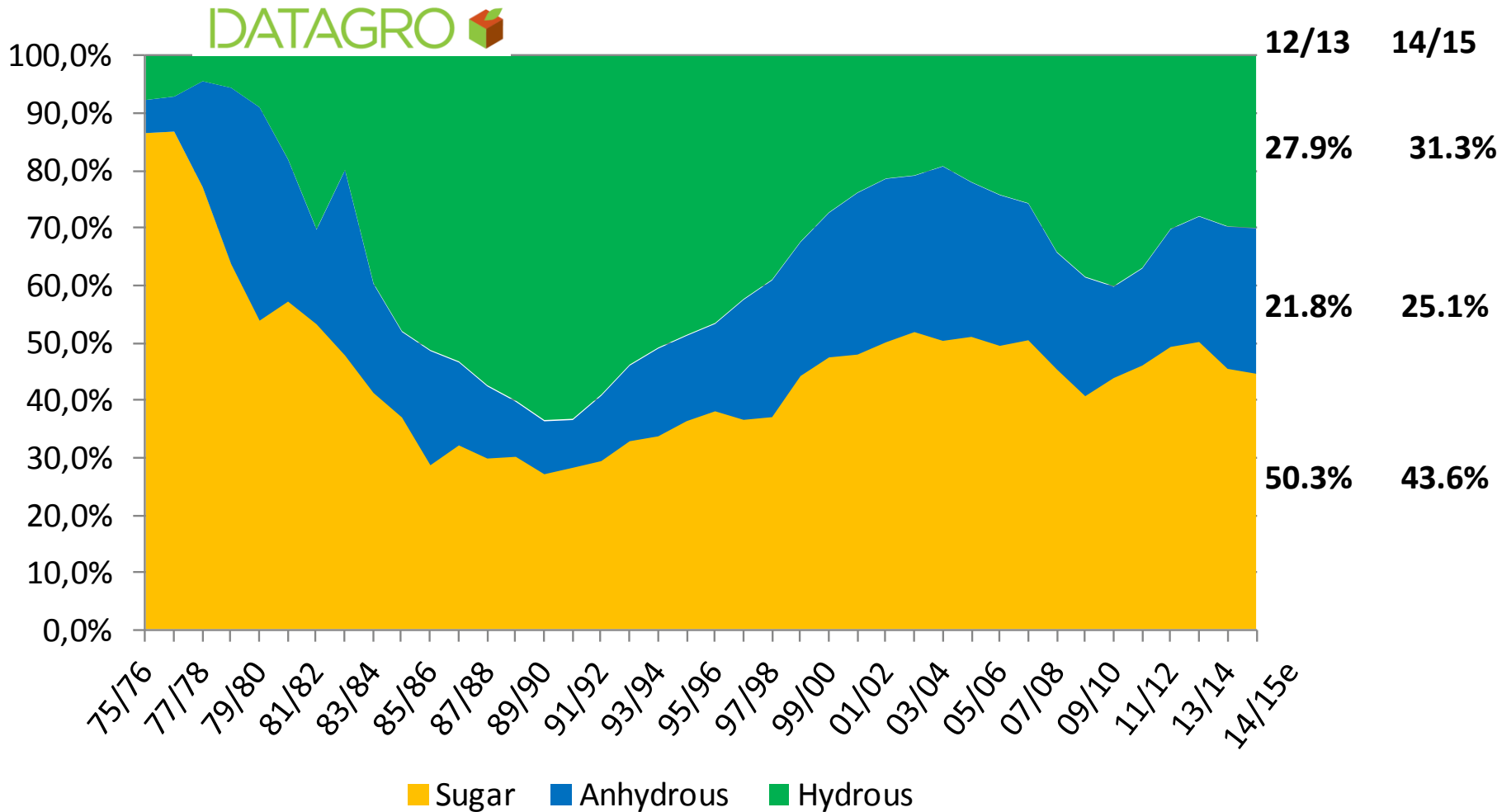
# Ethanol Production in Brazil

## (000 m3)



Source: DATAGRO.

