

**Expert Meeting on
Participation of Developing Countries in
New Dynamic Sectors of World Trade:
*Review of the Energy Sector
Adjusting to the New Energy Economy***

**Panel 4
The technological dimension of biofuels**



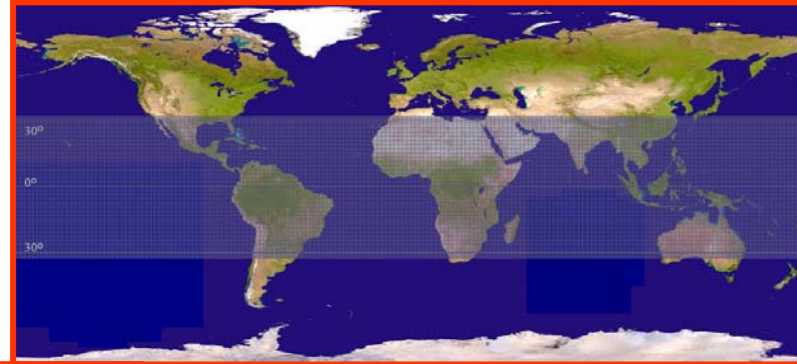
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Energy Research Group
Director
Geneva, 29 November – 1 December 2006



Why biomass is an effective alternative for Brazil

Brazil has a great potential to bioenergy (biofuel and bioelectricity)

- **Favorable geographic and natural conditions**
 - land quantity available to agriculture
 - soil characteristics
 - privileged climate conditions (sun, rain and etc.)



- **Technology developed**
 - ethanol
 - biodiesel
 - cogeneration from bagasse
 - other uses

- **Low production cost**

Country/Region	Ethanol Production Cost (US\$/liter)
Brazil	0.22-0.28
United States	0.30-0.35
European Union	0.45-0.55

Sources: Henniges, O.; Zeddies, J.: Fuel Ethanol Production in the USA and Germany – a cost comparison, F.O. Lichts World Ethanol and Biofuels Report, vol 1, nº 11, 11/02/2003.

Biomass from sugarcane is an effective alternative

Sugarcane has a high energetic contents



153 kg sugars and alcohol → 608×10^3 kcal

276 kg bagasse (50% humidity) → 598×10^3 kcal

165 kg cuts & leaves (15% humidity) → 512×10^3 kcal



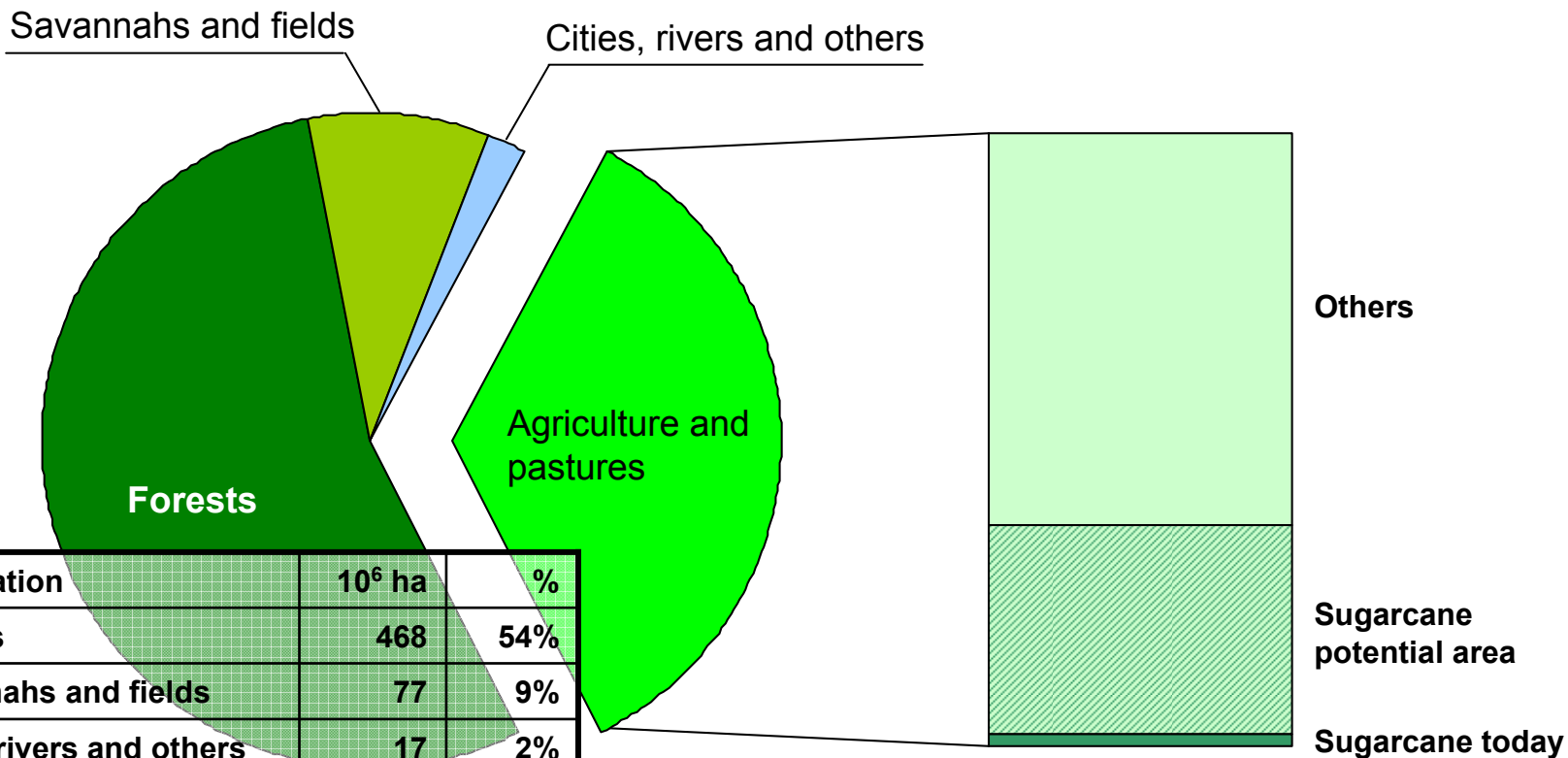
1 ton sugar cane
 $1,718 \times 10^3$ kcal

