The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific
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Energy Agency

ICTP Experts Meeting on "Science & Renewable Energy"
January 15 - 18, 2007

Venue: ICTP Adriatico Guest House - Lundqvist Lecture Hall

310/1905

"Brazilian Experience in the Use & Promotion of Renewable Energy"

P. Guardabassi
University of Sào Paulo
Brazil

Strada Costiera 11, 34014 Trieste, Italy - Tel. +39 040 2240 111; Fax +39 040 224 163 - sci_info@ictp.it, www.ictp.it

Brazilian Experience in the Use and Promotion of Renewable Energy

Patricia Guardabassi

CENBIO – The Brazilian Reference Center on Biomass
University of São Paulo

Trieste,15 January 2007

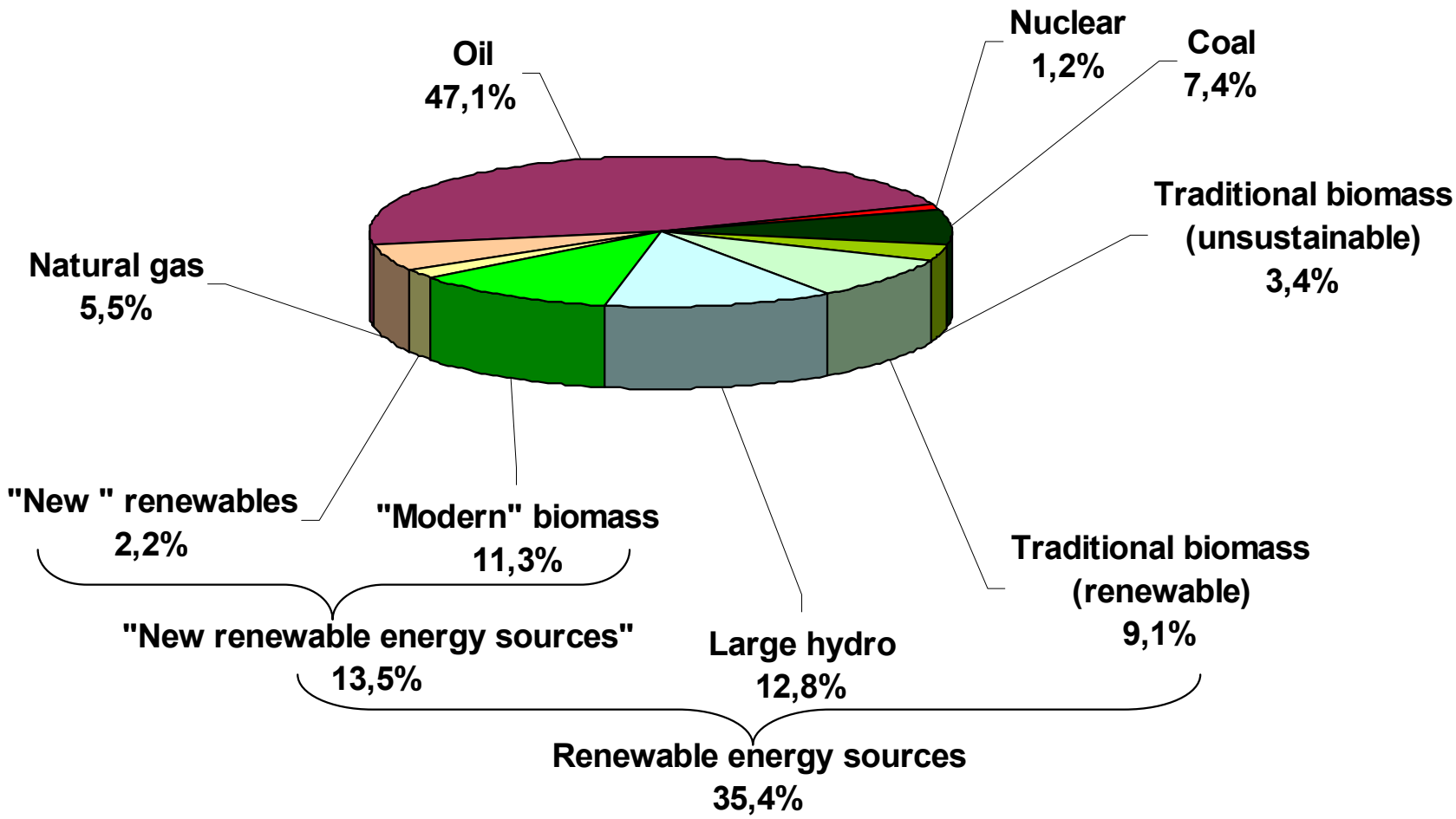
Brazilian Experience in the Use and Promotion of Renewable Energy