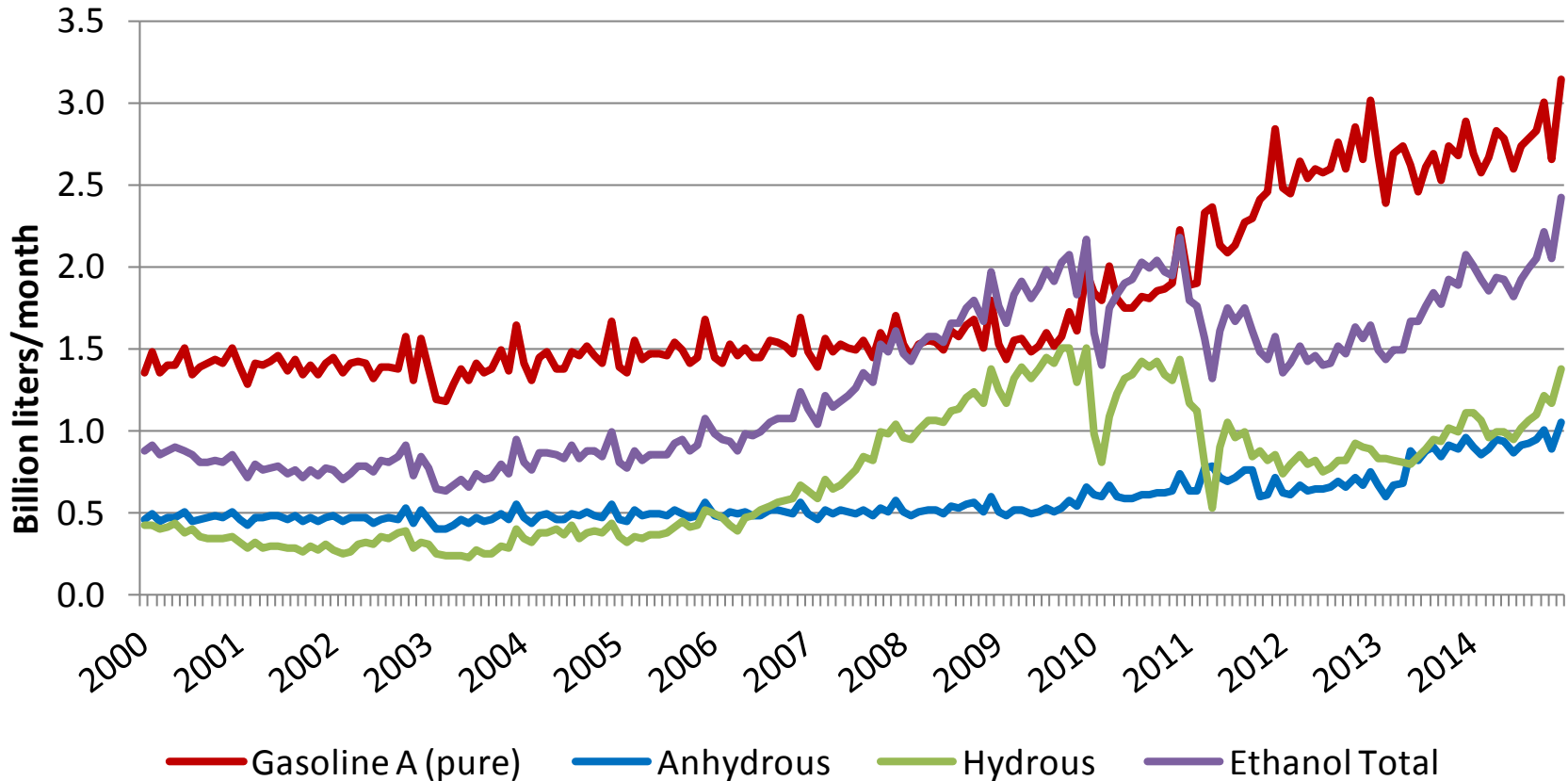
# A large shift in production mix since 2012/13