1 crude oil barrel
 $1,386 \times 10^3$ kcal

1 ton sugar cane = 1.2 crude oil barrel



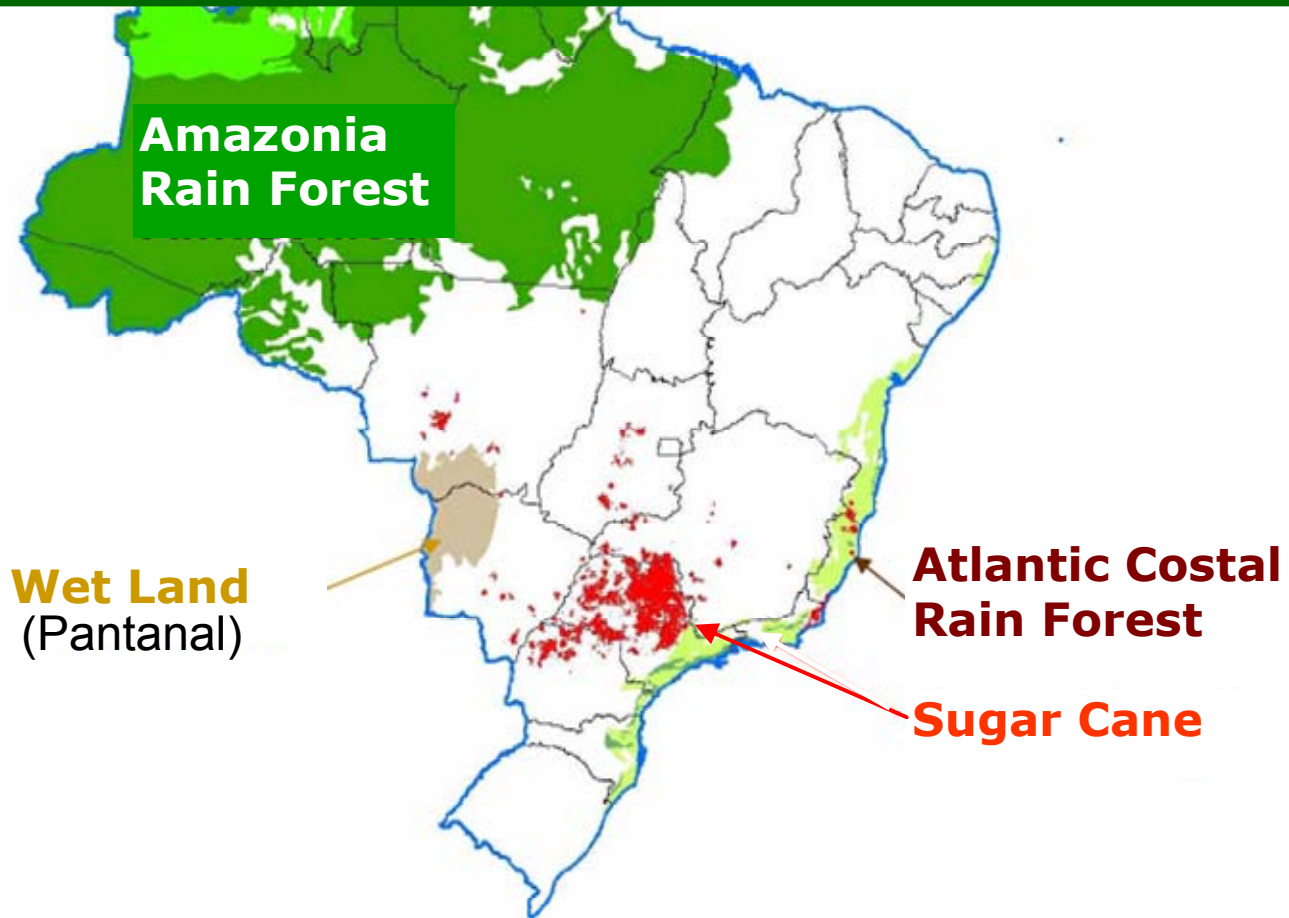
Occupied area by agriculture and biomass production in Brazil