- Electricity

- Biofuels

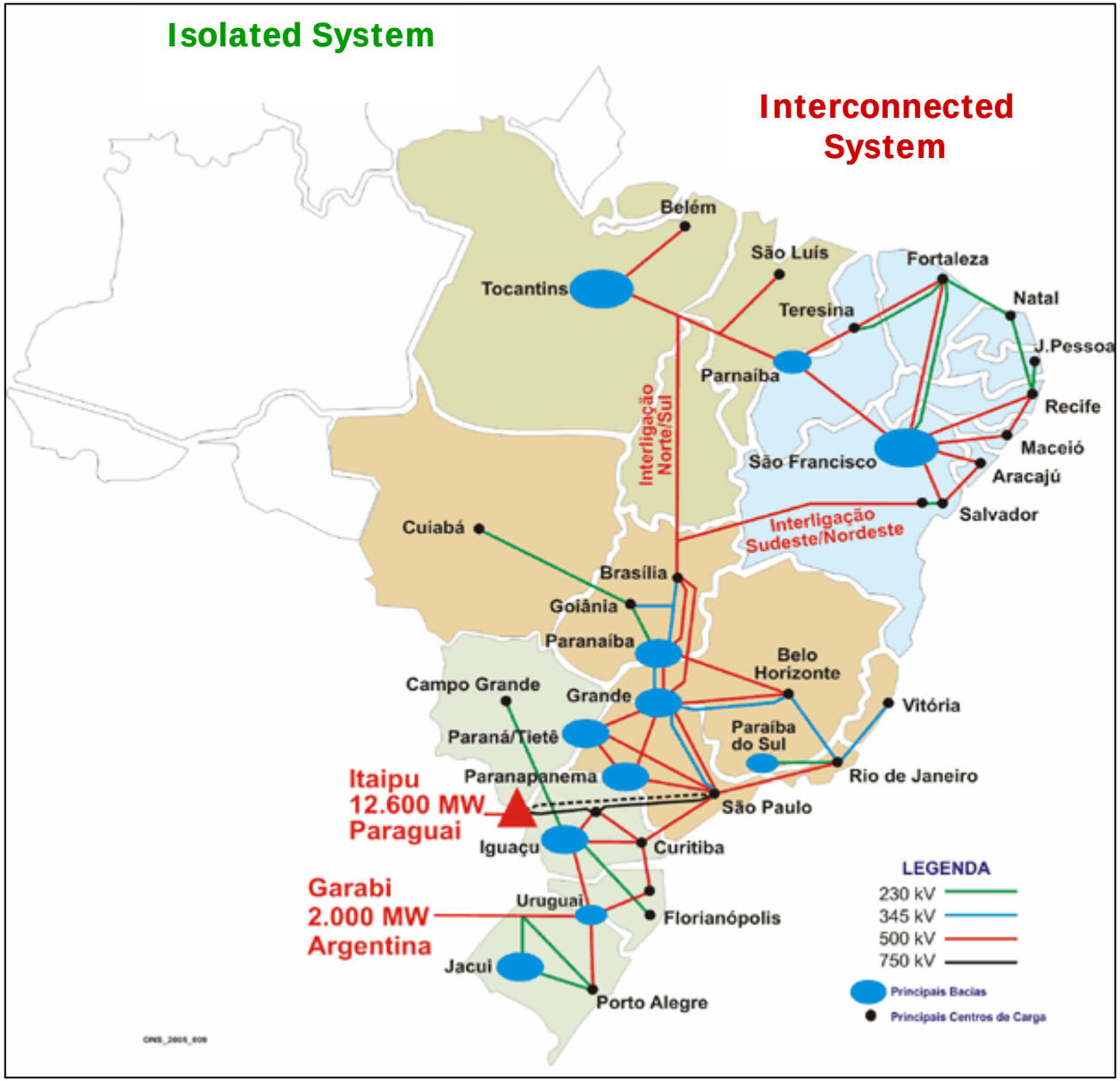
Electricity

Brazilian Total Primary Energy Supply, by Energy Type 2002



Source: Brazilian Energy Balance, 2002

Brazilian Electric System



Isolated System
Amazon Status

- **Amazon: 5.2 million km^2 (60% of Brazil's territory).**
- **Huge consumption of diesel (810,000 m^3/ano)**
- **Transportation cost: R$ 2,00/litre - R$ 2,50/litre.**

Interconnect System

- Agroindustry residues
  - Cogeneration based on sugar cane bagasse and rice husks.
- Pulp and Paper Sector
- Sawmills
- Biogas
  - Landfills / Sewage Treatment
  - Rural area (animal residues)

Agroindustry Residues

Green cane mechanical harvesting

São Paulo, 2000

- Installed Capacity
  - Sugar cane
    - 2640 MW (self consumption + surplus)
    - 350 MW (surplus sold in 2004)
  - Pulp and Paper
    - 1500 MW
    - No surplus
  - Sawmill residues - 200 MW
  - Agriculture residues
    - Rice husks – 6.4 MW
  - Technology – steam cycles (commercially available)

Sugar / Alcohol Sector

- Season 2005 / 2006:
  - Sugar cane crushed:387 million tonnes
  - Sugar production: 26 million tonnes
  - Ethanol production: 16 million m3
    - Anhydrous: 7.7 million m3
    - Hydrated: 8.1 million m3

Sugarcane-origin Cogeneration

- Huge potential for more efficient technologies:
  - around 4,000 MW of surplus electricity.
  - 5% of Brazilian energy installed capacity.

- Efficient technology commercially available in the country (higher pressure boilers, etc).

Policies

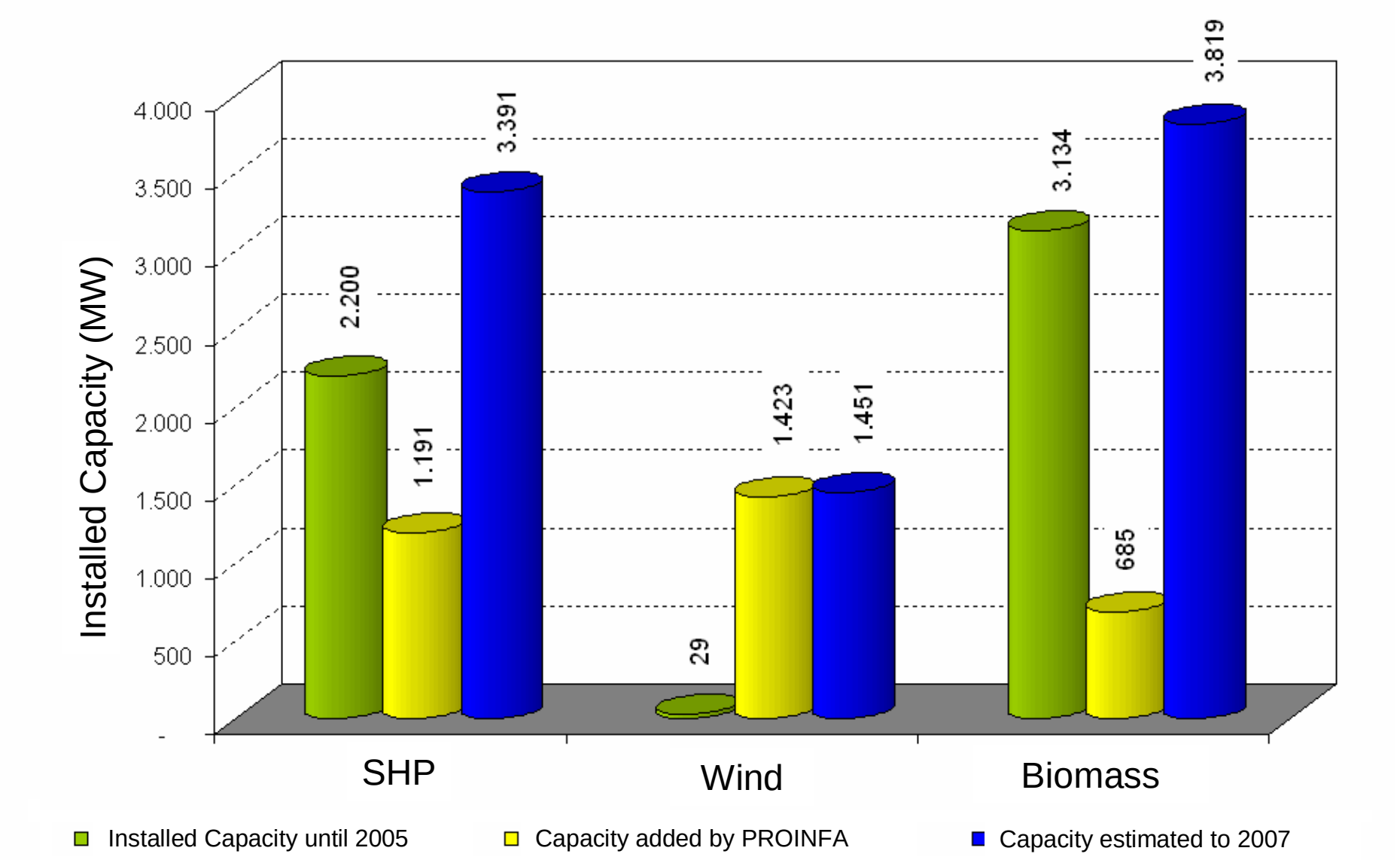
- PROINFA (Federal Law, 2002) - incentives for RE
  - Creation of a national fund (CDE) to promote universal access and use innovative sources of energy
  - Long-term contracts: the state-owned company (Eletrobras) purchases electricity for 20 years
  - 3,300 MW of installed capacity from wind, small hydro and biomass until 2006
  - Establishment of purchase tariffs for each RE source
  - Increase in the following 20 years the share of alternative sources to reach 10% of National electricity supply from RE

PROINFA's Results

Total	**3300 MW**
Wind	1423 MW
Small Hydro Power Plants	1191 MW
Biomass	685 MW

Source: Eletrobras, August 2005

Energy Sources – PROINFA's Result



Fonte: Porto, L. (2006)

