



THE WORLD ETHANOL MARKET

by

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World Ethanol

Biomass ethanol has gone long ways to reach the production levels observed today.

US: Henry Ford and his automobile using pure ethanol as fuel, in 1896



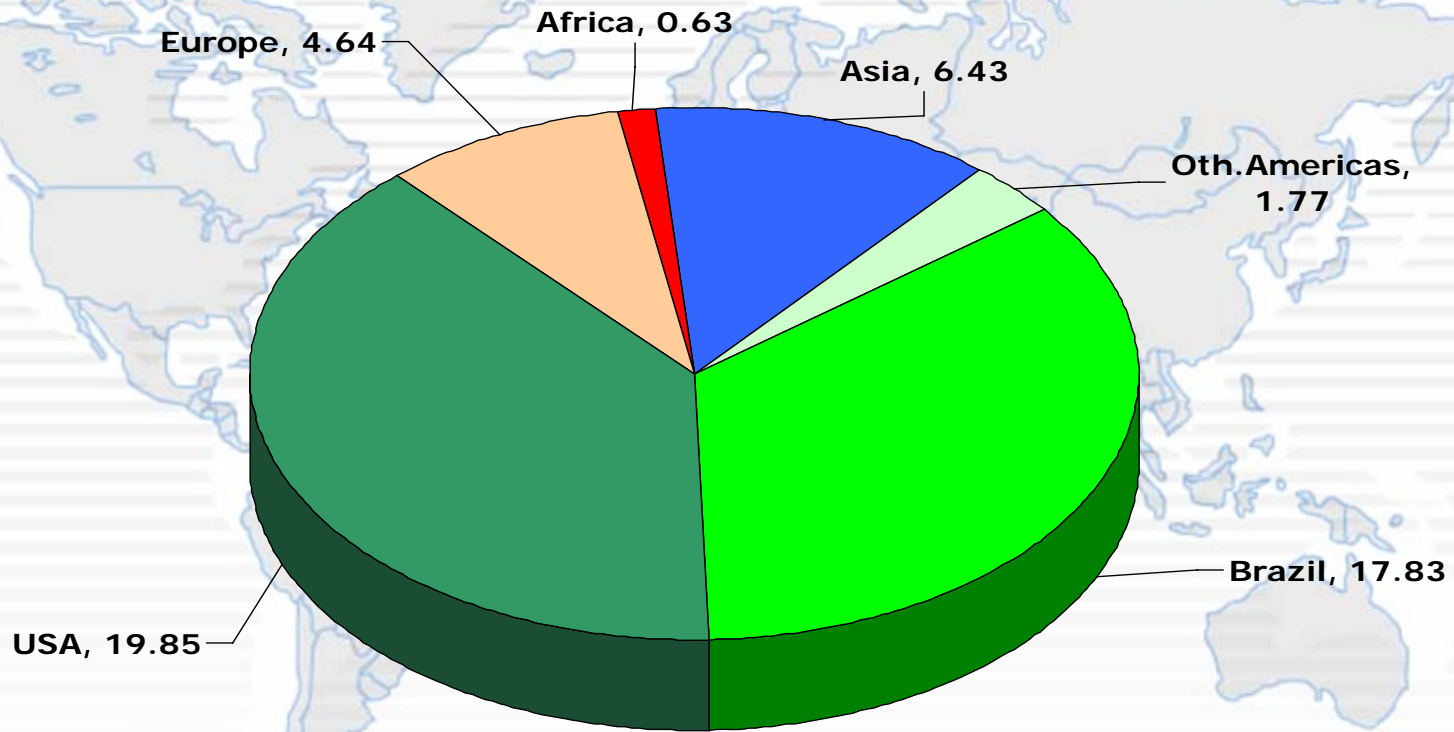
Brazil: ethanol use dates back to 1931 (5% v/v)

First tests made in 1925.



World Ethanol Production

2006 - 51.32 billion liters



57 producing countries in the world

For 2007, world ethanol production projected at 62.6 billion liters,
Or 109.6 million tons of sugar equivalent.

DATAGRO

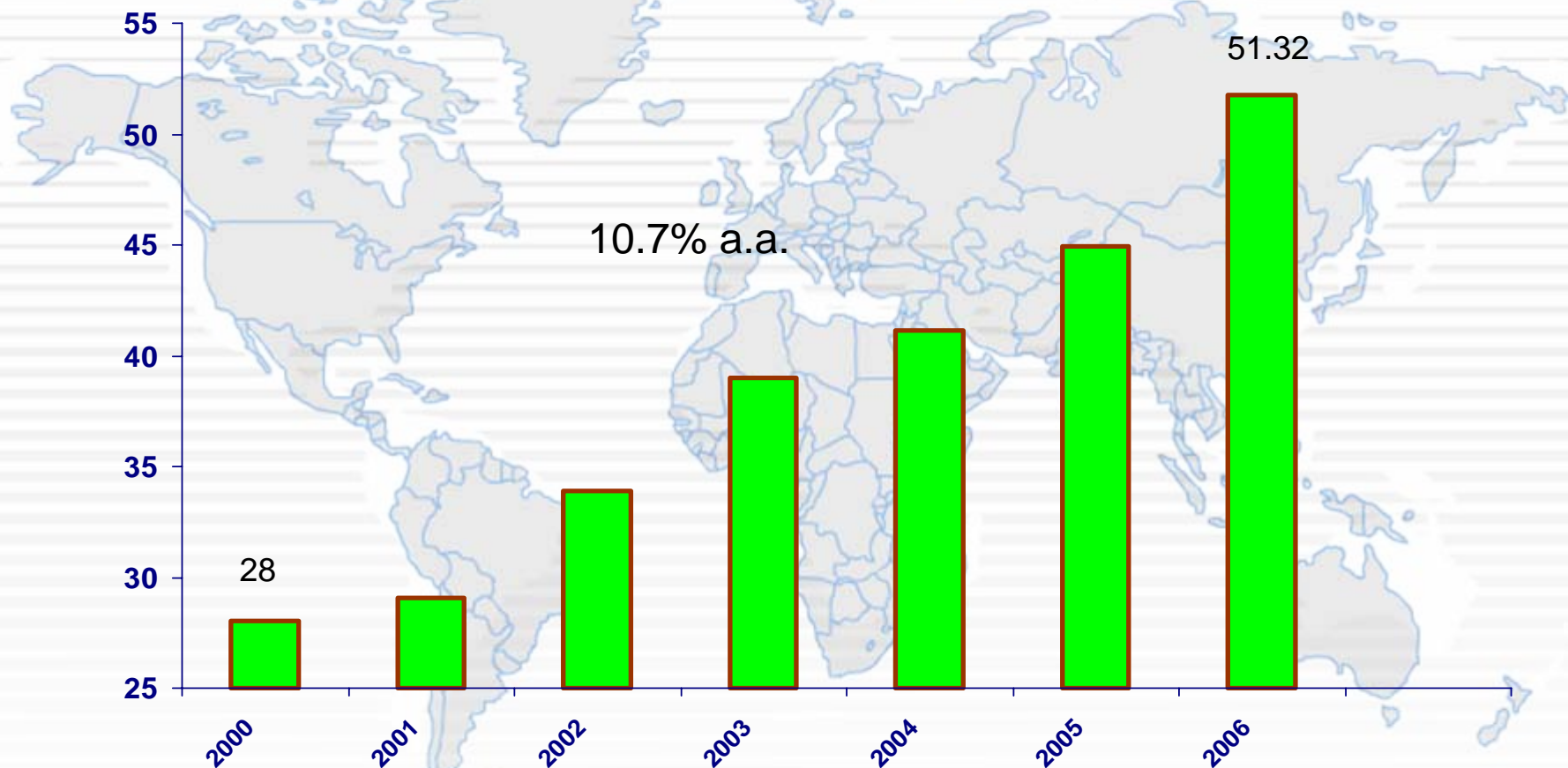
Ethanol market is growing faster than Sugar



- The ethanol market rises at a higher rate than sugar, in Brazil and abroad.
- In the short run, world production and use of ethanol will rise faster than exports.