Occupation	10 ⁶ ha	%
Forests	468	54%
Savannahs and fields	77	9%
Cities, rivers and others	17	2%
Agriculture and pastures	299	35%
• Sugarcane today	5,5	0,6%
• Sugarcane potential	102,0	12%
• Others	197,0	23%
BRAZIL	851	100%

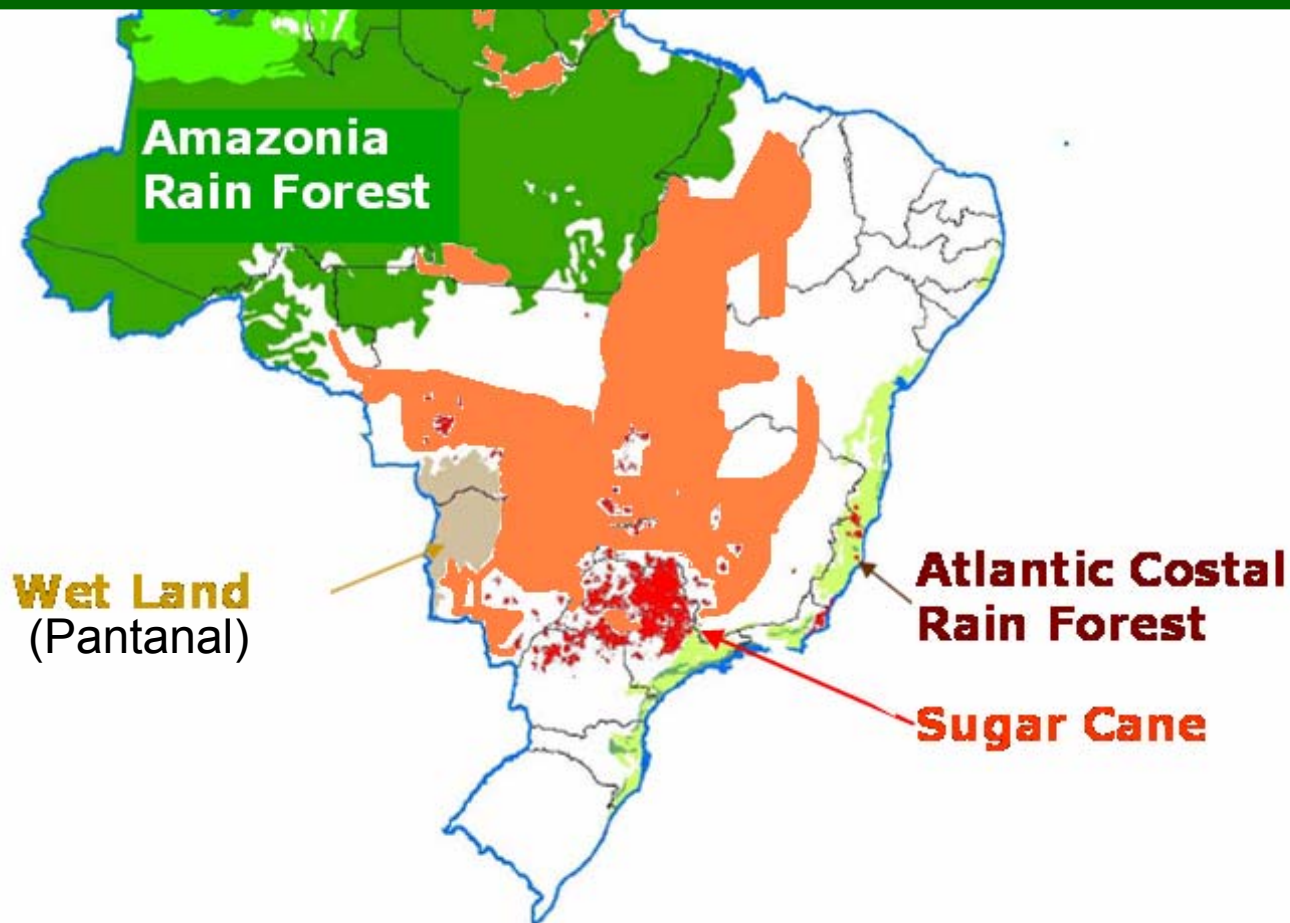


Potential of expansion for agriculture area in Brazil





Potential of expansion for agriculture area in Brazil





Why technology is very relevant for biofuels strategy

Because technology provides

- Managerial agricultural practices
- Sustainable crops
- Plant variety selection
- Maintenance of disease-free crops and biomass