Biofuels

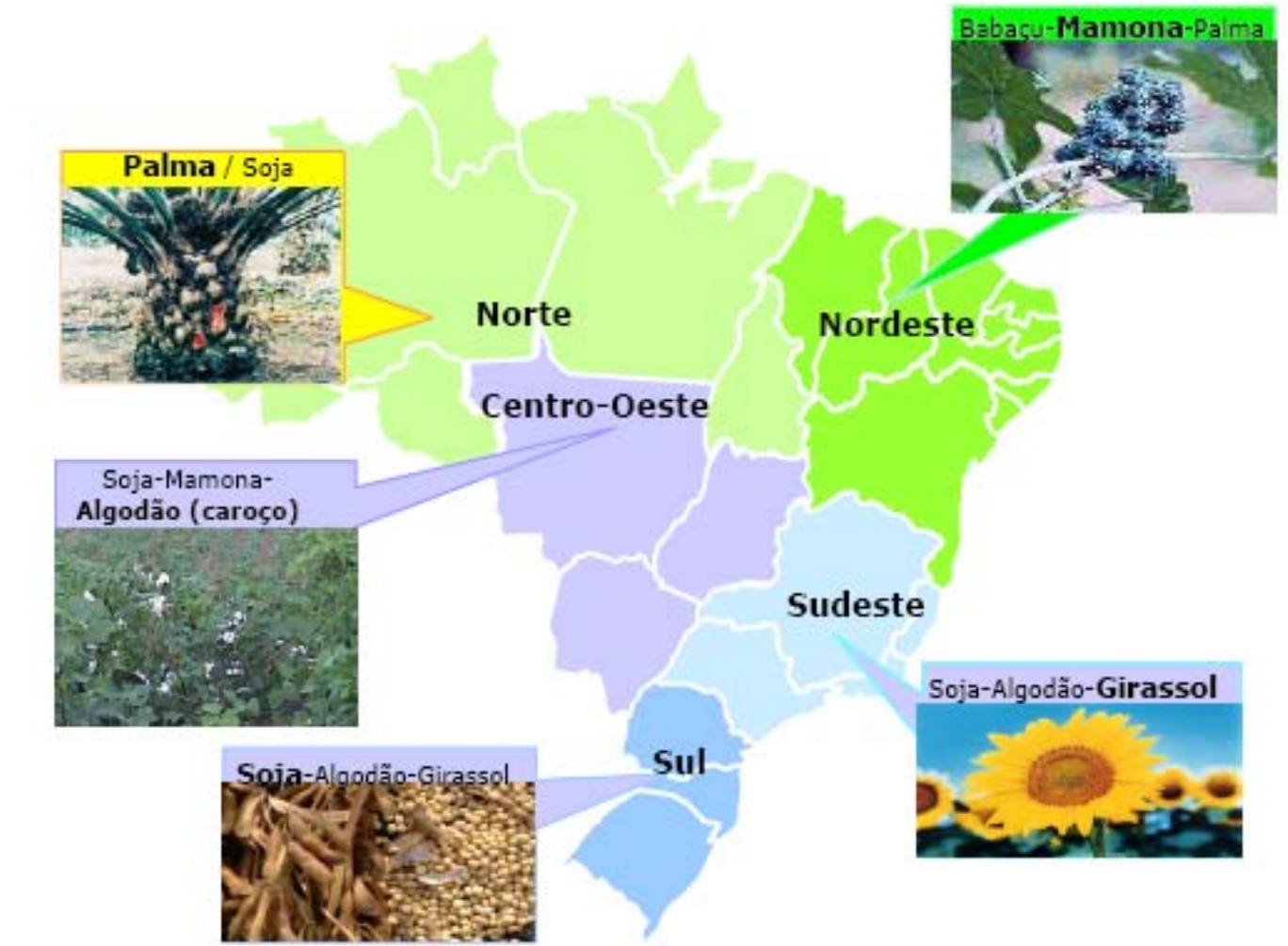
Programa Brasileiro de Biodiesel

- Progressive introduction of biodiesel in Brazilian energy matrix:
  - 2004 - 2007: B2 allowed
  - 2008 -2012: B2 mandatory
  - 2013: B5 mandatory

Biodiesel in Brazil

1. ethanol route is natural choice
2. main oil alternatives: castor and soybean
3. challenges:
   - (a) quality assurance for blending in diesel;
   - (b) vehicle performance tests;
   - (c) residues, by-products;
   - (d) fuel standards
   - (e) fuel costs
   - (f) Logistics
   - (g) Sustainable crops to produce the vegetable oil

Oleaginous plants in Brazil



Fonte: MME, 2004

The Brazilian Alcohol Program

- The world largest commercial program on biomass
- Started in 1975 by Federal Government
- Decision from Brazilian Federal Government to produce ethanol in addition to sugar (from sugarcane): objective of reducing petroleum imports.
- High-octane fuel in vehicles, replacing lead and/or MTBE.
- 1,300,000 cars running on pure (hydrated) ethanol in Brazil
- 2,300,000 flex-fuel vehicles (both ethanol and gasoline, any blend)
- all gasoline blended with (anhydrous) ethanol: 20 to 26% of ethanol in volume basis – gasohol
- Nowadays - economically competitive to gasoline

Policies Developed in Brazil for Proalcool

- In Brazil, ethanol is used in one of three ways:
  - as octane enhancer in gasoline in the form of 20-26% anhydrous ethanol at 99.6 Gay-Lussac (GL) and 0.4% water (a mixture called gasohol), or
  - in neat-ethanol engines in the form of hydrated ethanol at 95.5 GL, or
  - in flex fuel vehicles (Brazilian flex fuel vehicles can run with any blend of alcohol/gasoline, up to pure ethanol, E-100)

Policies Developed in Brazil for Proalcool (1975-1990)

- Incentives at the beginning of the Program and later on eliminated:
  - the state-owned oil company, PETROBRAS, purchased a guaranteed amount of ethanol;
  - alcohol prices to consumer were established to be sold at the pump for 59% of gasoline's price;
  - prices paid to alcohol producers were defined by Federal Government to guarantee the payment of production costs;
  - special financing conditions to alcohol producers to increase alcohol production;
  - pump stations were obliged to sell hydrated ethanol;
  - special reserves for ethanol supply were mandatory.

Evolution/Results of Policies Developed in Brazil for Proalcool

- Transition to free market: 1990-2002
- 2002 – all prices are free
- investments in the agricultural and industrial sectors for the production of ethanol (1975-1989): reached a total of US$ 4.92 billion (2001 US$)
- oil imports avoided meant savings amounting to US$ 52.1 billion (January 2003 US$) from 1975 to 2002.