Fonte: DATAGRO

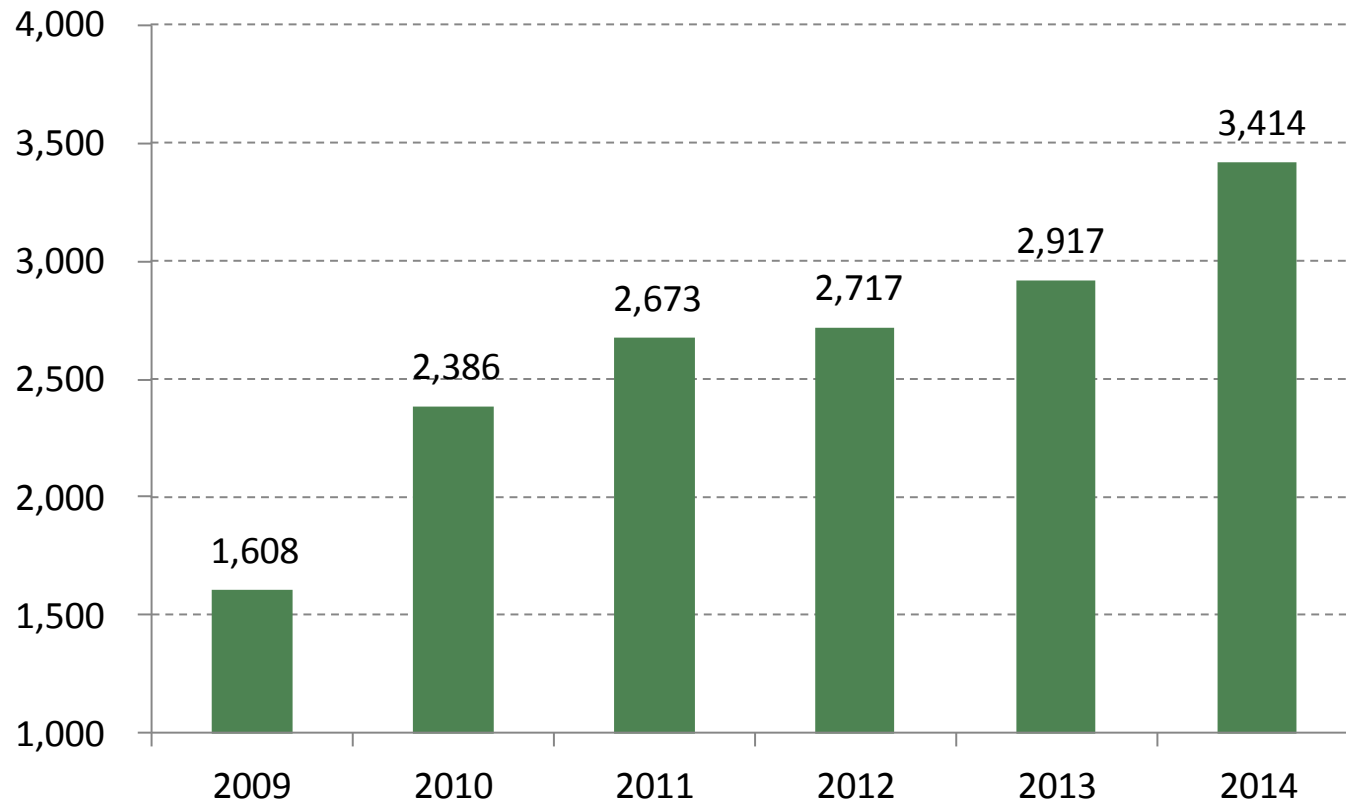
# Consumption as Fuel

(Gasoline, Anhydrous & Hydrous Ethanol, in billion liters/mo)



Source: DATAGRO.

# Biodiesel Production in Brazil (million liters)



Source: ANP/MME.