World Ethanol Production

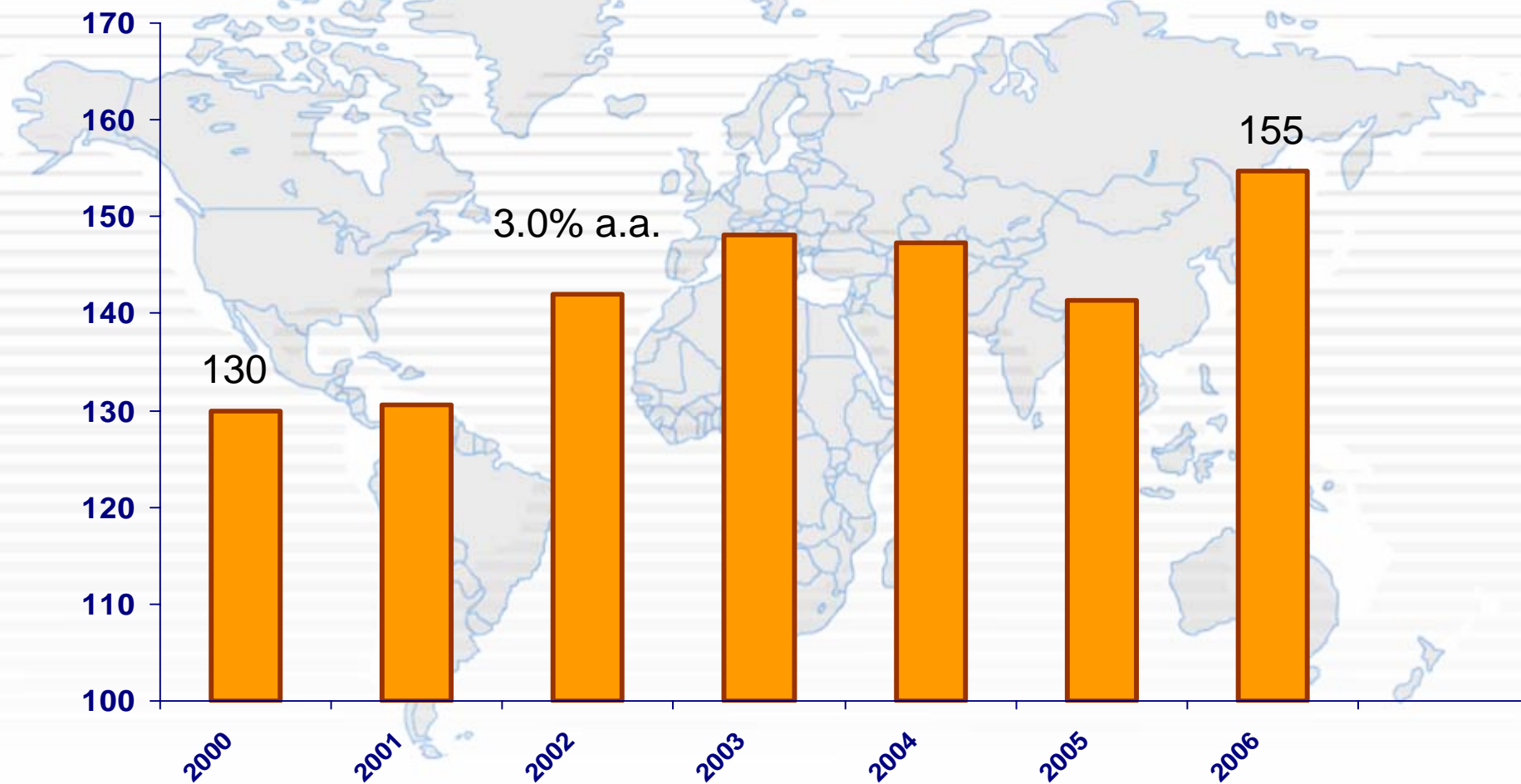
(in billion liters)



Source: Datagro

World Sugar Production

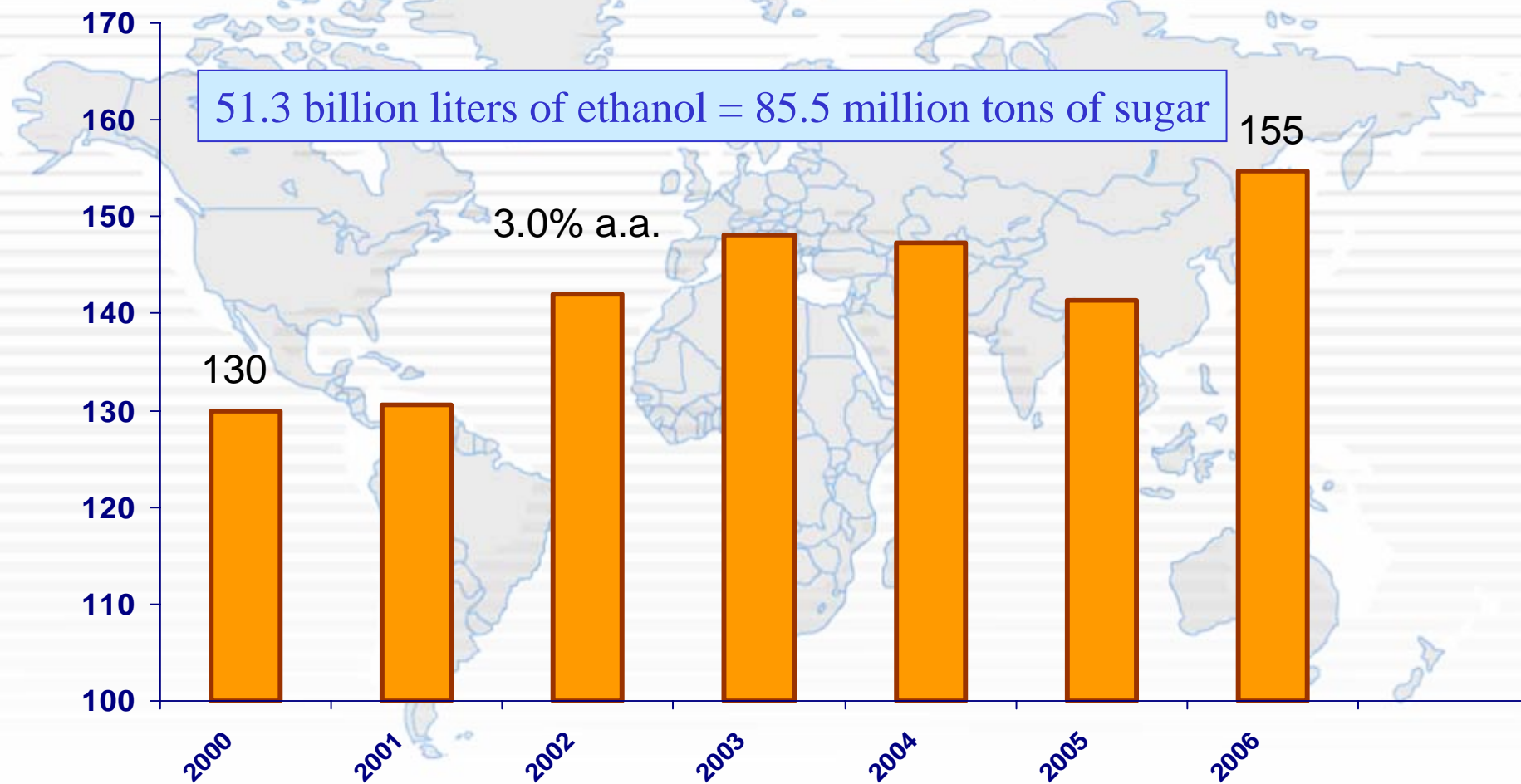
(in million tons raw equivalent)



Source: ISO

World Sugar Production

(in million tons raw equivalent)



Source: ISO

Increasing interest towards ethanol

It is increasingly recognized as one of the few attainable alternatives to solve the 2 most relevant issues of mankind today:

- find a viable replacement to oil;
- Mitigate emission of greenhouse gases that cause global warming.



Still a Drop in the Bucket

- **Brazil** stands out as the country where the use of biomass ethanol represents a large share of energy consumption (2006):
 - **13.2%** (in t.o.e.) of the consumption of energy used in transportation;
 - **36%** (in gasoline equivalent) of the total consumption of Otto-cycle fuels (this % reached 56.9% in 1988).
- In the **USA**, where ethanol production rivals with that of Brazil, ethanol represents **3.4%** of Otto-cycle fuel demand (2006).
- In the world: bioethanol represents
 - 3% of consumption of gasoline, and
 - 0.7% of oil demand, which explains why it is considered a exotic fuel for many.

Potential Market is Very Large

- The world of fuels and petrochemical applications is MUCH larger than the world of sugar.
- Sucrose can substitute starch in existing applications (aminoacids, vitamins, etc);
- Sucrose can become raw material for polyethylene, PET, textile fibers, etc.

Fuels vs Sugar

- 2006: world ethanol production for fuel use is 34.5 billion liters.
- 3% of world demand for gasoline.
- World fuels demand expected to grow 40% until 2020.
- E10 in world's gasoline today
 - =117 billion liters
 - =202 million tons of sugar
 - = 133% of current world sugar demand.