Brazilian policies still existing in alcohol sector

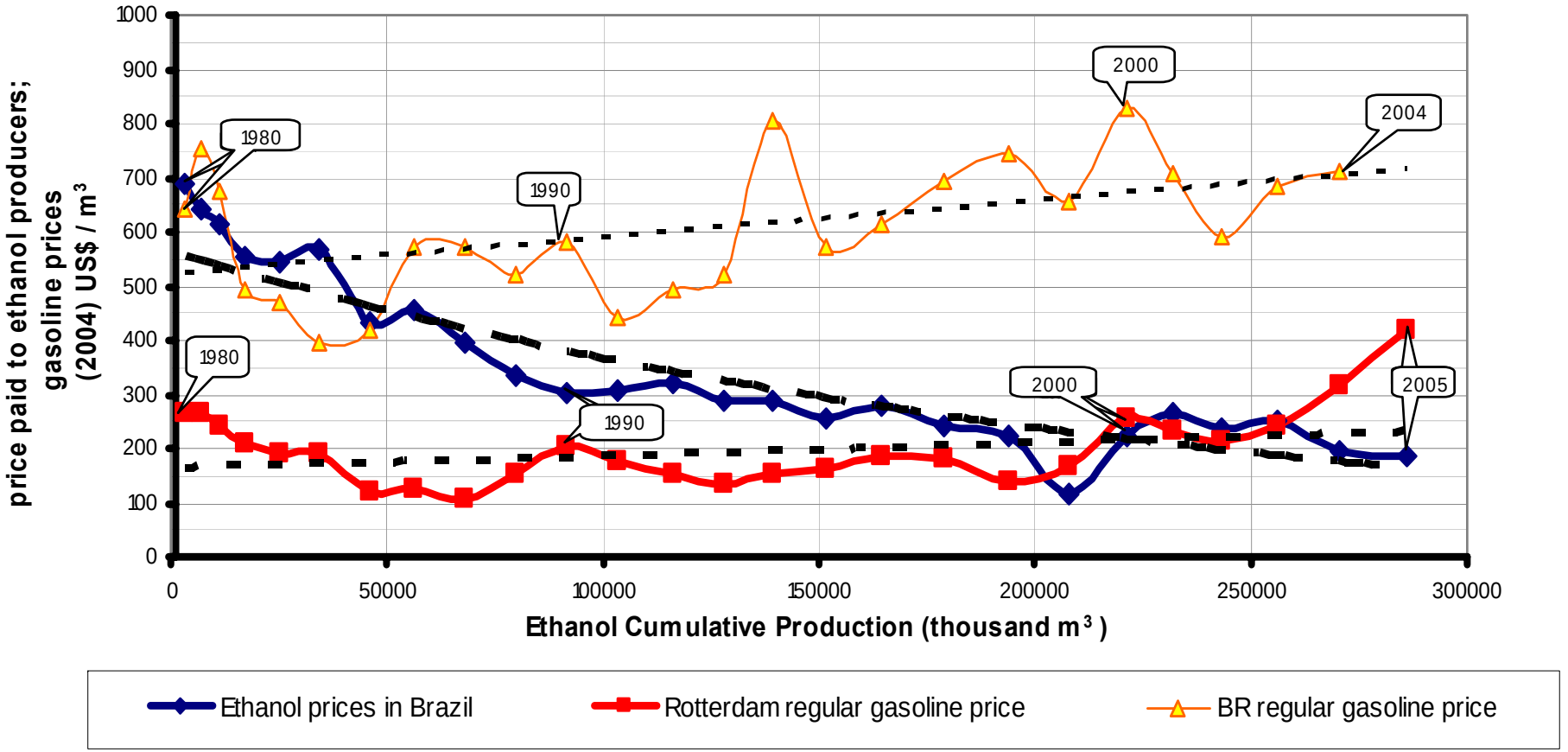
- Lower Federal taxes for alcohol/flex vehicles and alcohol fuel.
- Lower State taxes for alcohol fuel
- Impact of such tax policy: 3% of total costs of alcohol production

Ethanol Production Costs (Brazil)

- economic cost of production: US$0.18–0.25 per liter of gasoline-equivalent:
  - average export price of ethanol (2001-2003): US$ 0.23 per liter
- initial investment: US$ 60 million (2005 prices)
  - 40 NEW PLANTS in São Paulo State
  - processing capacity: 2.16 million tonnes of sugarcane per year
  - average yield 79.39 liters of anhydrous ethanol equivalent (82.86 liters of hydrous) per tonne of sugarcane.
  - Price paid per tonne of sugarcane is US$11.4 (UNICA, 2005)
  - plant lifetime of 25 years
  - feedstock cost of US$ 0.143 per liter of ethanol
  - investment cost around US$ 0.017 per liter of ethanol.

2006 → NEW INVESTMENTS ARE PRIVATE

The Economic Competitiveness of Alcohol Fuel Compared to Gasoline



Ethanol Production Costs

Country	Feedstock	Production cost (US$/l)
Brazil	Sugar cane	0.20
India	Sugar cane	0.40
United States	Maize	0.80
United Kingdom	Sugar beet	0.97
Zambia*	Sugar cane	0.50

Note: Sugar beet ethanol UK, Stlg 15/GJ; Wheat grain EUR16.9/GJ (UK DTI, 2003). Corn ethanol US Iowa US$1,04/gallon (USDA 2004). *Theoretical data based on CORNLAND et al, 2001. **Sources: UK DTI 2003; USDA, 2004**

Compatibility of Existing Fleets with Ethanol-gasoline Blend

Ethanol Content in the Fuel	Carburetor	Fuel Injection	Fuel Pump	Fuel Pressure Device	Fuel Filter	Ignition System	Evaporative System	Fuel Tank	Catalytic Converter	Basic Engine	Motor Oil	Intake Manifold	Exhaust System	Cold Start System
≤ 5%	For any vehicle NN													
5 ~ 10%		For relatively new fleets (10 ~ 15 years old)											NN	
10 ~ 25%	Brazilian Application - PN									NN				
25 ~ 85%	USA Application PN													NN
≥ 85%	Brazilian Application PN													

