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# **Brazil: Historic Developments and Current Opportunities on Bio-Energy Trade**

**Business Forum on International Bio-Energy Trade  
Task 40 “Sustainable Bio-Energy Trade; Securing  
Supply & Demand”  
IEA Bioenergy  
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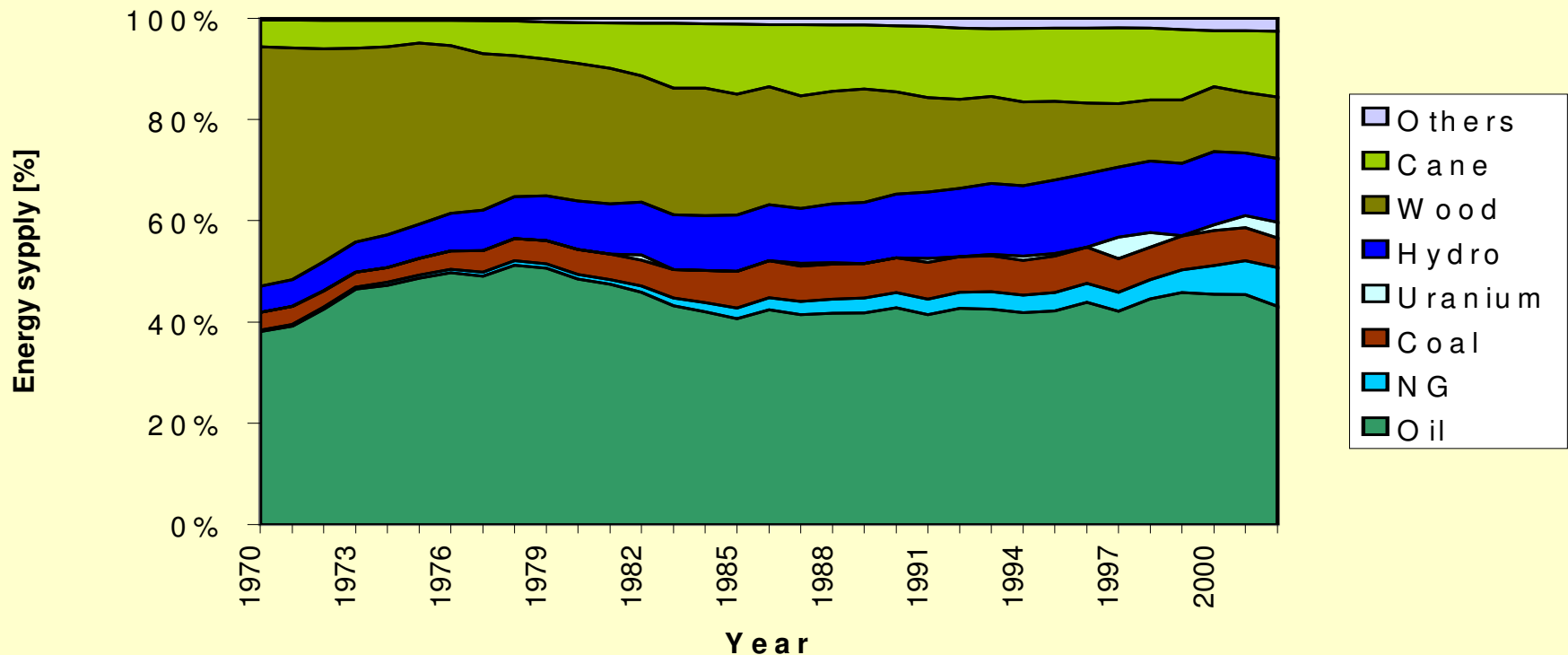
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# Outline

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- ◆ Renewables in the energy matrix and biomass share;
- ◆ Wood production, firewood use, wood pellets (use and exports), wood chips (exports), perspectives;
- ◆ Charcoal production, current perspectives;
- ◆ Ethanol Program (historic facts – phases, current situation, main results, cost reduction tendency);
- ◆ Ethanol international market and Brazilian participation.

# Renewables in the energy matrix



- ◆ Historical importance, but declining participation since 1985 (essentially, due to the decline use of wood in the household sector);
- ◆ In 2002, 40.3% of the Brazilian primary energy supply (27.7% was biomass - wood, sugar-cane and residues).

# Biomass energy in Brazil

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- ◆ Brazil has tradition and a significant potential as biomass producer.
- ◆ A set of factors should be highlighted: size of the country (land availability), adequacy of its weather, availability of the working force (cost in some places is still very low) and domain of biomass-production and biomass-conversion technologies in the agricultural and in the industrial sectors.