- Efficient harvesting transport and storage
- Control of the plant's maturity and crop's harvest period
- Minimization of losses
- Efficient industrial converting process



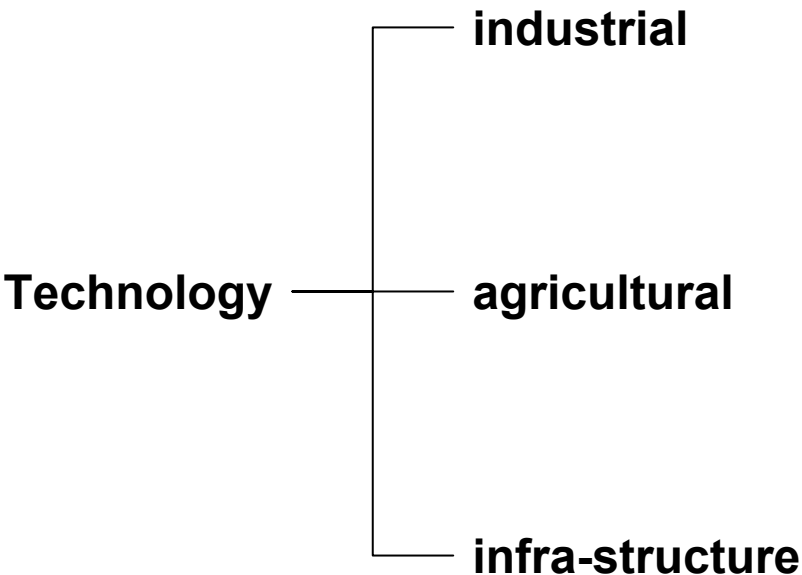
Why technology is very relevant for biofuels strategy

Taking into account

- Soil life
- Water resources
- Minimization of environmental impacts
- Social-economic small rural communities inclusion
- Projects legitimating (*social and environmental acceptance*)



Which technological conditions are necessary for developing countries to become efficient biofuel producers