Brazil's current production of Sugar and Ethanol

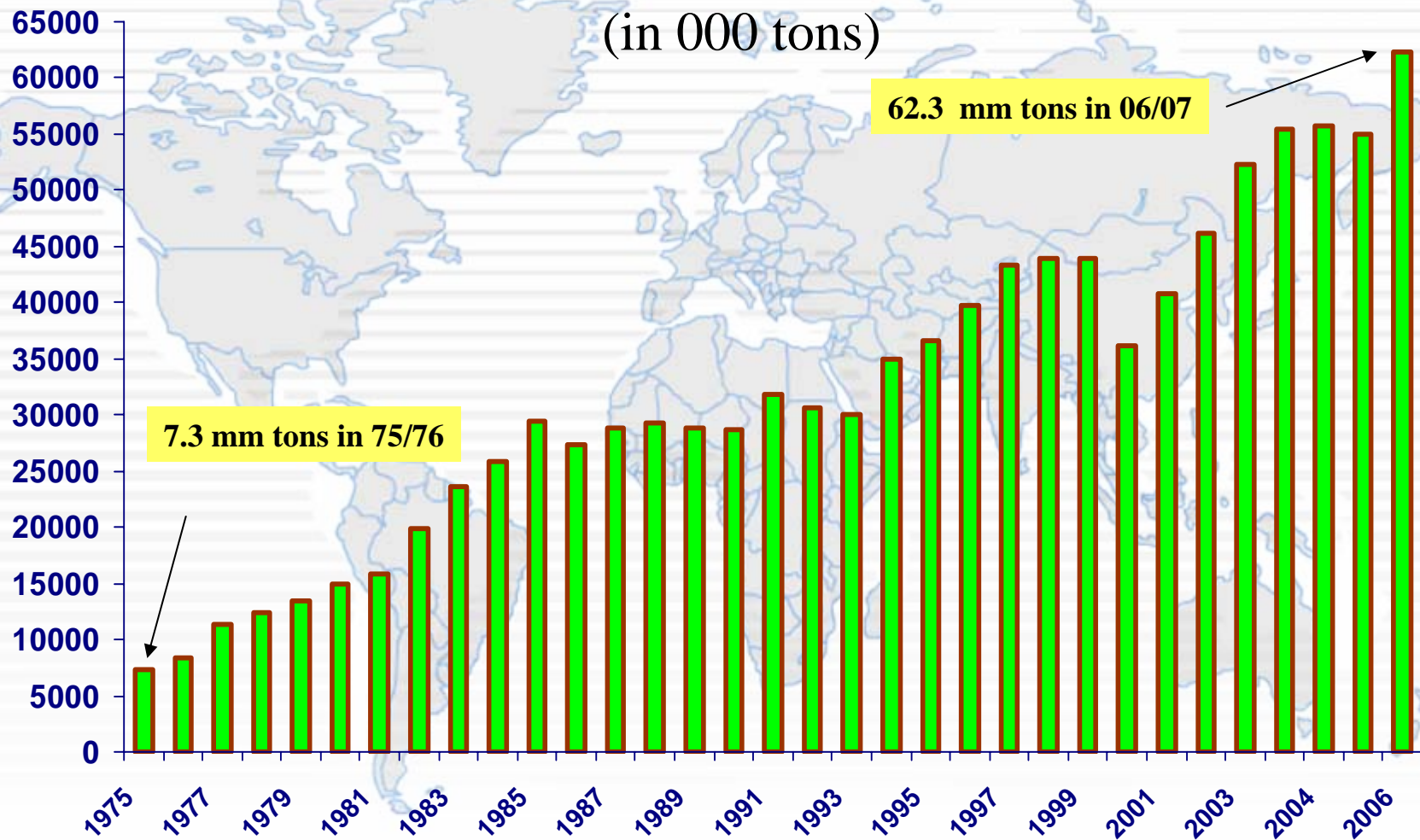
- Sinergy between the production of sugar and ethanol allowed accumulation of capital which enabled expansion during the past 31 years.
- Production in 2006/07 vs 1975/76:

Crop Year	2006/07	1975/76
Cane (milion tons)	428.01	91.52
Sugar (milion tons)	30.05	6.02
Ethanol (billion liters)	17.85	0.56
% sucrose for ethanol	49.5%	13.7%
% sucrose for export sugar	33.5%	19.7%
% sucrose for export ethanol	10.7%	0.0%

Source: Datagro

Supply of Sucrose in Brazil

(in 000 tons)



Source: Datagro

DATAGRO

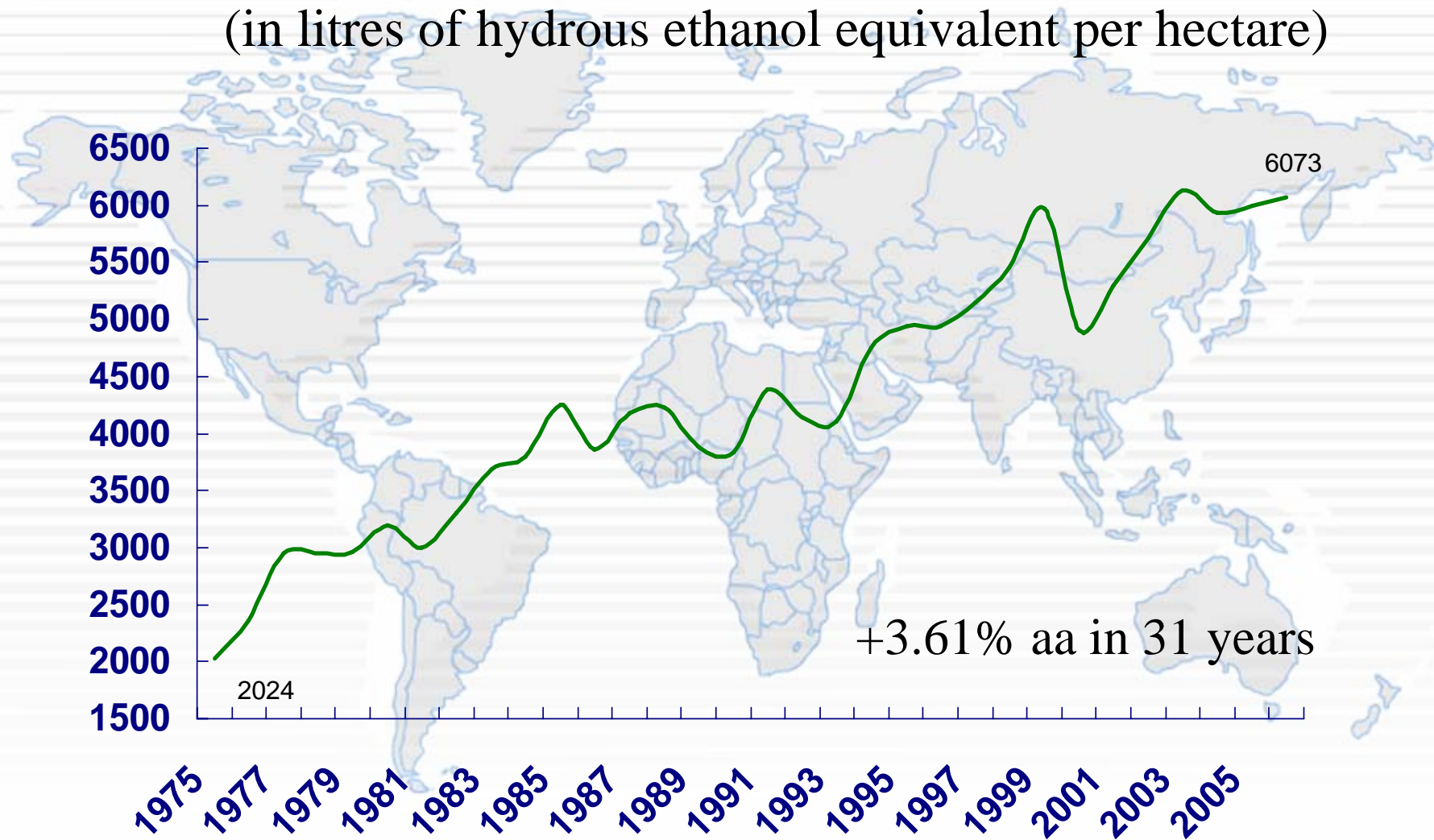
Sugar and Ethanol Market Analysis

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Aver. Agroindustrial Yield – Brasil

(in litres of hydrous ethanol equivalent per hectare)