# Wood production

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- ◆ A well-established activity: the forest sector offers about 700 thousand direct jobs and more than two million indirect jobs.
- ◆ Brazil has one of the best technologies for implementation of dedicated forests of eucalyptus in the world.
- ◆ High productivity: 20-25 t/ha.yr; short cycle: 5-8yr (for most of the industrial purposes).
- ◆ Costs for eucalyptus before harvesting: just 0.5 - 0.6 US\$/GJ + 0.35 - 0.5 US\$/GJ for harvesting.
- ◆ Environmental aspects: some of the constraints of the past are no longer a matter of concern.

# Firewood – uses

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- ◆ Consumption 2003: 55 Mt.
- ◆ Uses: 40% charcoal, 29% domestic cooking; 23% industrial and commercial sectors (bakeries, restaurants, beverage, brick, ceramic, steam, heating, drying).
- ◆ Average prices: 0.5 U\$/GJ (at the field) to 2 U\$/GJ (at the consumption site).
- ◆ Energy contribution 2003: 580 PJ (except charcoal).
- ◆ Constraint: transportation: 30-40% of the final price.

# Wood pellets

## - production and exports

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- ◆ Consumption in a starting phase.
- ◆ Substitute for firewood and charcoal.
- ◆ Advantages: denser in mass and energy; cleaner.
- ◆ Potential use of forest residues: 30 Mt – 250 PJ .
- ◆ Prices of residues: 0.7 U\$/GJ (Amazon) to 1.7 U\$/GJ (South and Southeast).
- ◆ Wood pellets: exportation in 2004 – 10 thousand t.
- ◆ Consumption in 2005: estimated as 30 thousand t.
- ◆ Current destination of exports: North America (Canada).
- ◆ Uses: packed for households, restaurants, bakeries.
- ◆ Pellets initial price: U\$ 52.00/t FOB (packed) 2.7 U\$/GJ.

# Wood Chips - exports

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- ◆ Main destination: pulp and paper industry (Asia is an important market).
- ◆ Just one company is exporting chips from residues (barks) and acacia trees for energy purposes.
- ◆ Exportation in 2004: 250 thousand GMT – 3 PJ.
- ◆ Potential, considering forest residues: 30 Mt – 250 PJ .
- ◆ Current destination of energy chips exports: Europe.
- ◆ Uses: co-firing and biomass power and heating plants.
- ◆ Use of chip carriers up to 40,000 t.
- ◆ Average prices: 25 US\$/ton (1.2 US\$/GJ) FOB; 42 US\$/ton (2.1 US\$/GJ) CIF Europe.