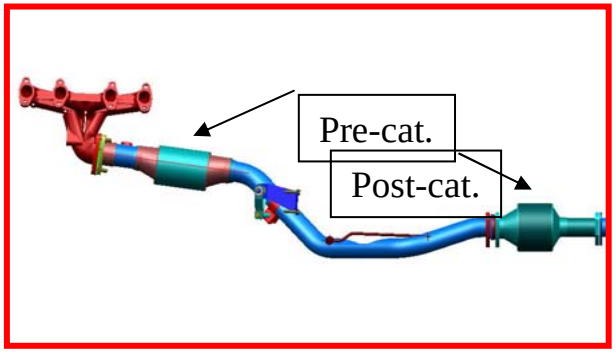
Source: ANFAVEA, 2005

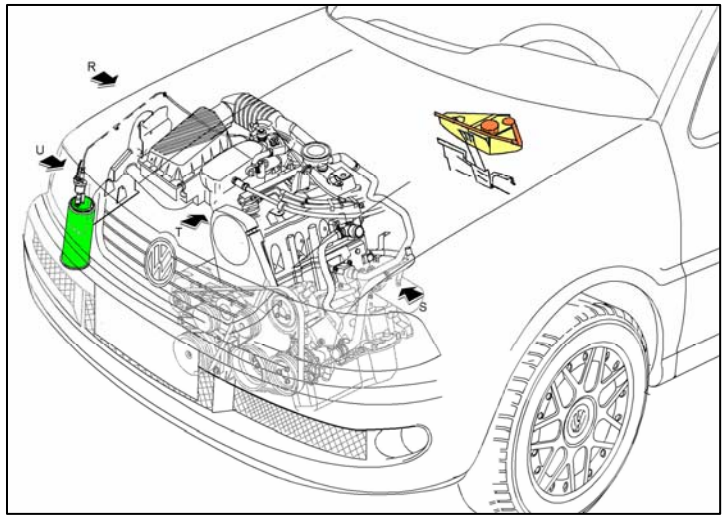
- Not Necessary

- Probably Necessary

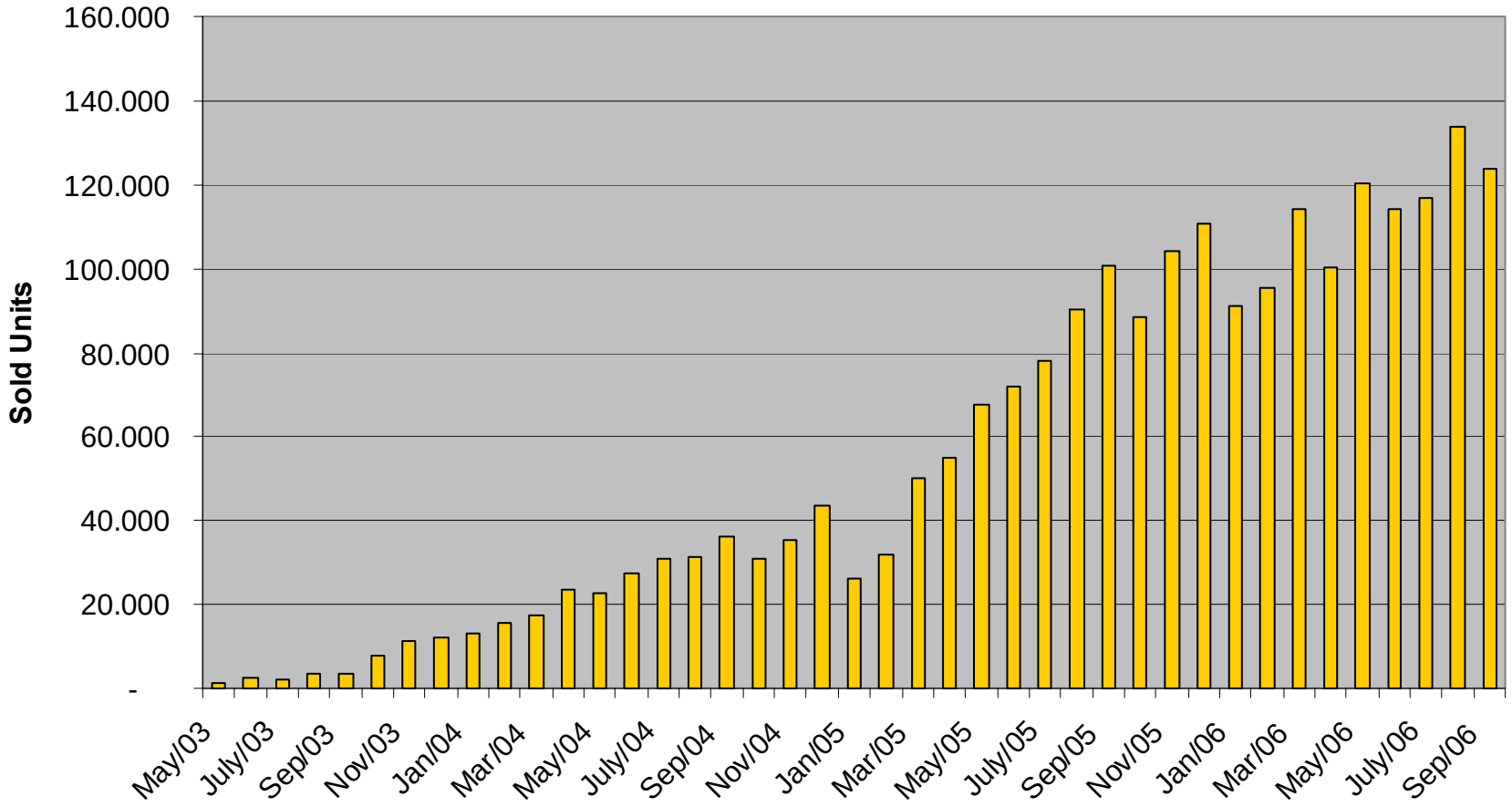
Flexible fuel vehicles (FFVs) in Brazil

- A new motorization concept, original from Brazilian manufacturers
- Use of hydrated ethanol (E100), any blend of alcohol-gasoline or pure gasoline
- Automatically adapting to the fuel (censor)
- Free choice of consumer
- Vehicle hardware changed, to control evaporative emissions, plus pre and post catalytic converters
- Booming sales:
  - 48,000 (2003) to ~ 2,000,000 (September,2006)
  - already 80% of total car sales
  - soon will dominate the market





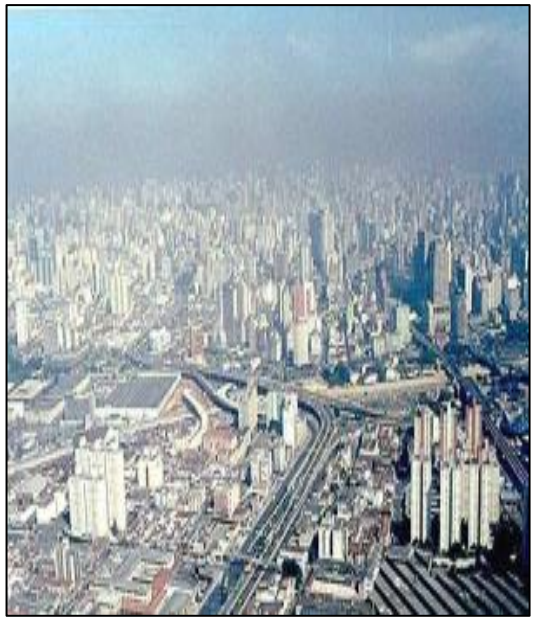
Flexible Vehicles Brazilian Market



In October 2006, Brazilian automotive industry announced the 2.3 million units of FFV sold.