Source: Datagro

DATAGRO

Sugar and Ethanol Market Analysis

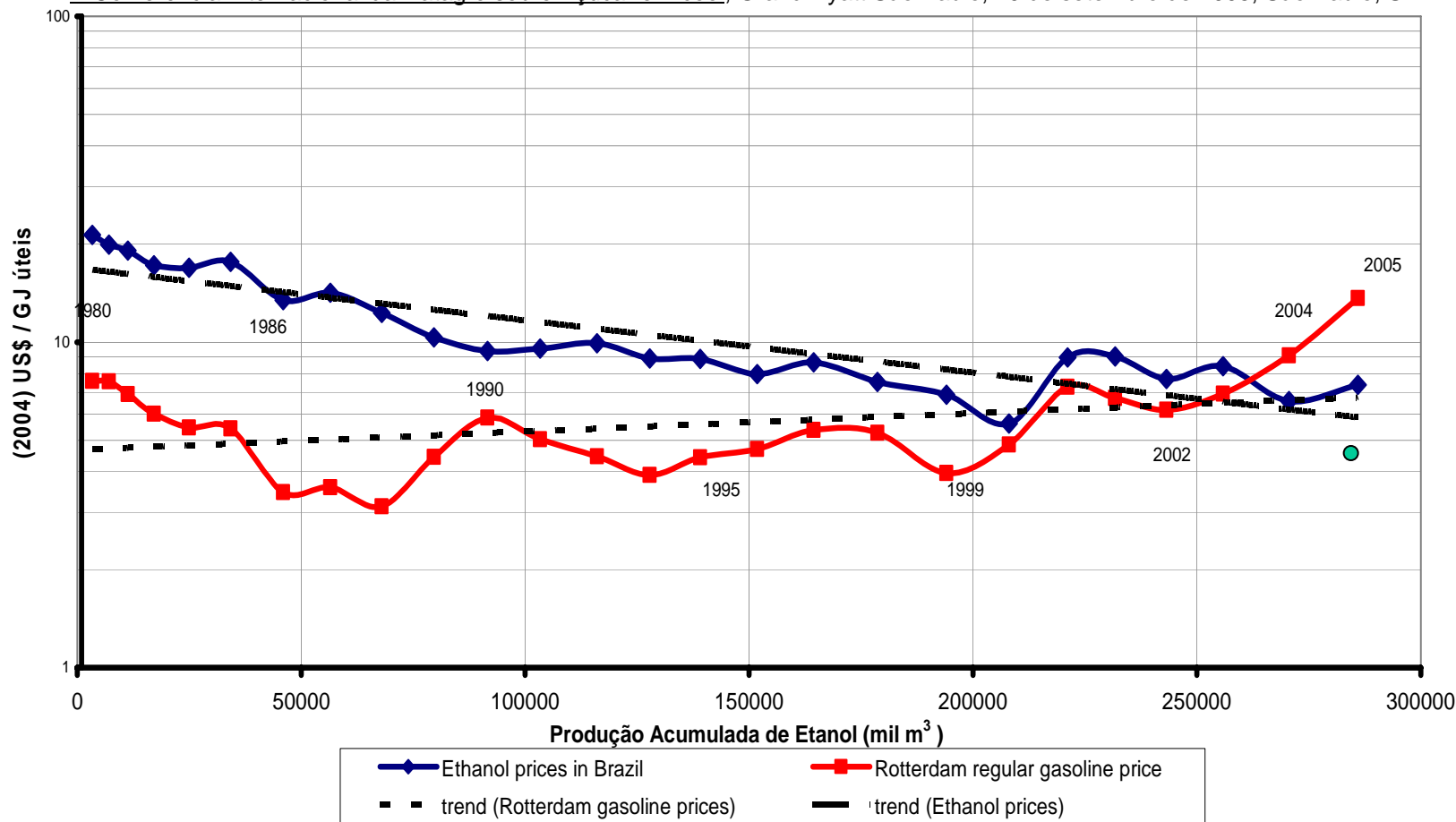
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Learning Curve – Anhydrous Ethanol

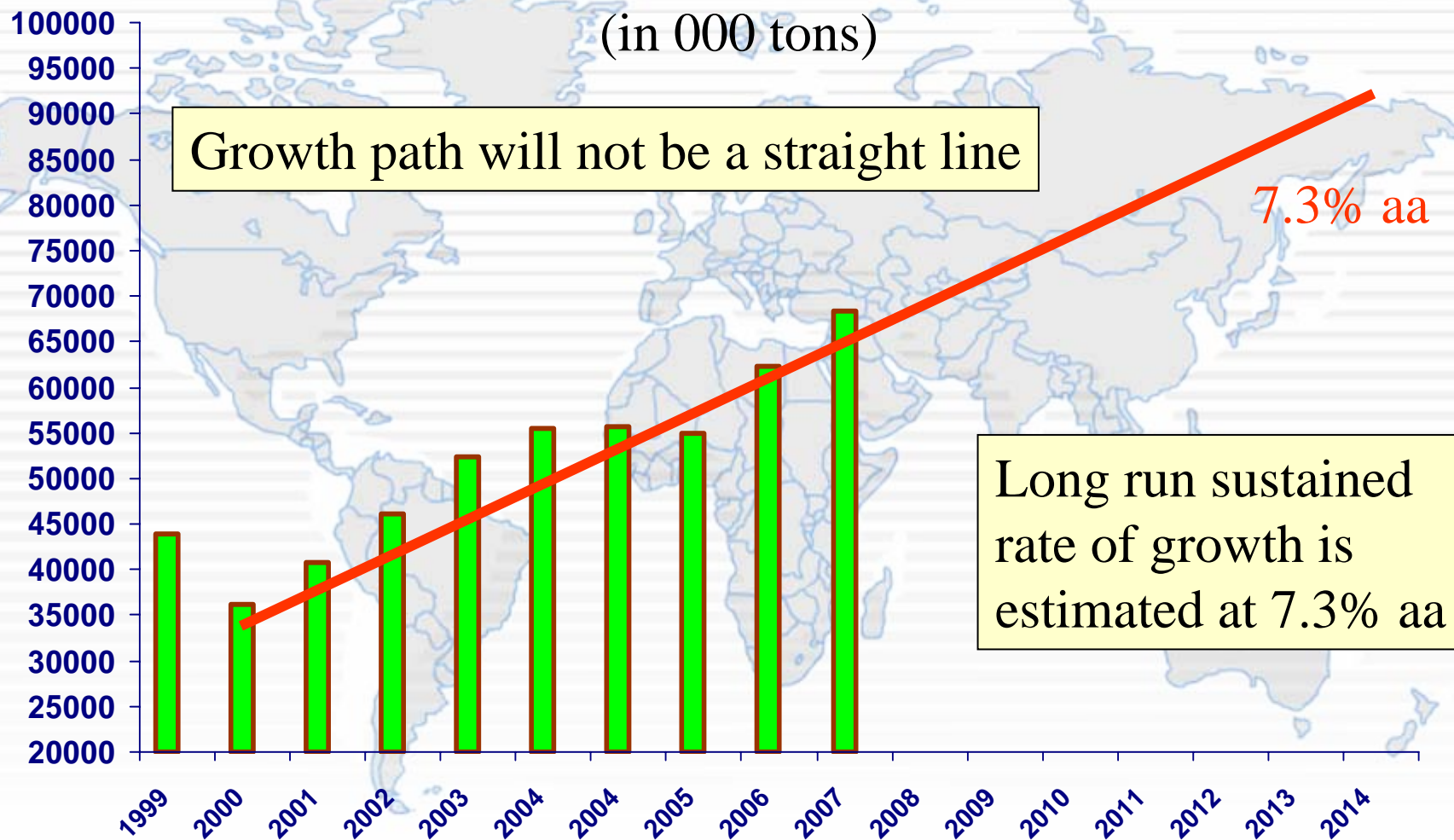
2002

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.



Supply of Sucrose in Brazil

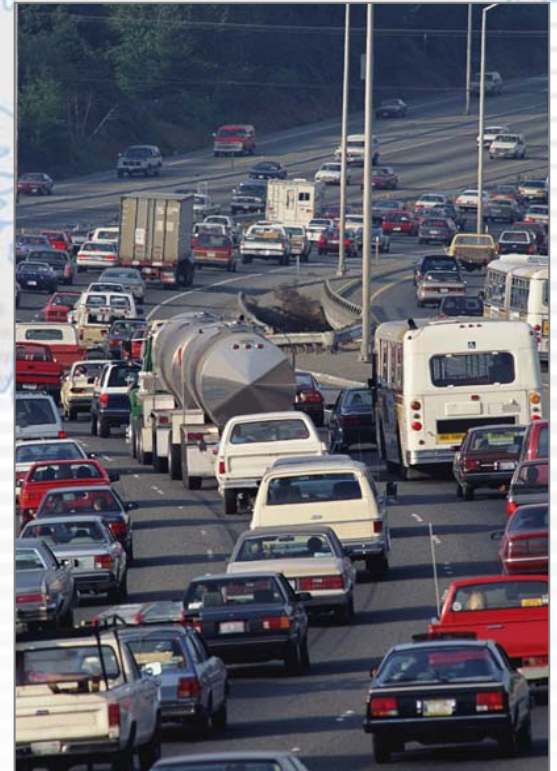
(in 000 tons)



Source: Datagro

The Flex Fleet as the Lung of the System

- With this perspective, the **flex fleet** can work as the ‘**lung**’ of the system, absorbing TRS surplus.
- Flex fleet brought **greater price-elasticity to fuel demand** in the short-run.
- Many are not taking this effect into account.
- Over time, reduces the importance of surplus stats on world S&D.