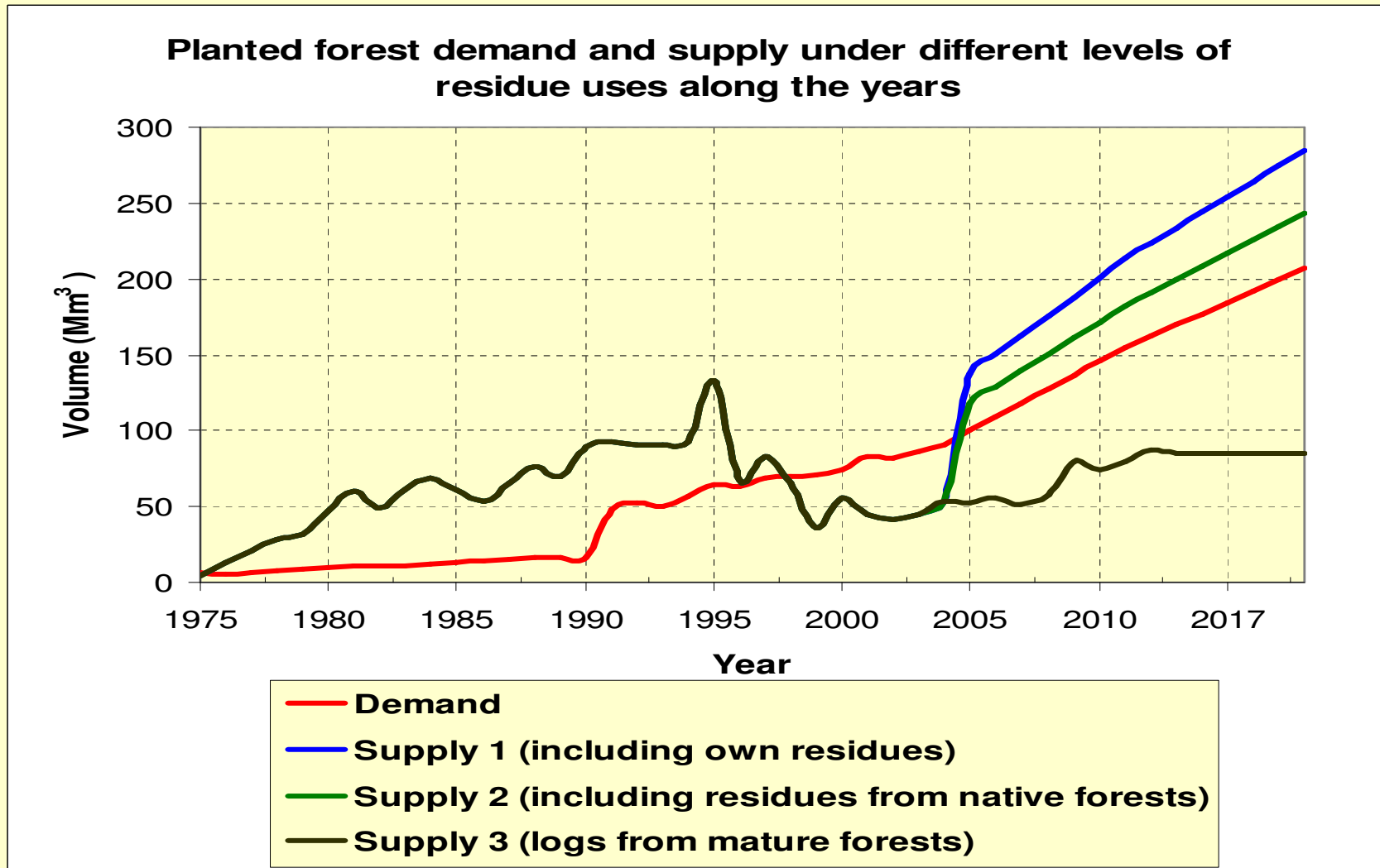
# Perspectives and comments

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- ◆ Forestry sector is awaking from a stage of 15 years of decreasing aforestation and reforestation.
- ◆ Several programmes are being implemented aiming at supplying all sector demands: Pronaf Florestal; Propflora; Profloresta; Proambiente.
- ◆ Pathways: increasing annual planted forests and incorporating native sustainable forests through certification process (e.g.: FSC)
- ◆ Target 1: 550 kha/yr of plantations.
- ◆ Target 2: 15 Mha of native certified forests.
- ◆ Residues estimated from planted and native forests are about 120 Mm<sup>3</sup>/yr.
- ◆ Production of wood pellets/chips from residues may supply internal and external demands (exports).
- ◆ Exports for energy uses: 65 Mt/yr (500-800 PJ) - potential from residues of planted and native forests surplus.

# Planted forests

## – demand x supply



# Charcoal

## - large-scale production

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- ◆ Production increased sharply during the 1980s due to a government policy aiming at reducing imports of coal and coke.
- ◆ Peak of charcoal output was in 1989, when almost 40 per cent of the pig-iron production were based on this biomass source (29.5 per cent in 2003). During the 1990s large-scale integrated steel mills shifted again their energy matrix, returning to coke.
- ◆ Charcoal use for pig-iron production is mainly concentrated in small independent factories.
- ◆ Charcoal consumed by steel industries: 97 per cent based on planted forests. Overall production: 74 per cent is based on planted forests (2003).

# Former “charcoal program” - failures and other aspects

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- ◆ Most of charcoal production during the 1980s was based on native forests.
- ◆ Abusive labor practices: an expressive share of charcoal production at that time was based on children working force.
- ◆ Regarding the future of the charcoal-based industry, modernization and increase in efficiency to reduce costs are still required.

# Present

## - new trends for charcoal

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- ◆ Price of imported coke is about four times higher than charcoal (550 x 150 US\$/t).
- ◆ Steel industries are increasing investments in forests for charcoal to 2005, further than regular annual plantations (+ 30 thousand ha just in the State of Minas Gerais).
- ◆ Increasing efficiency leading from 330 to 450 kg of charcoal / t of wood (+ 36%).
- ◆ Certificate of environmentally friendly production (Sofex) opens new opportunities for exportation (+ packed / domestic).
- ◆ Average prices 2003: 2.7 U\$/GJ.
- ◆ Energy contribution in 2003: 225 PJ.