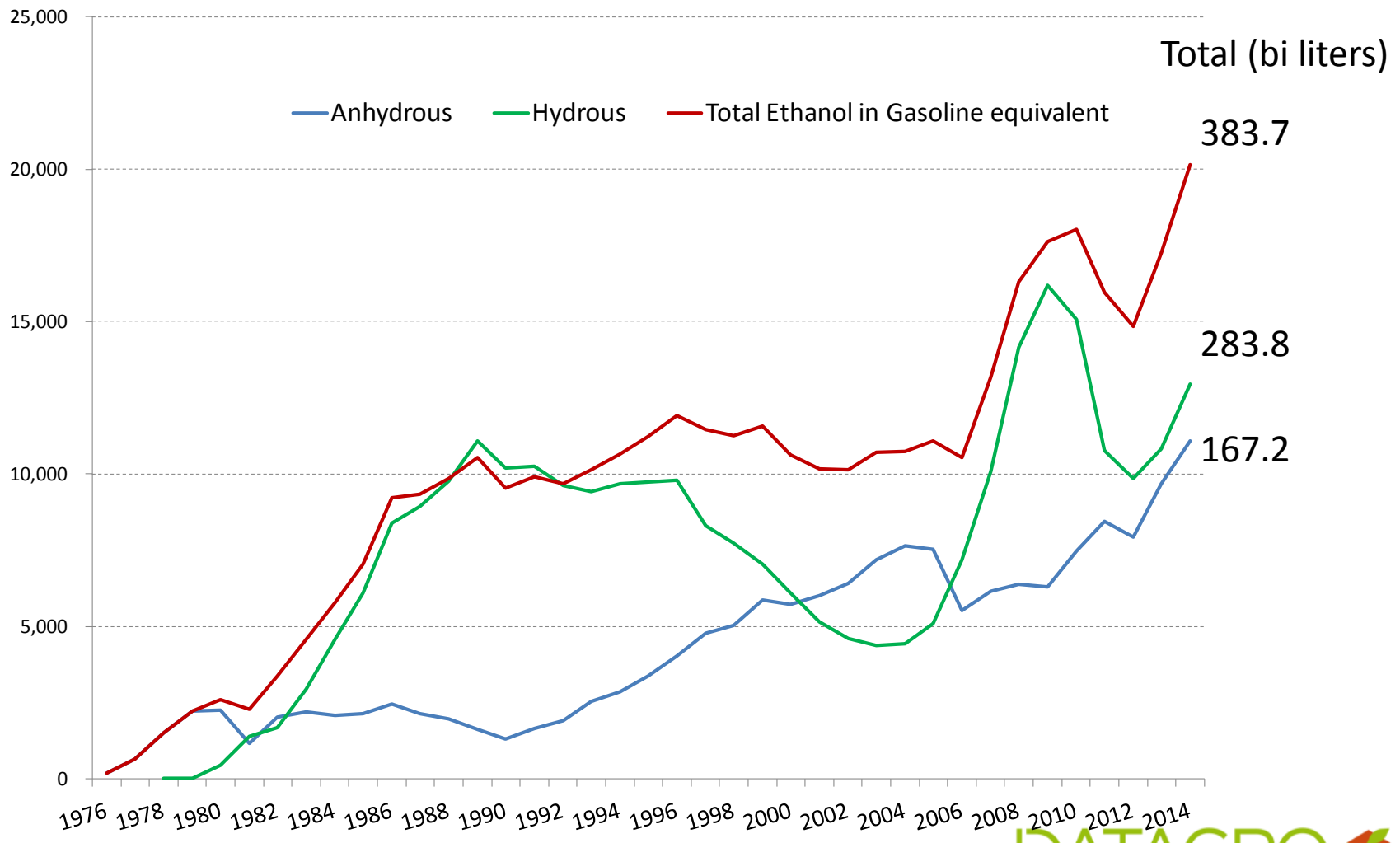
# Avoided Emissions from Biofuels (used as fuel only) in Brazil- 2014

<b>Avoided Emissions</b>				
<b>Source</b>	<b>Industry Average</b>	<b>Best practices</b>	<b>Industry Average</b>	<b>Best practices</b>
	<b>(kg CO2 eq/liter)</b>		<b>(2014 total in 000 tons CO2 eq)</b>	
Anhydrous ethanol	2.564	2.716	28,437.48	30,123.32
Hydrous ethanol	1.722	1.867	22,375.87	24,260.01
Biodiesel (soy)	2.530		8,637.65	
<b>Biofuels total</b>			<b>59,451.00</b>	

Source: DATAGRO.



# Total Volume of Ethanol Used as Fuel (1975-2014) in Gasoline Equivalent (in million liters)



Source: Datagro

# Avoided Emissions from Biofuels used as fuel (only) since 1975

<b>Avoided Emissions - Industry Average</b>		
<b>Source</b>	<b>(kg CO2 eq/liter)</b>	<b>Since 1975, in 000 tons CO2 eq.</b>
Anhydrous ethanol	2.564	428,670.03
Hydrous ethanol	1.722	372,809.56
Biodiesel (soy)	2.530	53,762.50
<b>Biofuels total</b>		<b>855,242.09</b>

Source: DATAGRO.