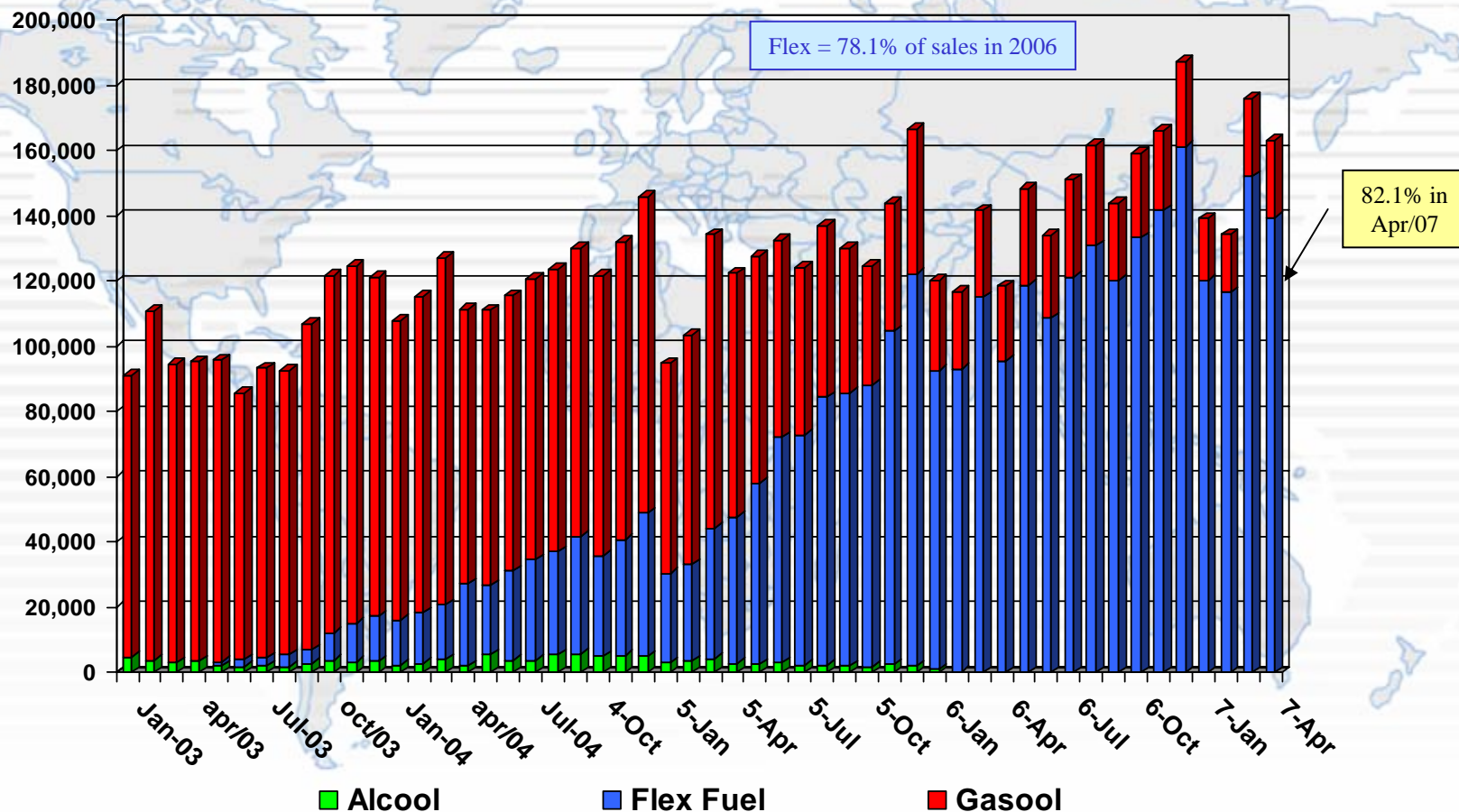
The Flex Revolution

- **Flex cars launched in March 2003.**
- **In June 2007 already represented 85% of total vehicle sales.**
 - **In Dec/06 flex fleet totalled 2.629 million cars, growing at the rate of ~1.6 million/year.**
 - **Consumption/vehicle is a function of vehicle age. On average is 200 l/v/m, or 2.4 m³/y, when using hydrous ethanol.**
 - **Potential annual rise in demand (100% flex cars using ethanol): $1.6 \times 2.4 = 3.84$ bi liters of hydrous = 6.2 mio tons sugar.**



Sales of Vehicle by Type of Fuel

January 2003 to April 2007



Source: Anfavea

The 'flex' impact overtime

- In 5 years, the flex fleet will be ~9.2 million vehicles.
- By then, a small 10% swing in fuel use preference will be equal to 2.2 billion liters hydrous/year, or equivalent to 3.6 mio tons of sugar/year.
- World S&D for sugar and ethanol will be very dependent on relative prices of ethanol and gasoline.



The explosive expansion in the US



2006

- Production of 19.85 billion liters, from 6.5 billion liters in 2000.
- Ethanol fuel: 3.4% of gasoline pool.

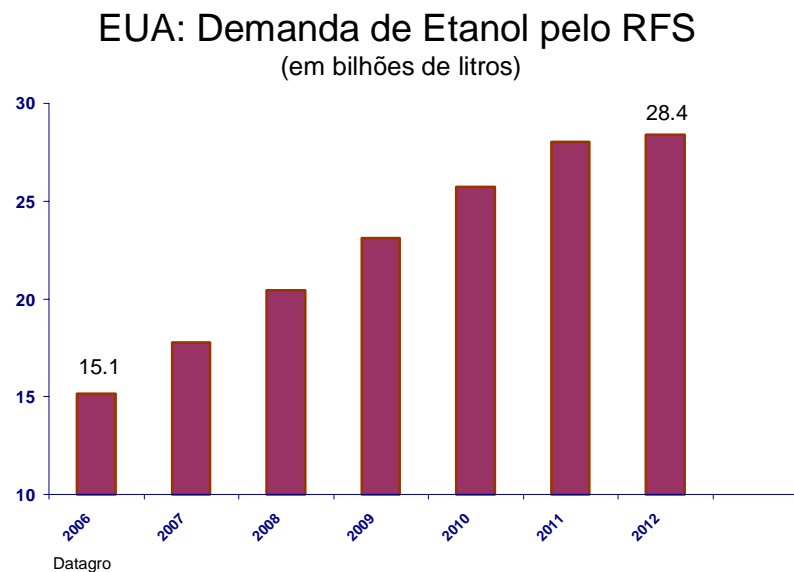
Capacity:

- 2007(1Q): 22.3 billion liters
- +12 billion liters under construction.
- Projects under evaluation: +66 billion liters of capacity
- Total capacity can grow to 100 billion liters.

Ethanol Demand in the US

Main factors until recently

- Substitution of MTBE
- Renewable Fuels Standard (RFS)
 - Rise in fuel demand from 15.1 to 28.4 billion liters (2006-2012).



Other Factors in the US Market

Other factors

- State mandates:
 - Minnesota: 10%, going to 20% (2010)
 - 10% (E10): Montana (2006), Louisiana (2007), Washington and Missouri (2008).
 - 20%: Nebraska considering.
- E85
 - >6 million flex cars already running.
 - Only 800 E85 pumps out of total 119,000
 - Introduction of legislation to provide incentives for more E85 pumps.
- Gasoline demand in the US (2006)
 - 540 billion liters, or 9.2 million barrels/day, or 46% of world demand, of 20.1 million b/d.



New Targets for Renewables in the US

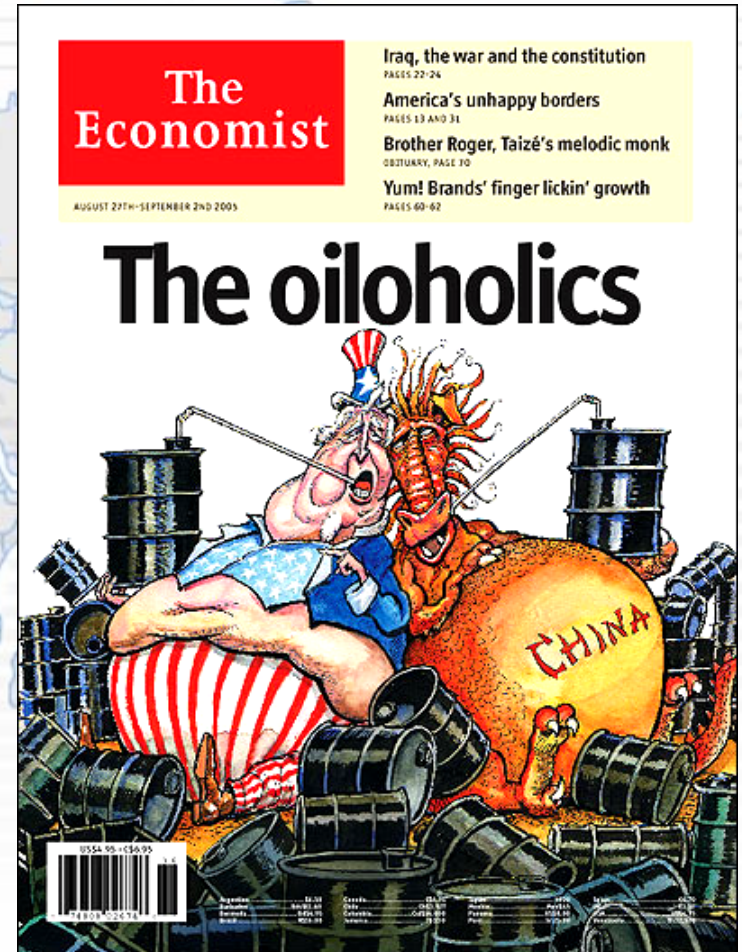
Pres. Bush (State of Union 2007)

- Until 2017: substitute 20% of all gasoline = 132 billion liters of renewables (AFS).