Environmental Benefits from Biofuels

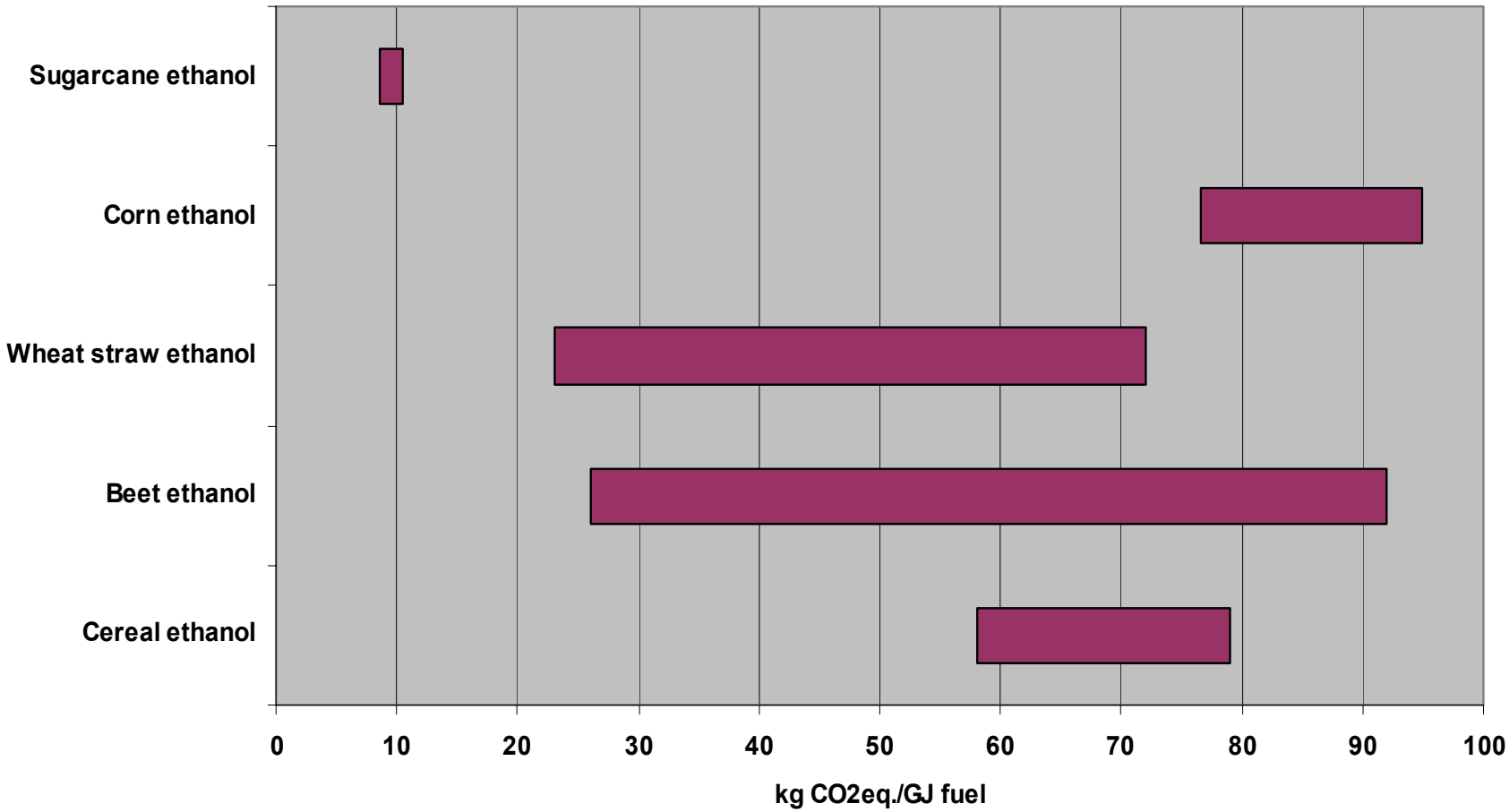
- To reduce local, regional and global environmental impacts;
- Ethanol is the only renewable source which can be used in transportation sector.



Pollutants Concentration in SP Metropolitan Region

- Lead: dropped from 1,4 $\mu g/m^3$ in 1977 to less than 0,10 $\mu g/m^3$ in 1991.
- Sulfur: dropped from 50 $\mu g/m^3$ in 1984 to 15 $\mu g/m^3$ in 2003.
- Particulate Matter: dropped from 90 $\mu g/m^3$ in 1986 to 50 $\mu g/m^3$ in 2003.

GHG emissions from different types of ethanol



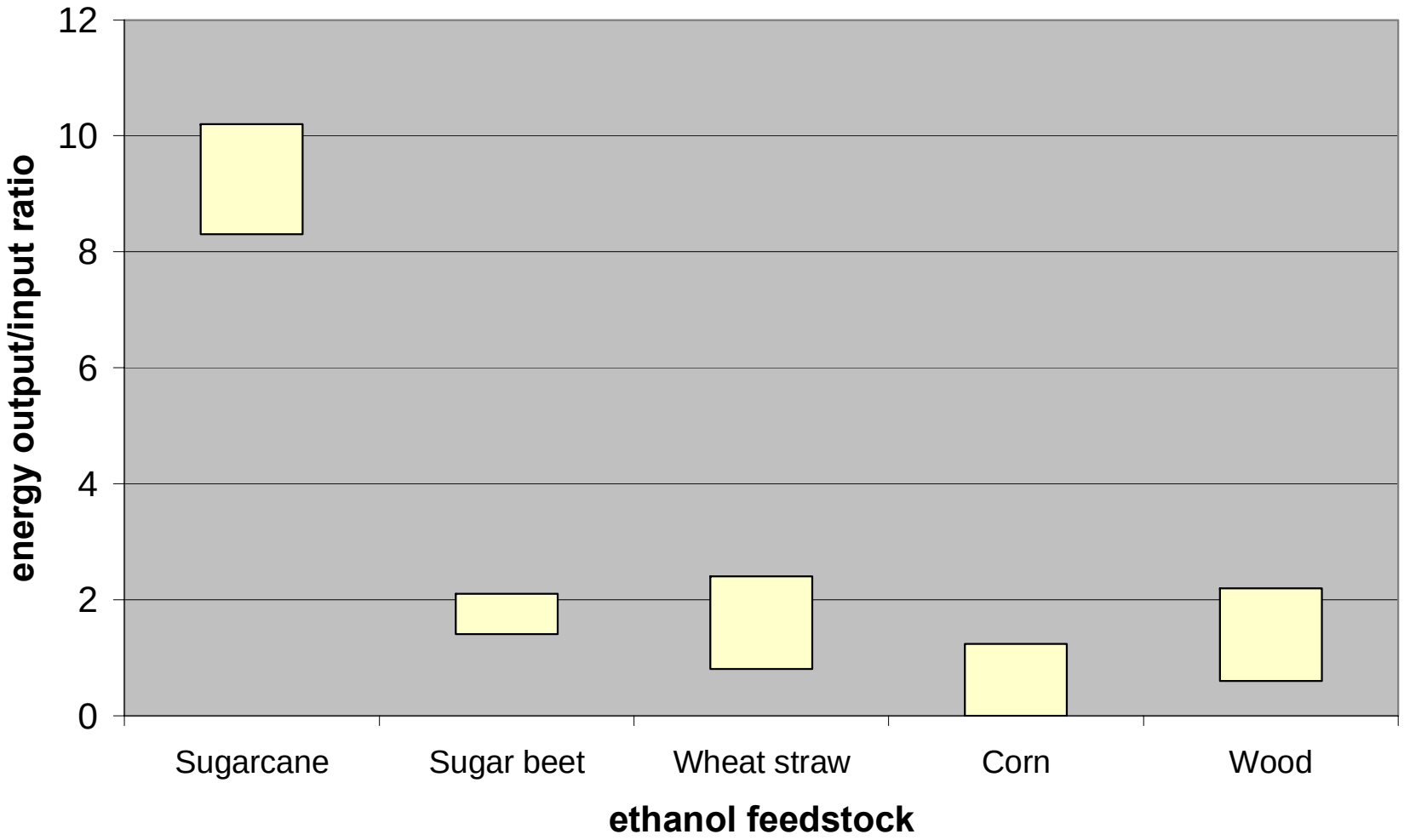
Sources: Macedo et. alii, 2004, UK DTI, 2003 and USDA, 2004

Ethanol Energy Balance

Activity	Energy consumption			
	Scenario 1 (kcal/TC)		Scenario 2 (kcal/TC)	
Sugar cane production (total)	**48,208**		**45,861**	
Agricultural operations	9,097		9,097	
Transportation	10,261		8,720	
Fertilizers	15,890		15,152	
Lime, herbicides, pesticides etc.	4,586		4,586	
Seeds	1,404		1,336	
Equipment	6,970		6,970	
Ethanol production (total)	**11,800**		**9,510**	
Electricity	0		0	
Chemicals, lubricants	1,520		1,520	
Buildings	2,860		2,220	
Equipment	7,420		5,770	
External energy flows	**Input**	**Output**	**Input**	**Output**
Agriculture	48,208	-	45,861	-
Factory	11,800	-	9,510	-
Ethanol produced	-	459,100	-	490,100
Surplus bagasse	-	40,300	-	75,600
Total	**60,008**	**499,400**	**55,371**	**565,700**
Output/input	**8.3**		**10.2**	