# Brazilian alcohol program

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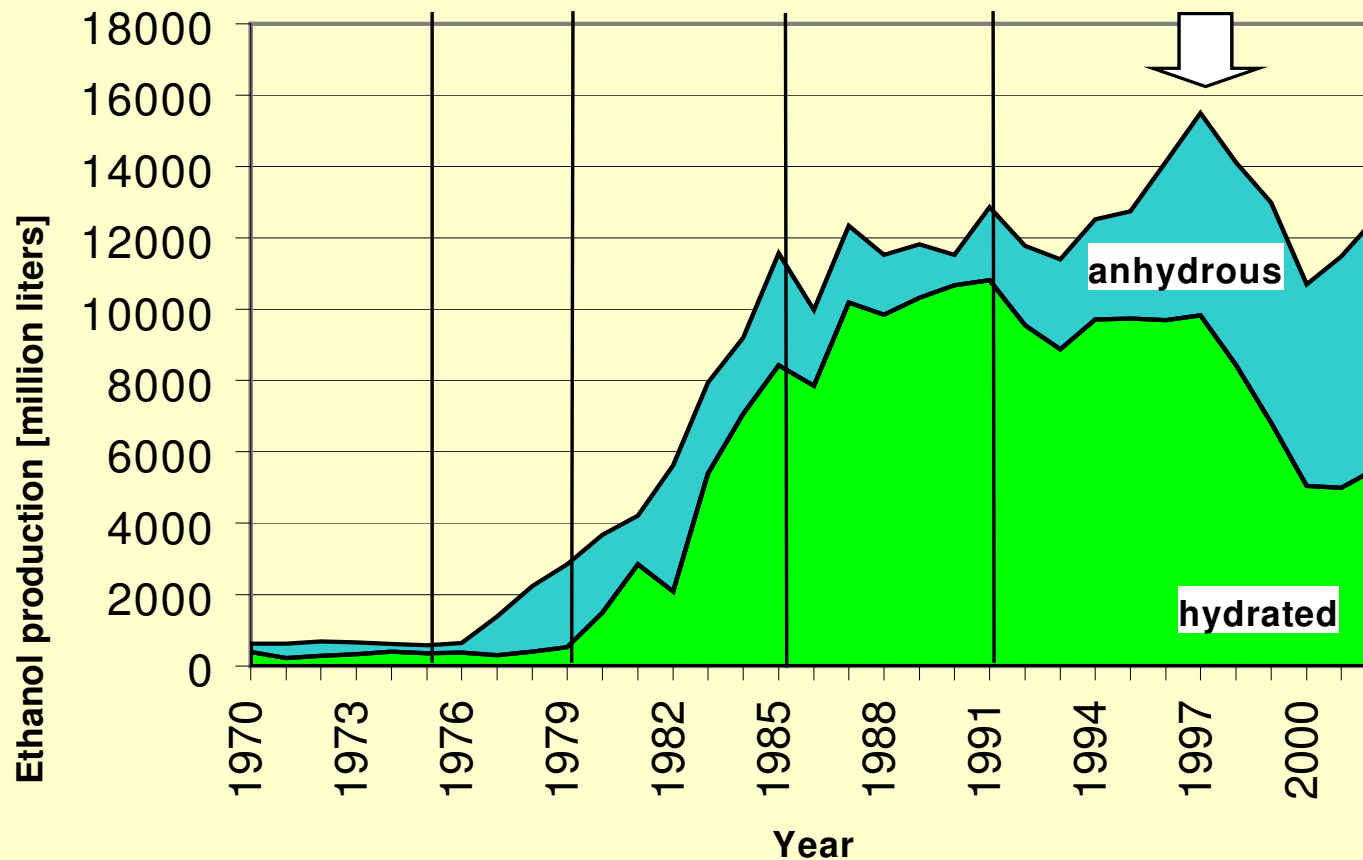
- ◆ Worldwide Brazil is the largest sugarcane producer.
- ◆ The Brazilian Alcohol Program (PROALCOOL) is still the largest biomass commercial program in the world.
- ◆ Large-scale production started in 1975: anhydrous ethanol to be blended with gasoline; production of hydrated ethanol to be used as neat fuel in 1979.
- ◆ About 10 billion US\$ were invested to create a structure able to produce 16 billion liters of ethanol per year (nowadays 18 billion liters/year; 22-23 billion liters in few years).
- ◆ Production is concentrated in SE Brazil: 65-70 per cent.
- ◆ About 320 sugar mills in operation ranging from 0.1 to 6.0 M tons of cane/year. More 25-30 sugar mills under construction.