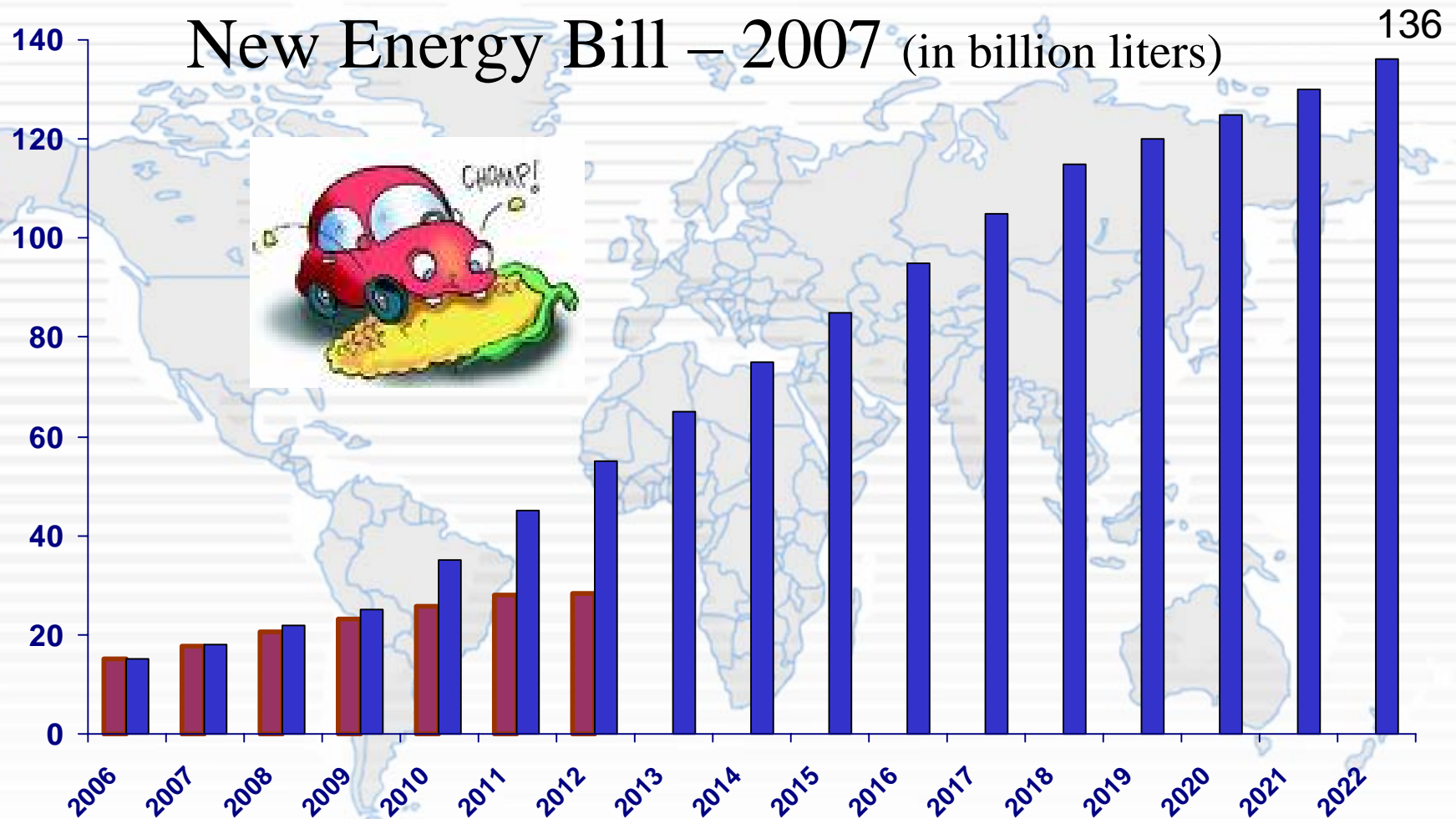


“America is addicted to oil, which is often imported from unstable parts of the world.”

President Bush's State of the Union Address—
January 31, 2006



Demand for Renewables from RFS and New Energy Bill – 2007 (in billion liters)



Datagro

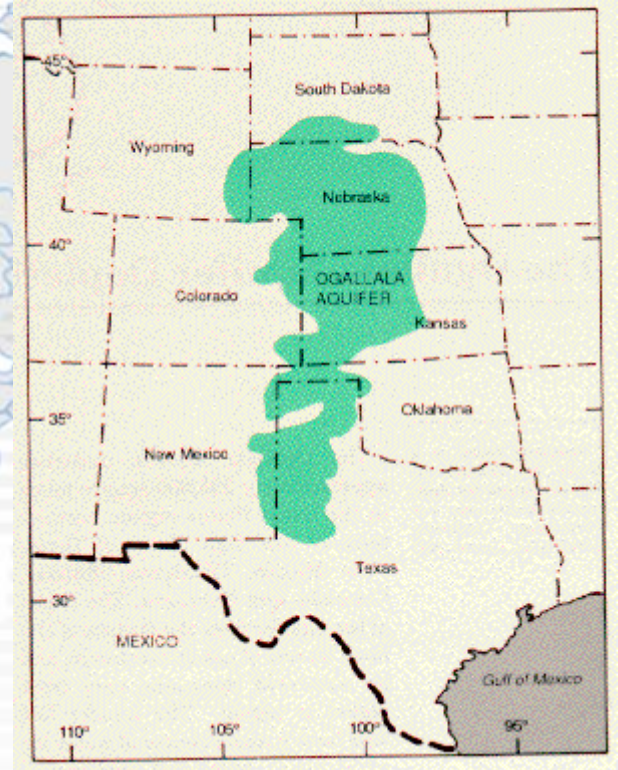
Limit to US Corn

- Depends on how much corn can be dedicated to ethanol, or,
- How soon technologies for ethanol from cellulose become applicable.
- 2006: 22% of all corn available in US, 53 million tons, is converted to ethanol.
- When production rises to 34 billion liters, corn use will be 90 million tons, 37% of current supply.
- Corn is also basic feedstock for:
 - Glucose and fructose: +50% of US sweeteners
 - Key ingredient for cattle, pork and poultry feed
 - Industrial applications
 - Human food.



Limits to US corn

- The ag frontier is determined by the availability of water.
- US has enough land – but no water.
- Depletion of Ogallala aquifer, largest groundwater reservoir, a prime example.
- Water from Ogallala mostly used for irrigation.
- At current rate, 6% of reserve used every 25 years, or 12 trillion liters/y.
- Biggest problem: no one really knows how long it will last.



Limits to US corn

- Ethanol frenzy is already causing substitution of soy land to corn.
- Main factor behind recovery in soy and meat prices.
- Ethanol is affecting world corn, soy, and meat prices.
- Limit to US corn ethanol is related to what price of corn will turn corn ethanol uncompetitive with gasoline.

	Nov/10/06	1995/96
Price of Corn (US\$/bu)	3.40	5.50
Cost of corn ethanol (US\$/gallon)		
w/o recov.invest.	1.75	2.53
w/ recov. Invest.	2.00	2.78

Source: Datagro



Ethanol in Europe

- 2006: Production 4.64 billion liters, from 3.65 billion liters (2000).