# Ethanol substituted between 1975-2014 2.41 billion barrels of gasoline



Proved reserves of oil & condensates  
(including Pre-Salt) in 2014:

**13.13 billion barrels (SEC), or  
16.61 billion barrels (SPE/WPC).**



Between 1975 & 2014, volume of  
**gasoline** substituted by ethanol:

**2.41 billion barrels**

At current pace, every year another 127 million barrels  
are substituted without the need of new investments  
**because it is renewable!**

# Hard currency savings

- Between 1975 & 2014, substituted gasoline valued at its world price enabled savings of

**US\$ 185.4 billion**, without considering the cost of foregone debt, or

**US\$ 381.3 billion**, considering the cost of foregone debt

(estimated at Prime Rate + 200 base pts).

Source: DATAGRO

**Brazil's foreign reserves  
(January/2015): US\$ 372.93 billion.**

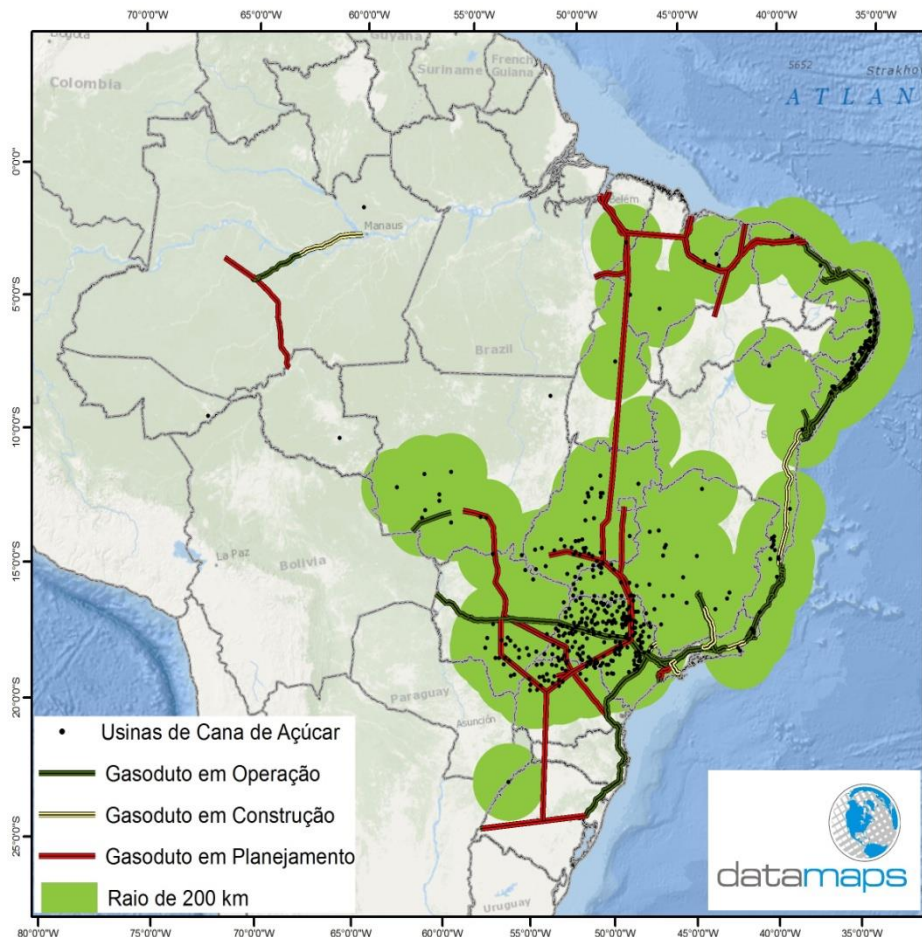


# Additional Potential

- Brazil has great potential for large scale biogas & biomethane use using organic residues from agrindustrial activity and urban waste.
- Large potential for substitution of fossil diesel (biomethane) and power (biogas) in distributed generation.

# Biomethane, Renewable Substitute to Diesel

## Substituição de Diesel a partir do Resíduo de Cana



### *Produção descentralizada*

- 43% da área total do território brasileiro;
- 81% da população brasileira; e
- As principais capitais brasileiras estão a menos de 200km de uma usina sucroenergética.

### *Eficiência logística*

### *Redução das importações*

- Possibilidade de aumentar em U\$ 6,1 bilhões o saldo positivo da Balança Comercial, ao substituir o diesel importado por biometano renovável.