# Phases of the ethanol program

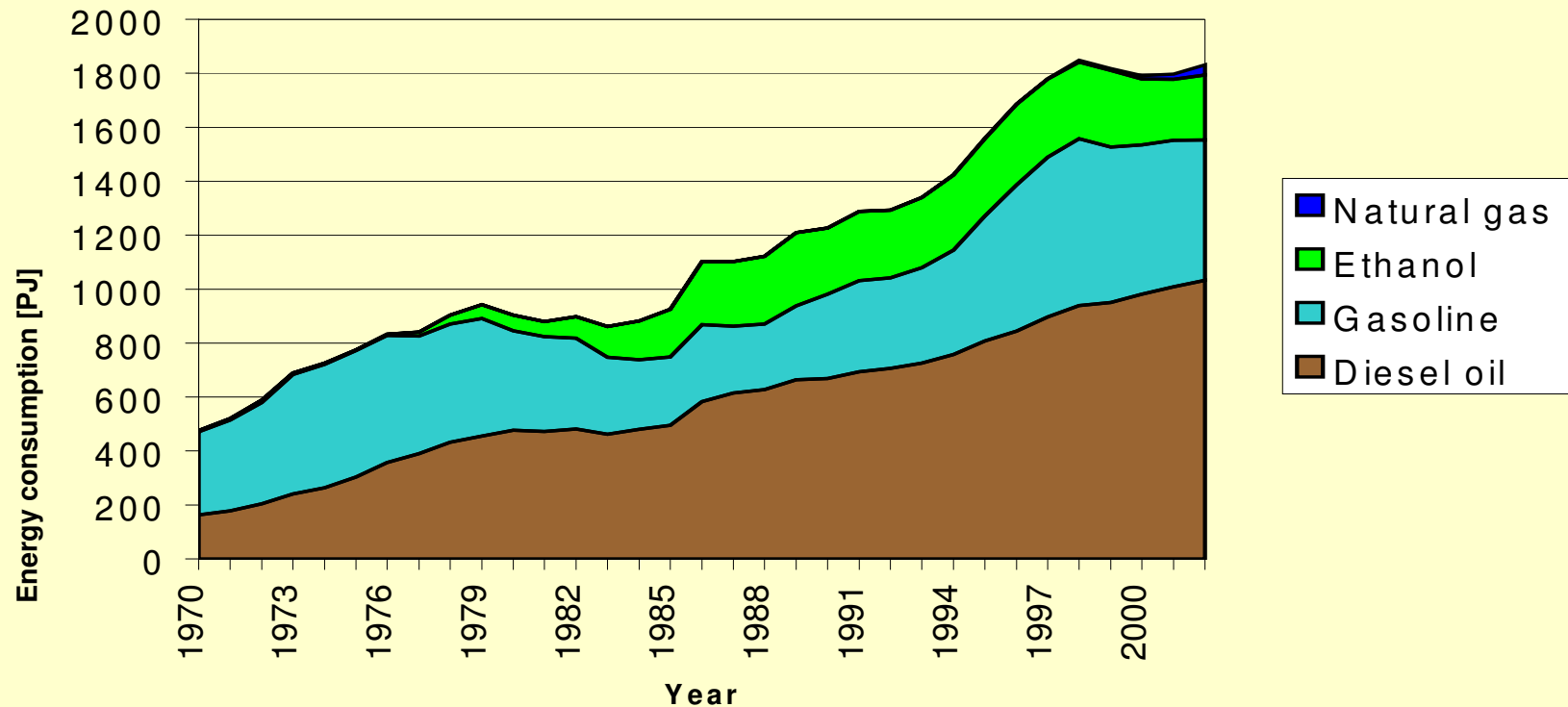
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- ◆ The first phase (1975-1979) – production of anhydrous ethanol to be blended with gasoline.
- ◆ The second phase (1979-1985) – large-scale production of hydrated ethanol to be used as neat fuel.
- ◆ The third phase (1985-1991) – stabilization of the production.
- ◆ The fourth phase (1991-onwards?) – started when a supply shortage deeply impacted the supplier's credibility, leading to a drop in sales of neat ethanol cars. Deregulation of the ethanol market has started in 1997.