Source: Macedo, I et alli, 2004

Energy balance of alcohol production from different feedstocks

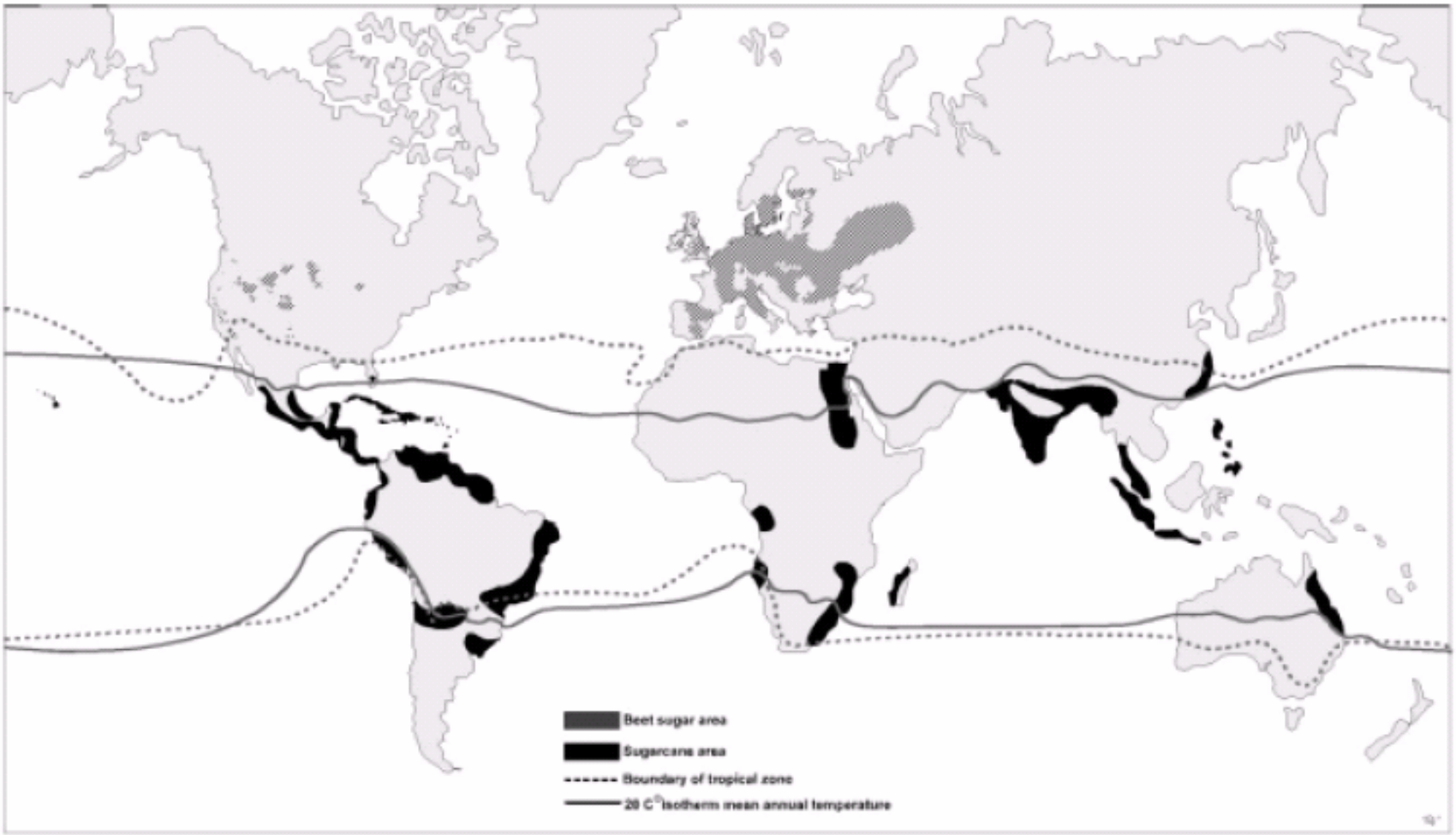


Sources: (Macedo et alii, 2004; UK DTI, 2003 and USDA, 1995)

Perspectives for Developed Countries

- Utilization of biofuels produced locally → high production costs
- Import of biofuels from developing countries
- Advantages
  - reduction on Carbon emissions → targets from Kyoto Protocol.
  - Diversification of energy matrix – energy security.