Ethanol Production in Europe (million liters)		
Country Bloc	2000	2006 (estim.)
EU	2.41	3.40
France	0.81	0.95
Germany	0.29	0.75
Spain	0.15	0.46
U.K.	0.44	0.28
Poland	0.16	0.25
Russia	0.62	0.65
Ukraine	0.21	0.27
Others	0.41	0.28
EUROPE	3.65	4.60

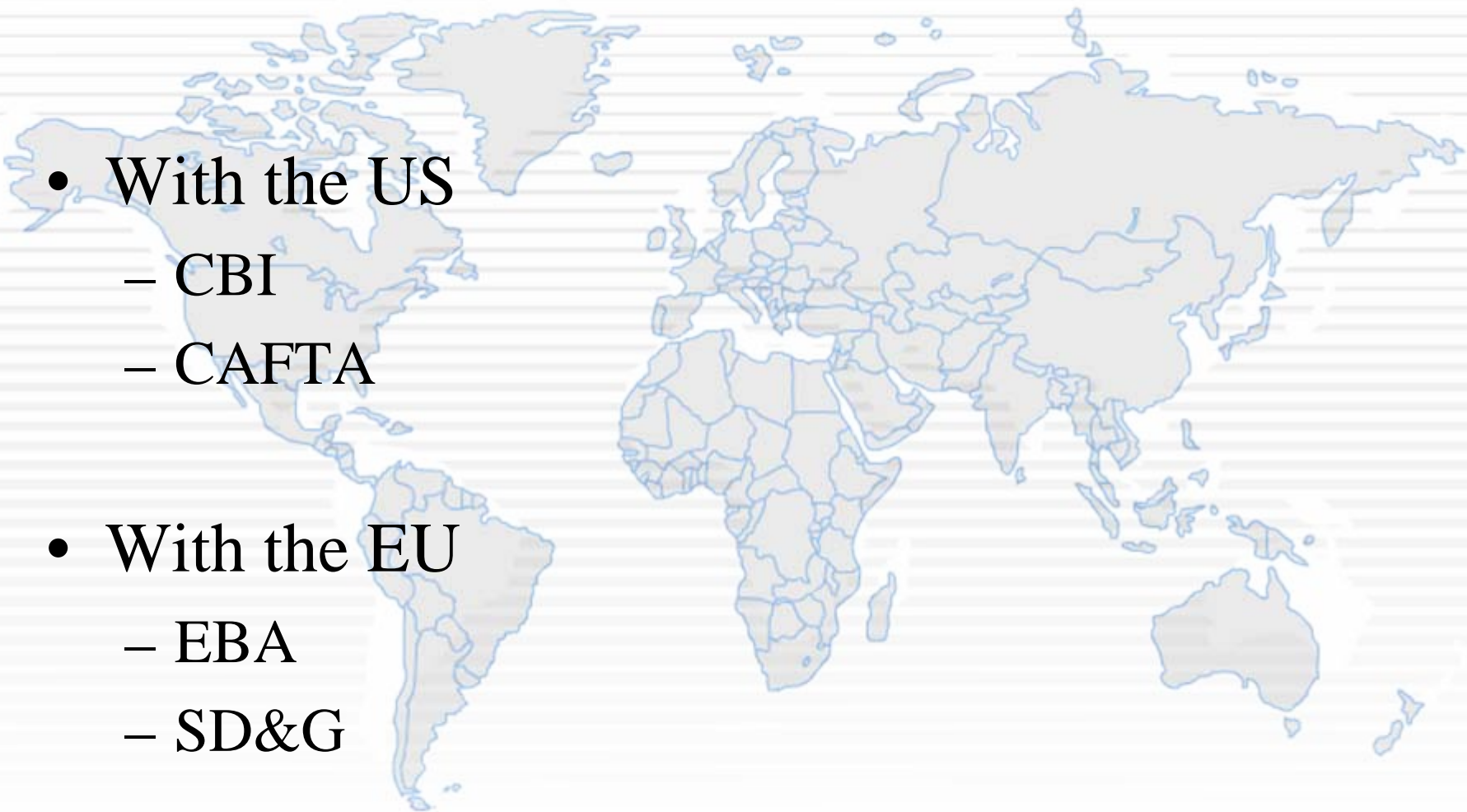
Ethanol in Europe

- **EU reducing sugar exports by 6.2 million tons (7.5 -> 1.3 million tons).**
- **Ethanol capacity expansion is by volume almost equivalent (6% higher) to that equiv. amount of sugar: 4.1 billion liters.**
- **France: 5.75% (2008)**
- **Sweden: 5.75% (2006)**
- **Germany: concentrated on ETBE, direct blending start in 2007.**

EU Ethanol Capacity Expansion	
Country Bloc	Volume in million liters
EU	
France	1.20
Spain	0.88
Belgium	0.57
Netherlands	0.44
Germany	0.23
Austria	0.19
U.K.	0.19
Sweden	0.15

Ethanol in Beneficiaries of PTA's

- With the US
 - CBI
 - CAFTA
- With the EU
 - EBA
 - SD&G



PTA Beneficiaries with US

CBI

- Free access to volume max. 7% of US ethanol demand.
- Mostly used for Brazilian ethanol dehydration, and in the past EU wine ethanol.
- Dehydration plants: Costa Rica, El Salvador, Jamaica.
- Volumes:
 - 2005: 354 million liters
 - 2006: 470 million liters
 - Window: 1,330 million liters (2007)

PTA Beneficiaries with US

CAFTA (signed Aug 04)

- Duty free with no quantitative limitation.
- Partners: Costa Rica, Dominican Rep., El Salvador, Guatemala, Honduras, Nicaragua.
- Most advanced: El Salvador.
 - Sustained solution for local competition with gasoline, and relationship mills-cane suppliers.
 - Drafted legislation.
 - Initiated investments.

PTA Beneficiaries with the EU

EU's General System of Preferences

- Everything But Arms Initiative, EBA (with 50 LDC's)
- Sustained Development and Governance Beneficiaries, SD&G (14 countries, mostly in Latin America).

Non-beneficiaries import-duty

- 19.2 cents Euro/liter undenatured
- 10.2 cents Euro/liter denatured.

PTA Beneficiaries with the EU

Interest, and in some cases investments

- EBA: Angola, Mozambique, Sudan, Tanzania, Zambia.
- SD&G: Bolivia, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Panama, Peru.

Other Initiatives

- Argentina
 - 5% mandated blending of ethanol and biodiesel, 2010.
 - Market: 600 million liters ethanol/year
 - 2006: production 170 million liters.
- Canada
 - Expected to announce 5% ethanol mandate
 - Market: 2 billion liters ethanol/year,
 - 2006: production 580 million liters.

Ethanol in Asia

China's Production

- 2006: 3.85 billion liters
- 2000: 2.97 billion liters.
- 18-20% of world's corn, 143 million tons (2006).
- Corn demand rising rapidly = exports diminishing.
- Ethanol = 2% gasoline pool.

Ethanol in Asia



India

- After many stops & goes, (re)introduction of 5% nationwide mandate, starting Oct/06.
- Production to grow from 450 to 615 million liters in 2007.

Ethanol in Asia

Thailand

- Gasohol demand is rising
- Ethanol demand (2006) 750 million liters.
- Production (2006) 350 million liters.

Ethanol in Asia

Japan

- PM Shinzo Abe instructed his government to take measures to boost annual use of bio-ethanol to 6 billion liters, equivalent to 10 percent of current gasoline usage. In his words, "...to protect the environment, revitalize regional economies and energize agricultural activities, the government will work on lifting the proportion of biofuels in gasoline consumption."
- In spite of all the interest, it looks like Japan will go for now with:
 - 7% ETBE in 20% of gasoline (premium) = 320 million liters of ethanol demand.