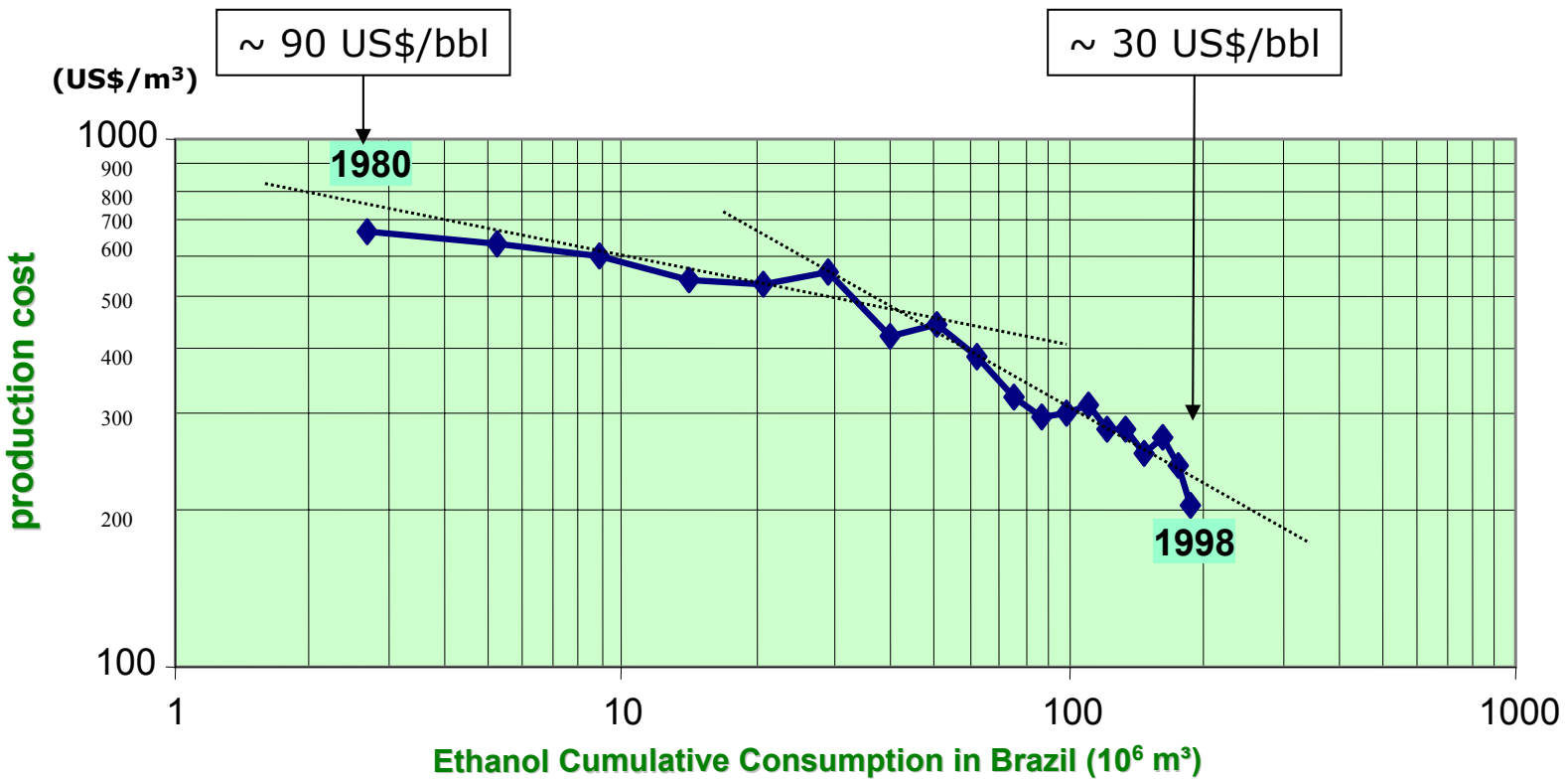


- Industrial technology could be transferred successfully from country to country
- But, production chain is much complex and depends on domestic capabilities in all three technological dimensions
- For a worldwide biofuels market, all the technological dimensions are very relevant for developing countries and each one should be improved
- Regarding to industrial and agricultural dimensions, Brazil is in advanced stage, specially for sugarcane and crops
- Brazil has still to make improvements in its infra-structure system taking into account competitiveness and new technological in order to reach an worldwide scale



Evolution of technology and production meant cost reduction (ethanol anhydrous)