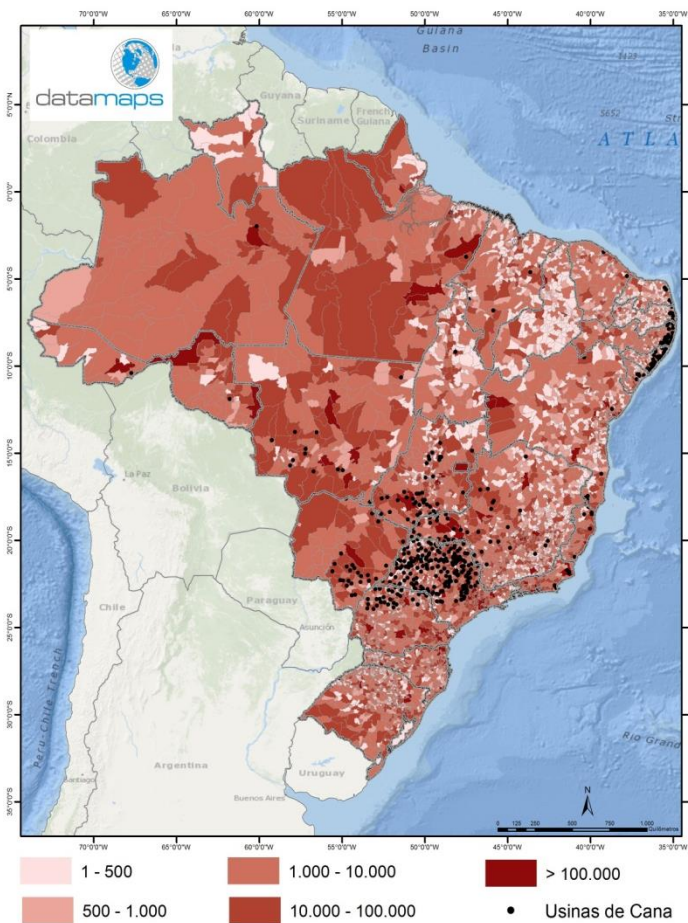
### *Desenvolvimento das regiões rurais*

- Possibilidade de gerar aproximadamente 25 empregos diretos por usina em áreas rurais.

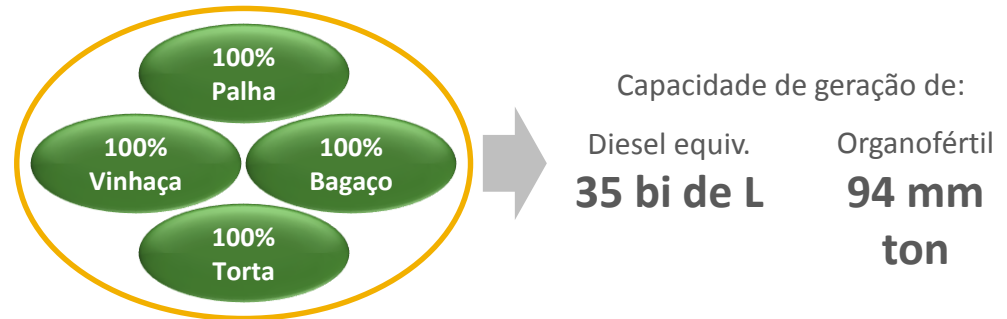
# Independence in diesel imports

*O biometano pode garantir a independência da importação de diesel do Brasil.*

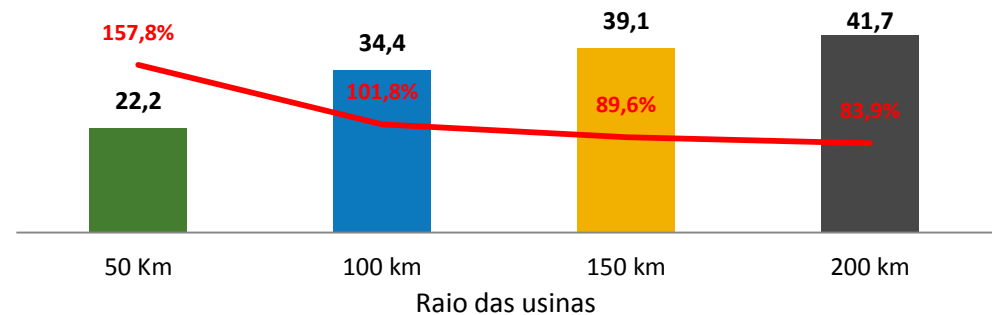
## Usinas e Consumo de diesel no Brasil | mil L