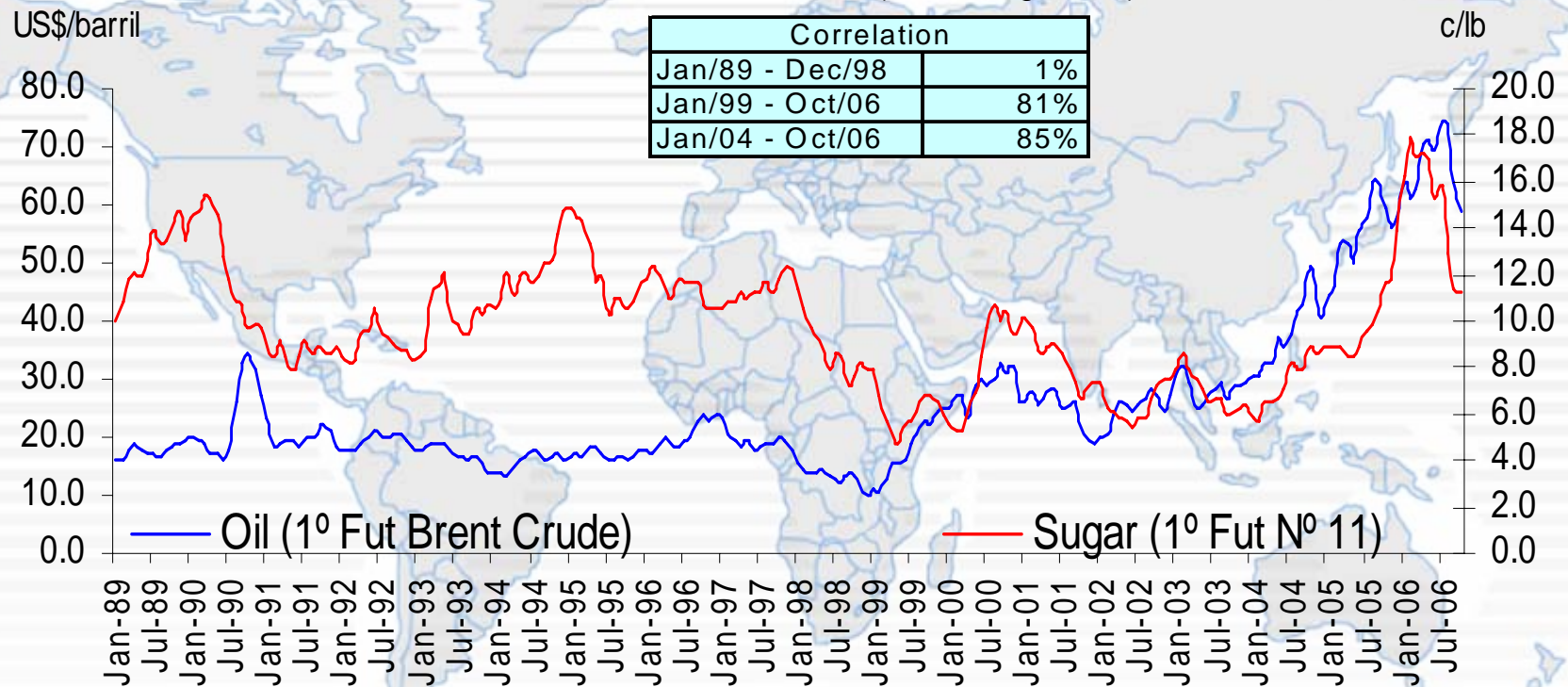
Markets are becoming interconnected

- Due to ethanol, prices of ag commodities are increasingly correlated to energy commodities,
 - via sugar, and
 - via corn.



Sugar and Petroleum: the ethanol link

Source: DATAGRO (www.datagro.com)



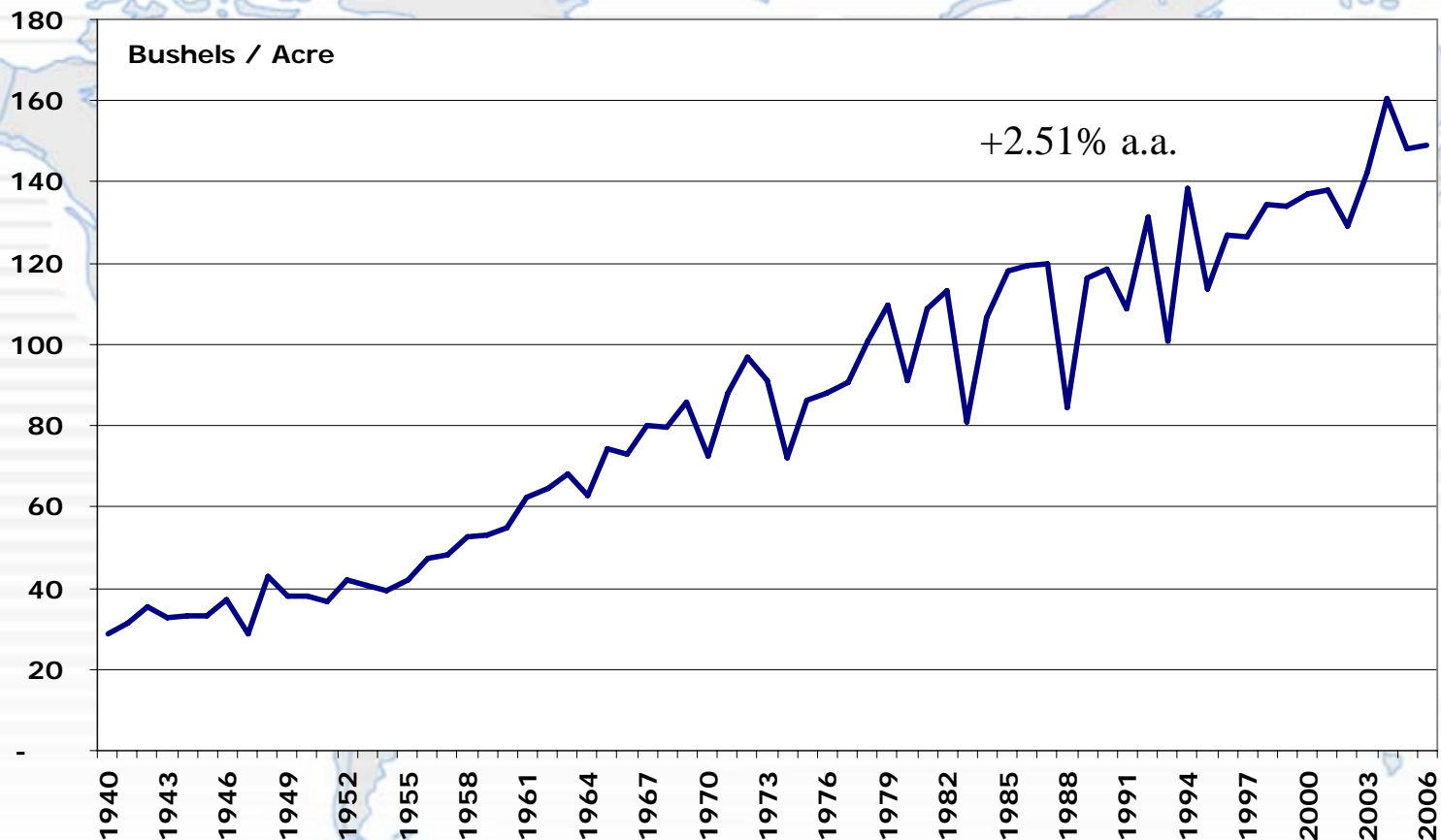
Source: Datagro

Challenges – Corn Ethanol

- Ethanol demand is growing faster than projected expansion in corn productivity (+2.5% aa).
- Anything that can speed up this rate is welcomed.

Agricultural Yield – US Corn

(1940 – 2006, in bushels/acre)



Source: USDA

Analysis: DATAGRO

Challenges – Cane Ethanol

- Use better sugar cane residues.
- Ethanol from cellulose:
 - Dedini (low acid conversion – DHR process): announced cost of 27 cents US\$/liter / immediate application;
 - NREL (ex-SERI), (mixed acid-enzymatic conversion): cost estimated to be equal to Brazil's in 10 years. Cost of collection leads to need of further refining of technology, which could be implemented in Brazil due to low cost of collection.
 - Cost of collection:
 - US\$ 2.5 – 4 /GJ in Northern hemisphere countries (US\$ 20-60/ton);
 - US\$ 0/GJ for bagasse, and US\$ 1/GJ for cane leaves in Brazil.

Comparative Costs

Comparative Average Cost ex-works - December 2006			
Country	Assumption	Ethanol (US\$/liter)	Sugar (US\$/ton)
Brazil - CS	Forex R\$2.15/\$	0.298	177.2
USA	Corn \$2.1/bu	0.370	308.6
USA	Corn \$4.3/bu	0.581	345.6
USA	Aver.cost fr cane	0.686	407.9
EU	Average	1.278	760.0
EU	Most efficient	0.908	540.0
Australia	Average	0.395	235.0
Thailand	Average	0.426	253.0
Guatemala	Average	0.538	320.0

Source: Datagro

Corn & Sugar Cane as Feedstocks

Main elements	CORN	SUGAR CANE
Feedstock	starch	sucrose
Agrindustrial yield (liters/hectare)	3600	6100
Energy Balance (ER)	1.3	8.9
GHG emission saved (t CO2 eq/kl)	0.9	2.4
GHG emission from bio-ethanol	1.9	0.4
GHG emission from gasoline	2.8	2.8
Competitiveness based on	Price of corn Price of crude	Cost of cane Price of crude Forex
Production economics	Optimized	Not optimized (cane not fully utilized yet)
Future perspective	fn of speed of rise in corn productivity	fn of speed in econ use of cane residues
Limits to growth	fn of availability of land & water	uses relatively little land
Food vs fuel	increasingly a issue	little impact from cane

Source: Datagro

Fuel Cells

- Fuel cells with on-board reform may represent a great opportunity for ethanol. Electric car using a liquid fuel.
- Internal combustion engine (thermodynamic efficiency):
 - Otto cycle, gasoline 26-28%
 - Otto cycle, ethanol 29-32%
 - Diesel cycle 34-36%
- Fuel cells: 55%-65%
- Hydrogen:carbon ratio
 - Methanol 4 : 1
 - Ethanol 3 : 1
 - Gasoline 1.83 : 1 (indolene)

Exothermic reaction
Heavy materials

The Future

- Ethanol has a brilliant future, due to the size of the world fuels market, and its potential use not only in fuel, but also petrochemical applications.
- Biomass ethanol increases accessibility & income in LDCs.
- Cane ethanol can extend the usage of grain (corn and wheat) ethanol beyond the food vs. fuel controversy.





www.datagro.com