# Evolution of ethanol production



# Road transport - ethanol contribution



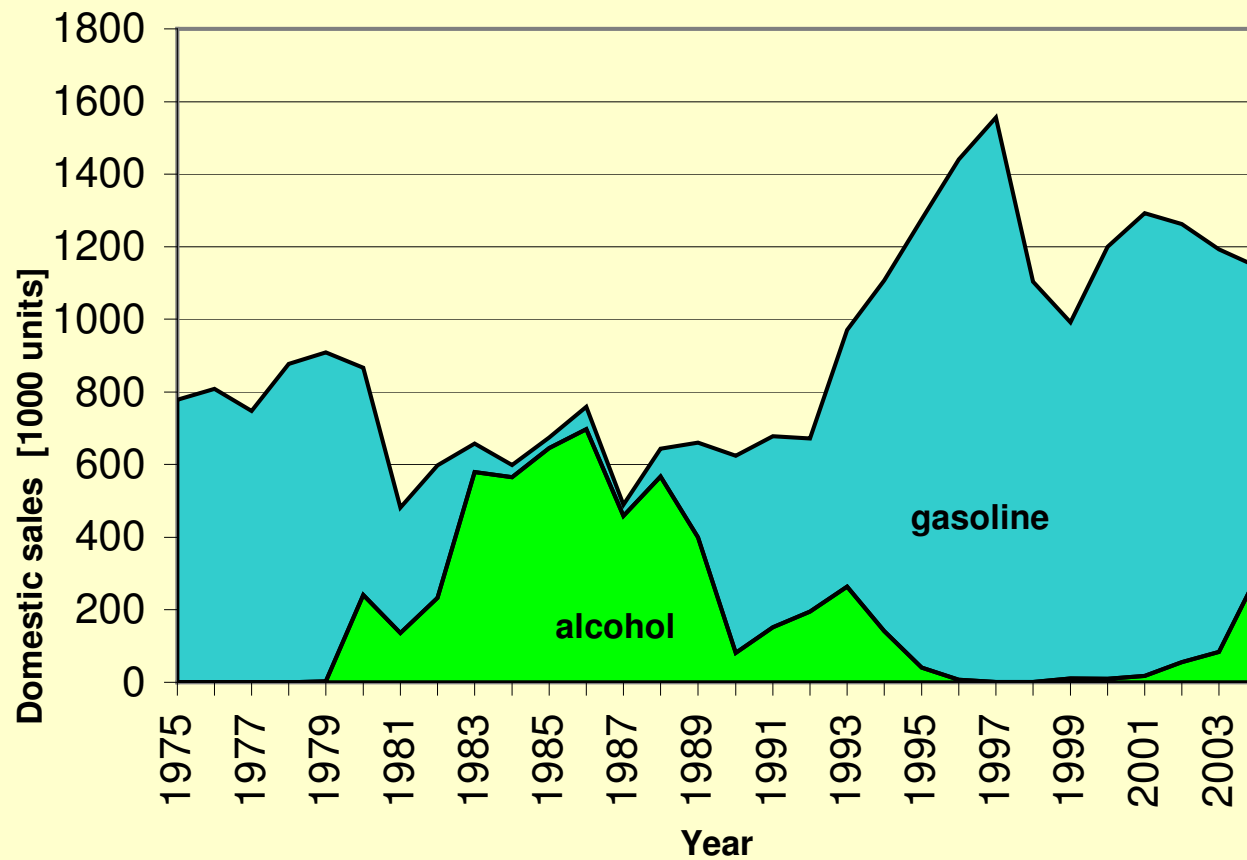
- ◆ Ethanol contributed with up to 50% of the energy consumption regarding automotive transport (30% in 2002).
- ◆ Natural gas is a new low price option for consumers.

# Is a new phase in movement?

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- ◆ Due to low prices of ethanol vis-à-vis gasoline (in some moments, lower than 40 per cent, per liter), and with the advent of flex-fuel engines (since May 2003), sales of ethanol cars are risen again.
- ◆ Regarding the sales of new light-vehicles, flex-fuel represented 32 per cent in September 2004. On average, sales of flex-fuel vehicles should represent 28 per cent of the total sales in 2004.
- ◆ Forecasts indicate that sales of flex-fuel vehicles will reach 67% in 2007. The fleet of flex-fuel cars should be 25-27 per cent in 2010. Forecasts for ethanol demand in 2010 are 18 billion liters.