## Potencial GEO Energética



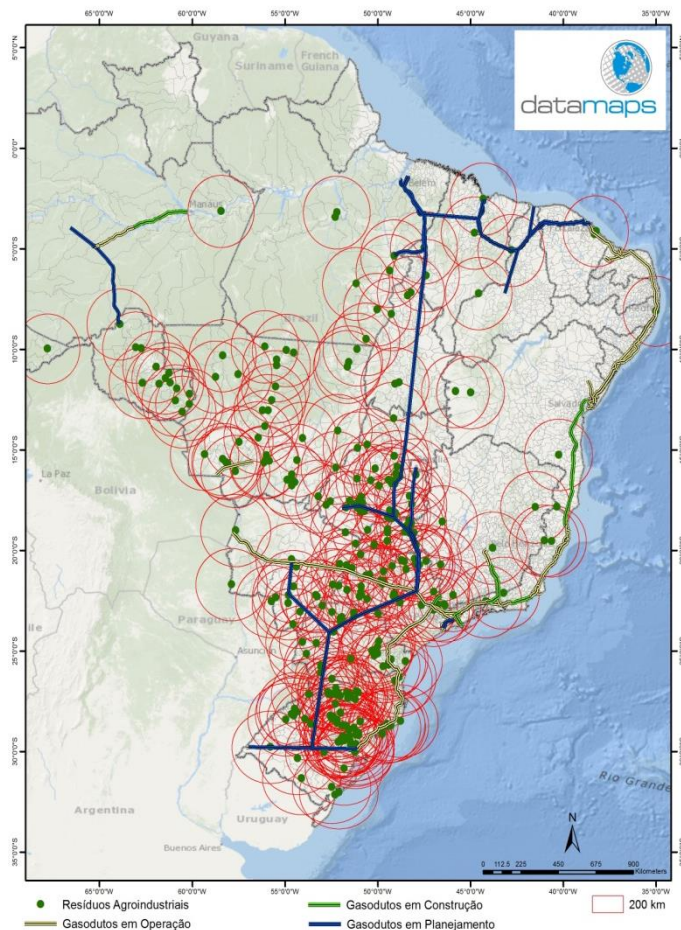
## Consumo de diesel (bi de L) e Potencial de Substituição (%)



- A produção de biometano é capaz de zerar toda a importação de diesel brasileira e reduzir a dependência energética de um produto fóssil
- A produção de adubo orgânico equivale a 9 vezes o consumo brasileiro de fertilizante químico e a 4,5 vezes o total de volume importado

# Organic Residues

## Substituição de Diesel a partir de Resíduos Animais



### *Complementariedade com o modelo de cana*

- As terras destinadas às plantações de cana e à pecuária não ficam localizadas na mesma região garantindo assim uma melhor distribuição pelo território nacional.

### *Alta produtividade na biodigestão*

- Comparado à biodigestão de cana, os resíduos animais apresentaram um produtividade 35% maior.

### *Solução para o problema de resíduos*

- Diferentemente do mercado sucoenergético, os resíduos animais são considerados um problema. A biodigestão é uma solução operacional e economicamente interessante para o mercado.





# PLANTING DATA

HARVESTING SOLUTIONS

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## FUTURE EVENTS CALENDAR

**13 May 2015 (New York Sugar Dinner)**

**9<sup>th</sup> ISO DATAGRO New York Sugar & Ethanol Conference**

Waldorf=Astoria Hotel, New York

**10 July 2015**

**4<sup>th</sup> Sugar & Ethanol Summit – Brazil Day**

IoD – Institute of Directors, London

**25 August 2015**

**4<sup>th</sup> DATAGRO Ceise Br Fenasucro Conference**

Sertaozinho, Brazil

**21-22 September 2015 (Sao Paulo Sugar Dinner)**

**15<sup>th</sup> DATAGRO International Conference on Sugar & Ethanol**

Grand Hyatt São Paulo, Brazil



**PLANTING DATA**

**HARVESTING SOLUTIONS**