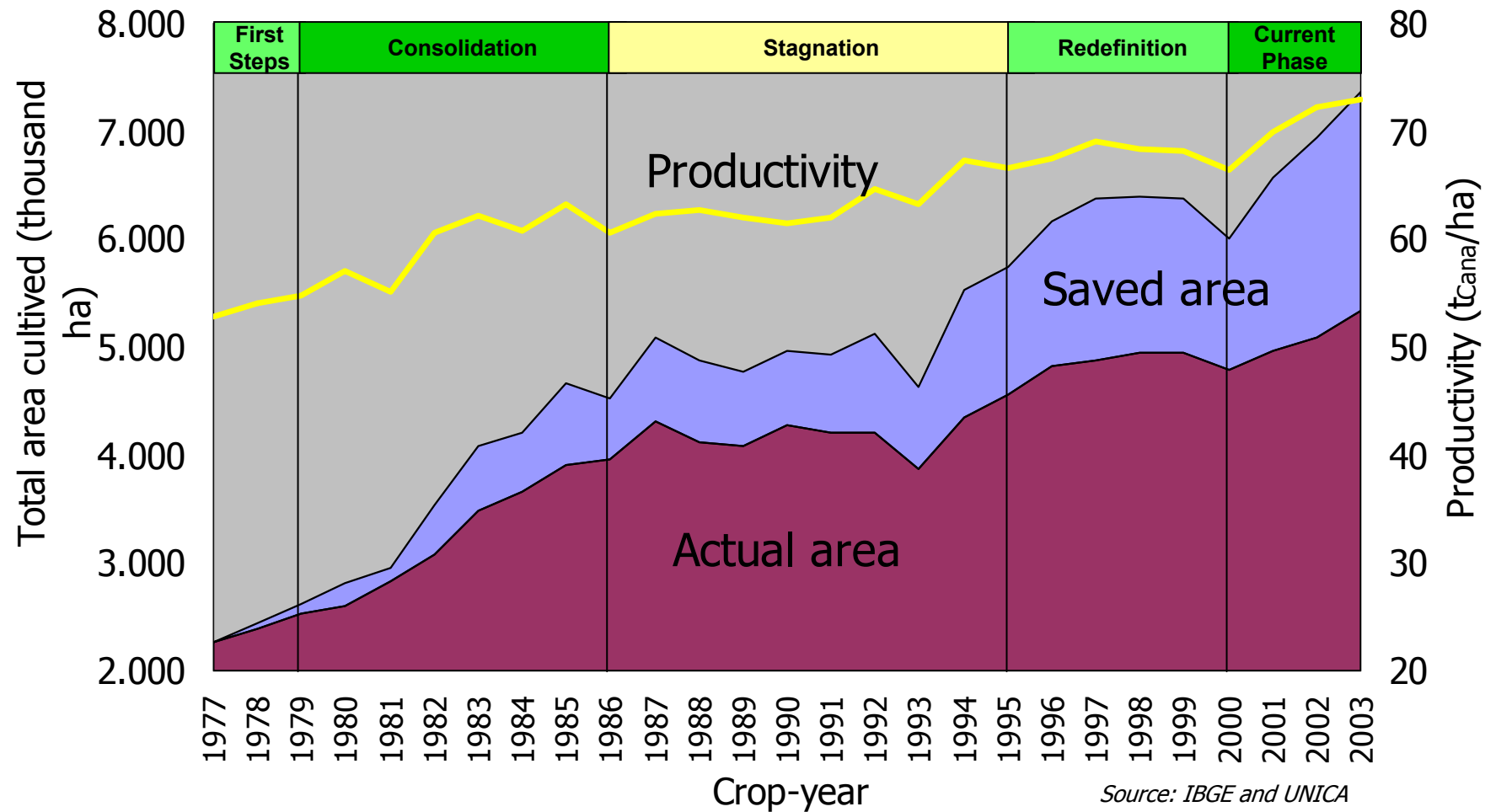
Ethanol cost learning curve



Source: Coopersucar, 1998



Technological progress: productivity and saved area



Source: IBGE and UNICA



Which industrial technology routes are available

Biochemical conversion

Sugar and ethanol plant
Anaerobic digestion
Hydrolysis

Physical-chemical conversion

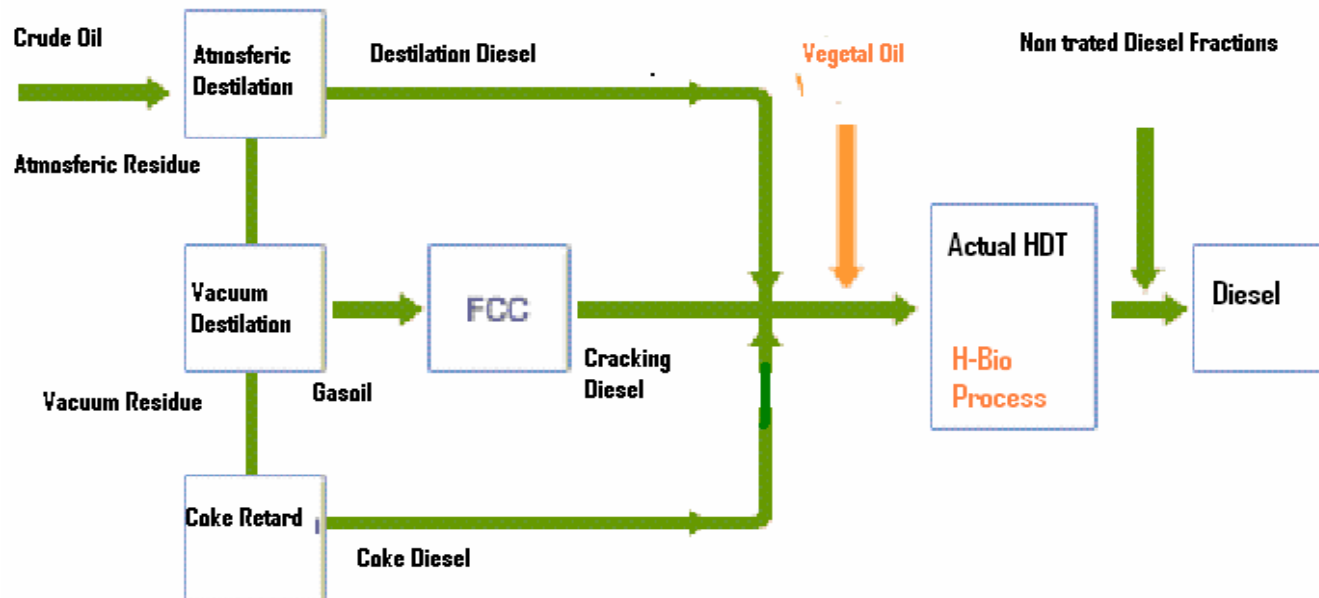
Vegetable oil ► Bio-diesel
H-bio

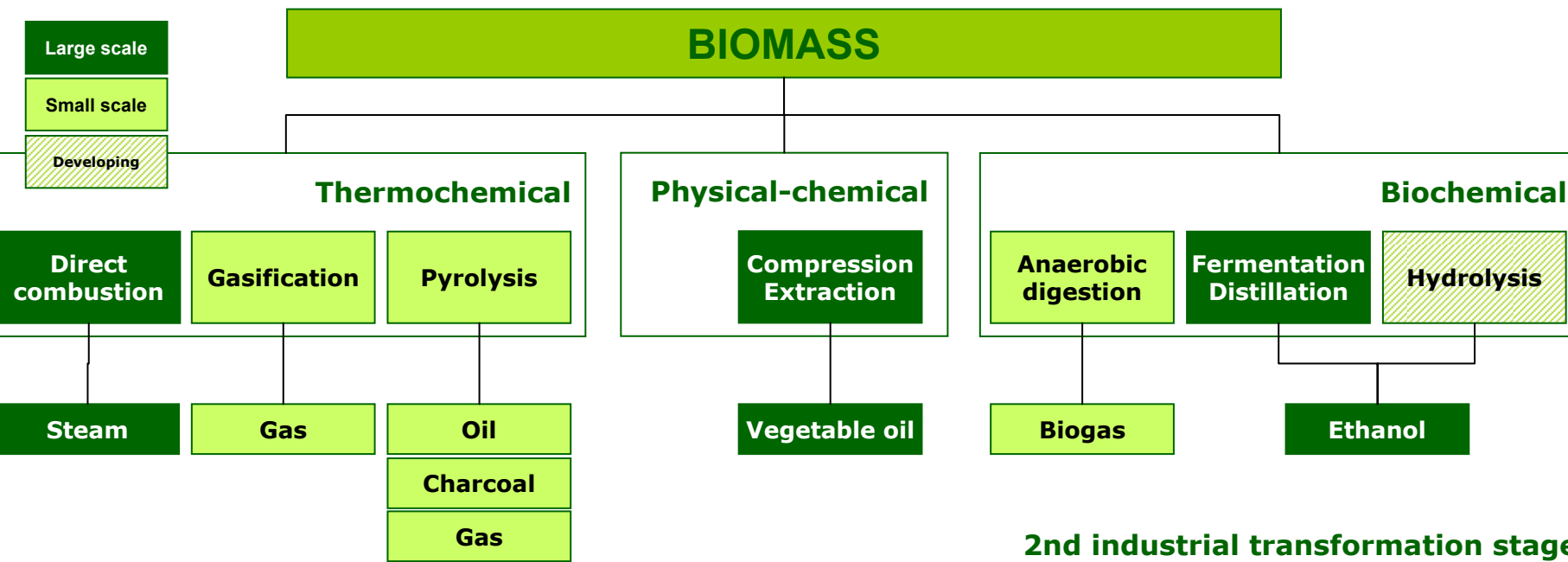
Thermochemical conversion (bio-refineries)



H – Bio process

- Catalytic hydro conversion of a blend of diesel oil and vegetable oil, in a HDT reactor, under controlled conditions (high temperature and pressure of hydrogen)
- Diesel that comes from this process presents high quality: better ignition, lower density and lower sulphur index
- Up to 2008, five Petrobras refineries will have installed HDT units, and the estimated production is 425 millions liters/yr