# Sales of new E100 cars



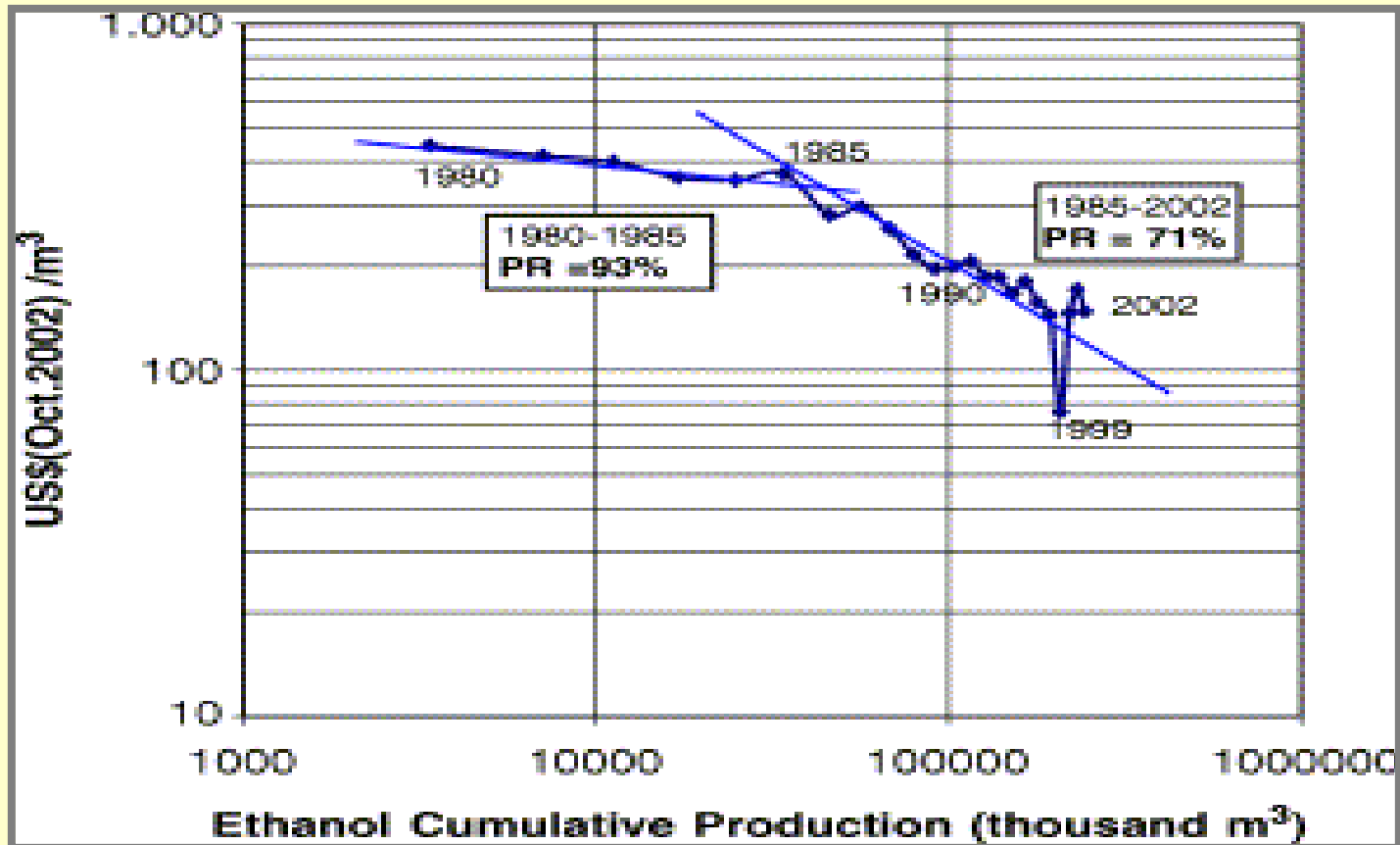
Sales until October 2004

# Ethanol program - main results

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- ◆ Despite some difficulties, the Program has been very successful regarding its primary goals: (i) reduction of oil imports, (ii) stabilization of the sugar market, (iii) enhancement of Brazilian competitiveness on the sugar market, and (iv) creation (at low cost) of one million jobs.
- ◆ A very positive energy balance is observed (output/fossil input = 8.3 to 10.2).
- ◆ A very substantial cost reduction was observed and ethanol is competitive vis-à-vis gasoline without subsidies. Cost of production is estimated as 17 cents U\$/liter (2003).

# Cost reduction



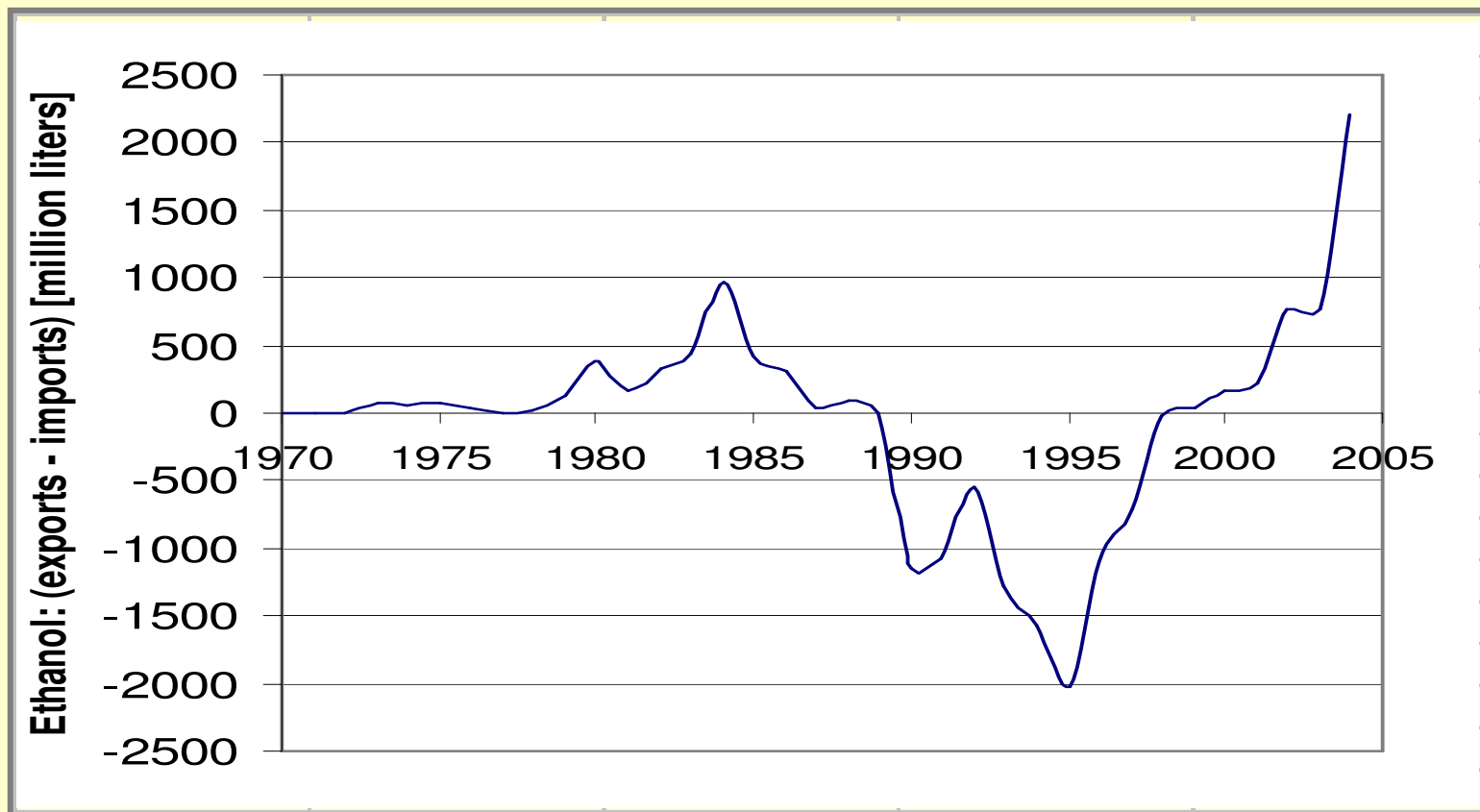
- ◆ Learning curve based on prices paid to producers (as “proxy”).
  - ◆ The progress ratio in the period 1985-2002 is estimated as 0.71.
- Source: Goldemberg *et al.* (2003)