Possibilities of Replication in Developing Countries

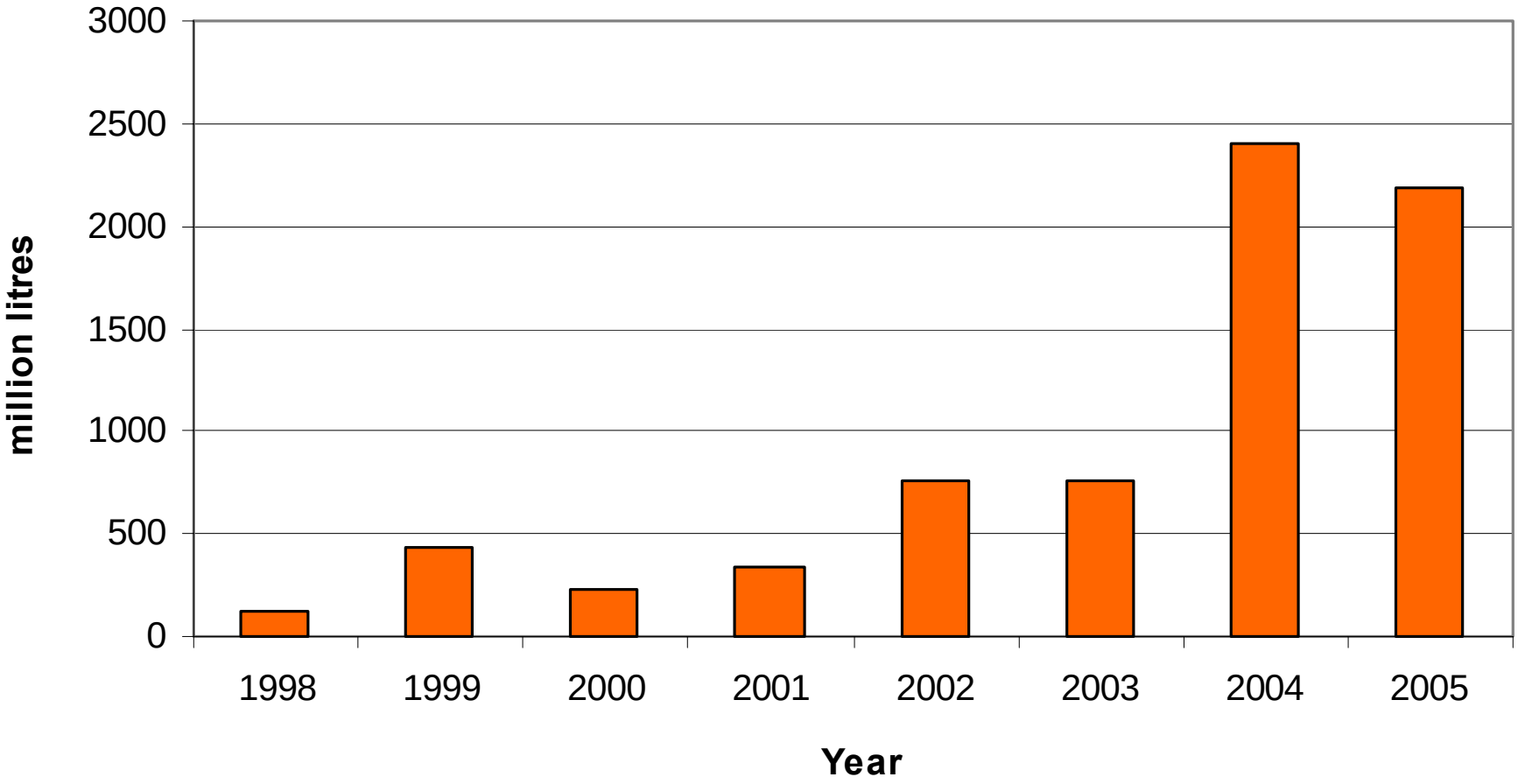


The Equator Belt; sugarcane potential (SI, suitability index). Source: FAO (2005)

Perspectives for Developing Countries

- Production of biofuels locally
  - job creation (rural areas)
  - industrial development
  - reduction on oil imports
  - use of degraded lands
  - electricity production from residues for rural areas
- Biofuels exports
  - increase on revenues

Brazilian Ethanol Exports



Possible Policies for Developing Countries

- There are two main issues to be addressed:
  - Countries already producing some sugarcane for sugar and interested in producing ethanol for local consumption, reducing oil/derivatives imports: these countries could start an alcohol program using part of the existing sugarcane production for alcohol production
  - Countries with no sugarcane production but with existing deforested land: these countries must start since the very beginning, including the choose for the best crop to be used for biofuels

Possible Policies for Developing Countries

- For sugarcane producer countries:
  - Establishment of policies for a mandatory blend of ethanol in gasoline up to 5%, which does not need any change in existing fleet;
    - Malawi is already blending
  - Discussion of fiscal policies (if necessary) regarding economic competitiveness of alcohol fuel.

Possible Policies for Developing Countries

- In both cases, ethanol export could be addressed in a second phase program, including the discussion on existing trade barriers in developed countries, especially import taxes, quota allocation and harmful domestic subsidies against the WTO rules.

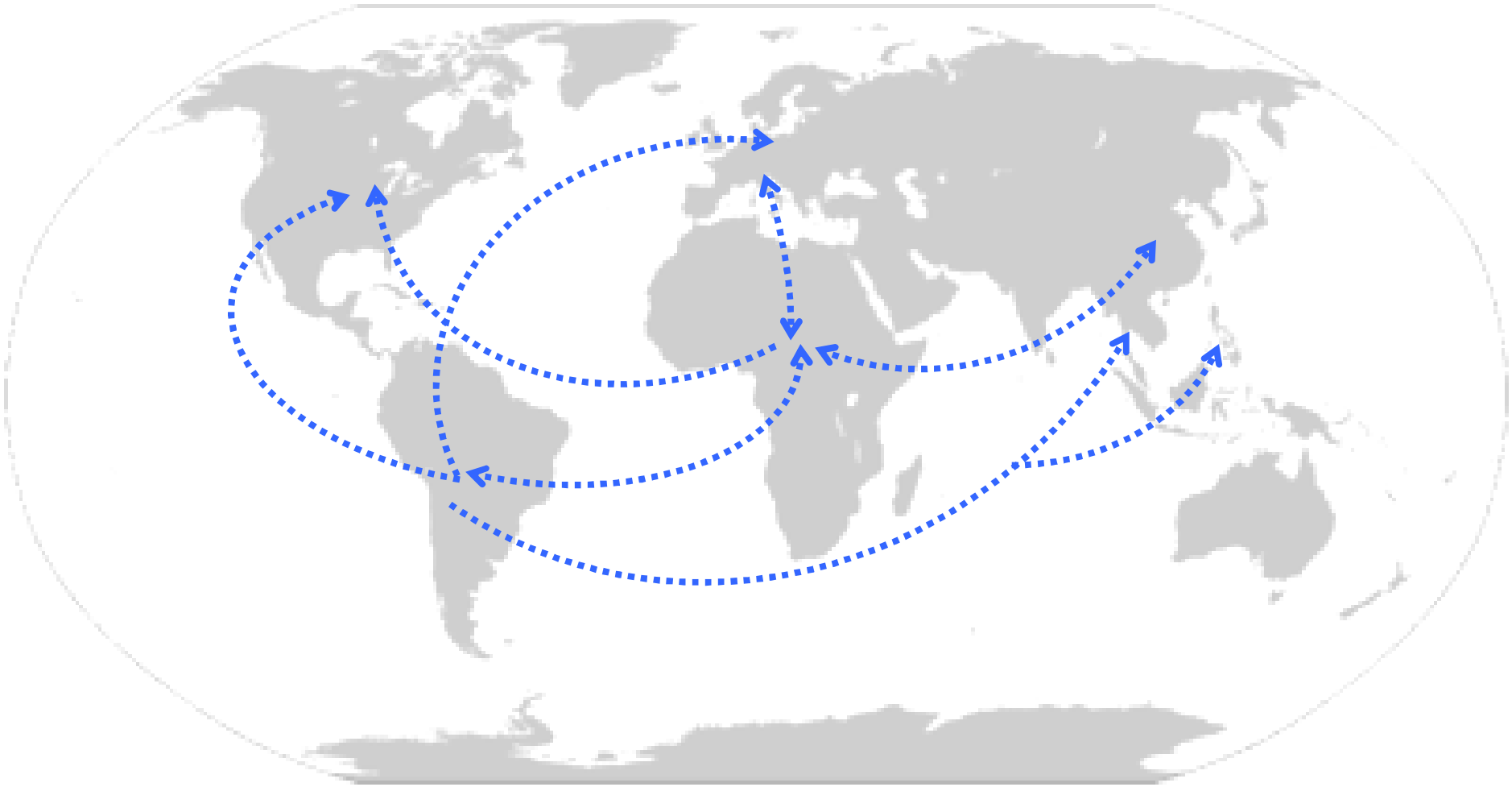
Perspectives for biofuels trade (1)

- South-North and South-South trade: important for developing countries producing biofuels.
- Biofuel production (Brazil's experience): sustainable production and low production cost.
- Biofuels from developing countries: can be commercialized with developed countries;
- Reduction of carbon emissions from developed countries (Kyoto Protocol).
- Brazilian experience:
  - be repeated in other developing countries
  - allow benefits for developed countries under the Kyoto Protocol.

Perspectives for biofuels trade (2)

- International trade in biofuels: strong barriers still existing
- Need for new approaches and policies:
  - Trade liberalization efforts
  - Kyoto Protocol implementation policies
  - Reduction on GHG emissions.

Potential Markets – Ethanol Flows



Conclusions

- Biofuels are, in first place, energy sources produced in rural areas to fulfill energy needs of cities that can afford it.
- The main barrier to ethanol production in developing countries is the lack of funding and adequate policies.
- Investments in basic infrastructure of production, distribution and exporting.

Thank you !

Patricia Guardabassi

guardabassi@iee.usp.br