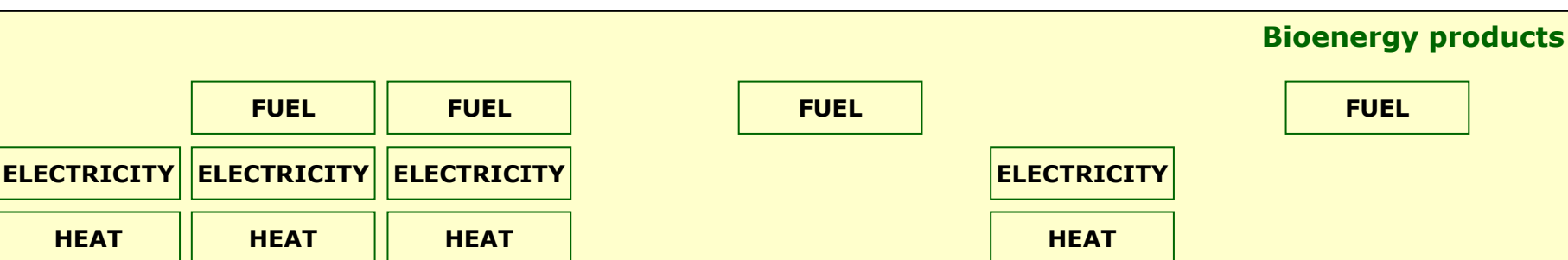
Steam turbine

Gas turbine
Gas engine
Combined cycle
Synthesis gas process

Synthesis gas process
Synthetic liquids refinery

Transesterification (biodiesel)
Oil refinery (H-bio)

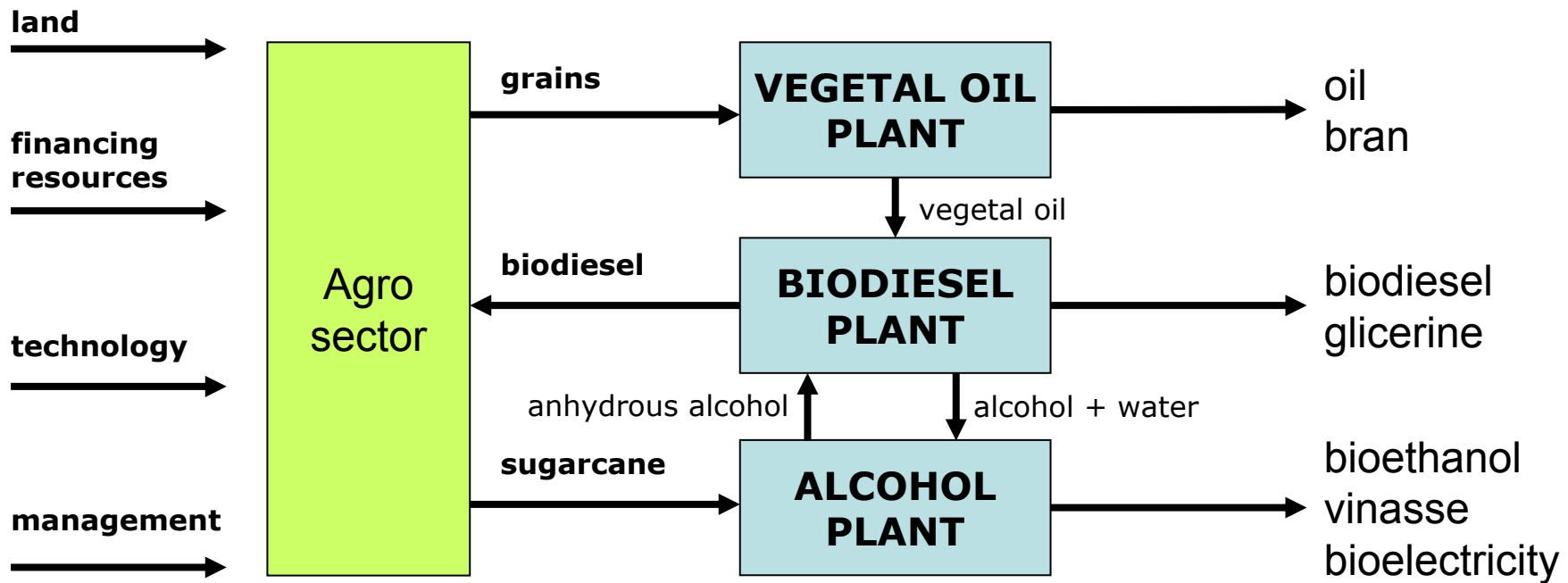
Gas engine
Steam turbine





Agro and industrial integration

Possibility of ethanol and biodiesel integration



Technology is available for agro-industrial integration

Thank you!



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