# Ethanol international market

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- ◆ At 2003, world production of alcohol was larger than 38 billion liters. Brazil has produced 14.1 billion liters, followed by the United States (10.6 billion liters), European Union (2.2 billion liters), and contributions from China, India and Russia.
- ◆ The international trade of alcohol was estimated in 2000 as 3.6 billion liters, mainly for industrial purposes and for beverage production. In 2003 trade reached about 5.3 billion liters. The share of fuel use is growing.

# Ethanol – imports and exports



- ◆ The figure shows net flow of ethanol in Brazil (exports – imports) from 1970 to 2004 (forecast).
- ◆ Exports in 2004 are predicted to reach 2.2 billion liters.

# Virtual market for exports [m<sup>3</sup>]

<b>Country/region</b>	<b>2005</b>	<b>2010</b>
Europe	1,000,000	3,000,000
India	600,000	1,500,000
Thailand	700,000	1,000,000
USA (through CBI)	600,000	1,200,000
Canada	400,000	600,000
Japan	500,000	6,000,000
<b>Total</b>	<b>3,800,000</b>	<b>13,300,000</b>

Note: China is not included. Small markets were also excluded.

CBI: Caribbean Basin Initiative.

# Virtual market - comments

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- ◆ Europe: a directive obliges the use of certain amount of renewables (2-10%) in automotive fuels.
- ◆ US: estimate based on the amount that can be imported through Central America and Caribbean countries (7% of the US market).
- ◆ Japan: based on the estimate of 3% (2005) and 10% ethanol in automotive fuels (2010)
- ◆ India and Thailand are producers and potential exporters. Currently, there is a supply gap.
- ◆ China: market can reach 5 billion liters if 10% ethanol is added to gasoline.

# Ethanol markets – 2010 [billion liters]

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Brazil	15 to 18
USA	18 to 20
Japan	6 to 12
Europe (EU)	9 to 14
Eastern Europe	1 to 2
Canada	1 to 2
Total	50 to 68

China and other Far-Eastern markets are not included. Some authors believe that the market can reach 120 billion liters in 2020.

# International market

## - trends to ethanol exports

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- ◆ There is a certain optimism regarding the enlargement of the alcohol market as some countries are interested in starting to use alcohol-gasoline blends.
- ◆ Brazil has adequate conditions to become an exporter of bio-energy fuels (e.g., adequate weather conditions, land availability, no constraint regarding labor, has technology/know-how).
- ◆ Producers are interested to export ethanol and are enlarging their production capacity.
- ◆ Trade barriers (US and EU) are difficult to be overcome.

# Additional remarks

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- ◆ Ethanol industry is well established in Brazil. The production of anhydrous ethanol, for blend with gasoline, assures a market of about 8-10 billion liters; consumption of hydrated ethanol is rising.
- ◆ Sugarcane production in 2004 will reach 380 million tons. In 5-10 years it will be necessary to rise the production to 500-550 million tons.
- ◆ Currently, Brazil answers by 40 per cent of the exports of sugar and by almost 40 per cent of the exports of ethanol.
- ◆ Considering exports, there is some constraints regarding logistics, despite recent investments.