

Brazilian bioethanol: sustainability debates

Markku Lehtonen
Sussex Energy Group
SPRU, University of Sussex
m.lehtonen@sussex.ac.uk

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1. History and background
 - Role of Brazil in global biofuel markets and governance
2. Debate on Brazilian ethanol – sustainable or not?
 - the role of knowledge and experts
3. Future: innovation, the ‘next generation’, and regional disparities
4. Sustainability certification
5. Conclusions

Bioethanol

- supply more than 40 billion litres in 2007
- projected to grow by a further 20% in 2008 (Gallagher review)

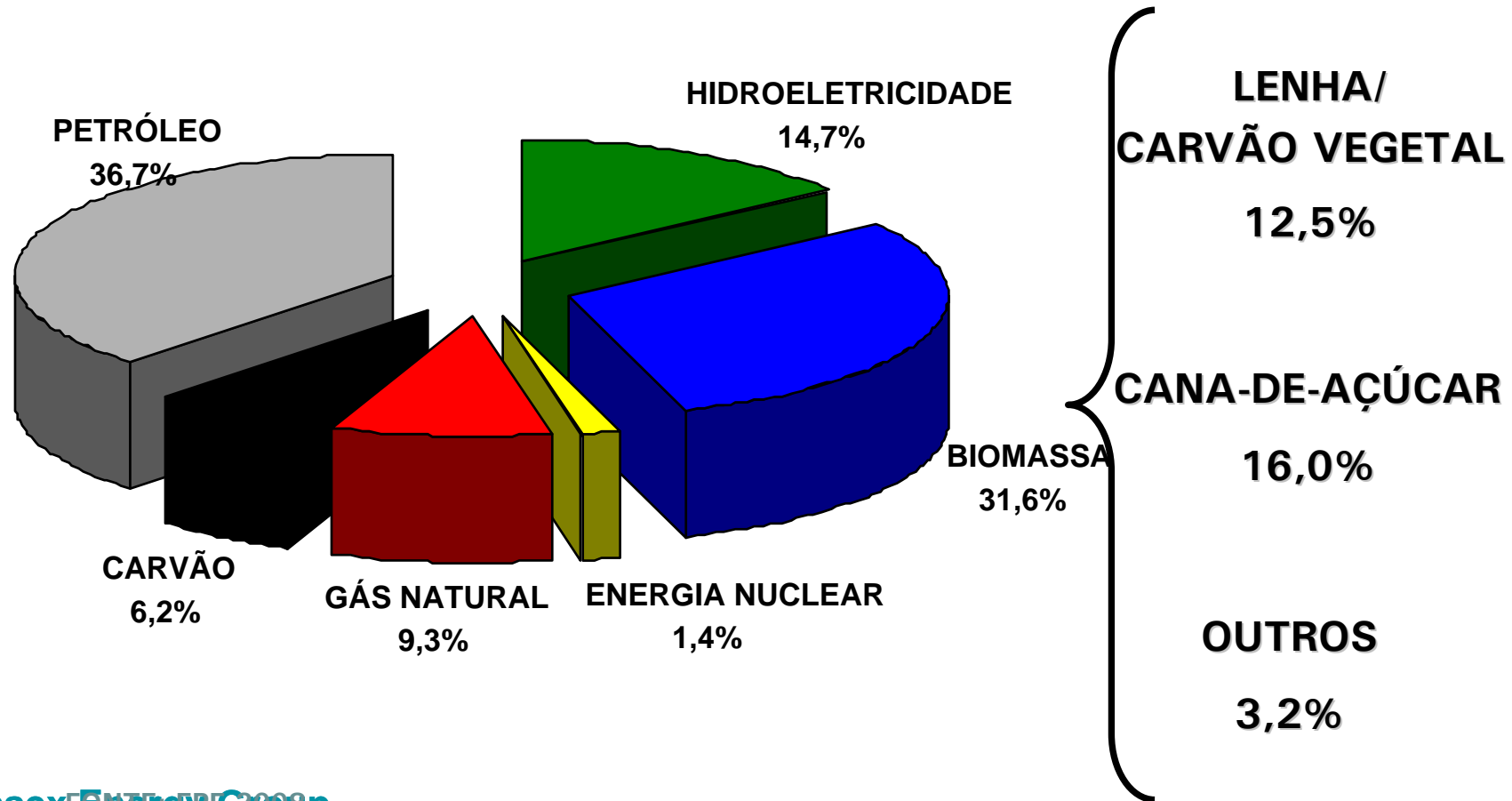
Biodiesel

- 10 billion litres in 2007
- use centred in the EU

Future biofuel demand

- Expected significant growth: USA, Brazil, EU, China and India
- Drivers: climate change, energy security and farming sector crisis

Brazil's energy mix 2007



Production

- ~40% of world's ethanol production
- **sugarcane output**: 11% annual increase 2001 - 2008
- **ethanol output** to more than double between 2005 and 2015

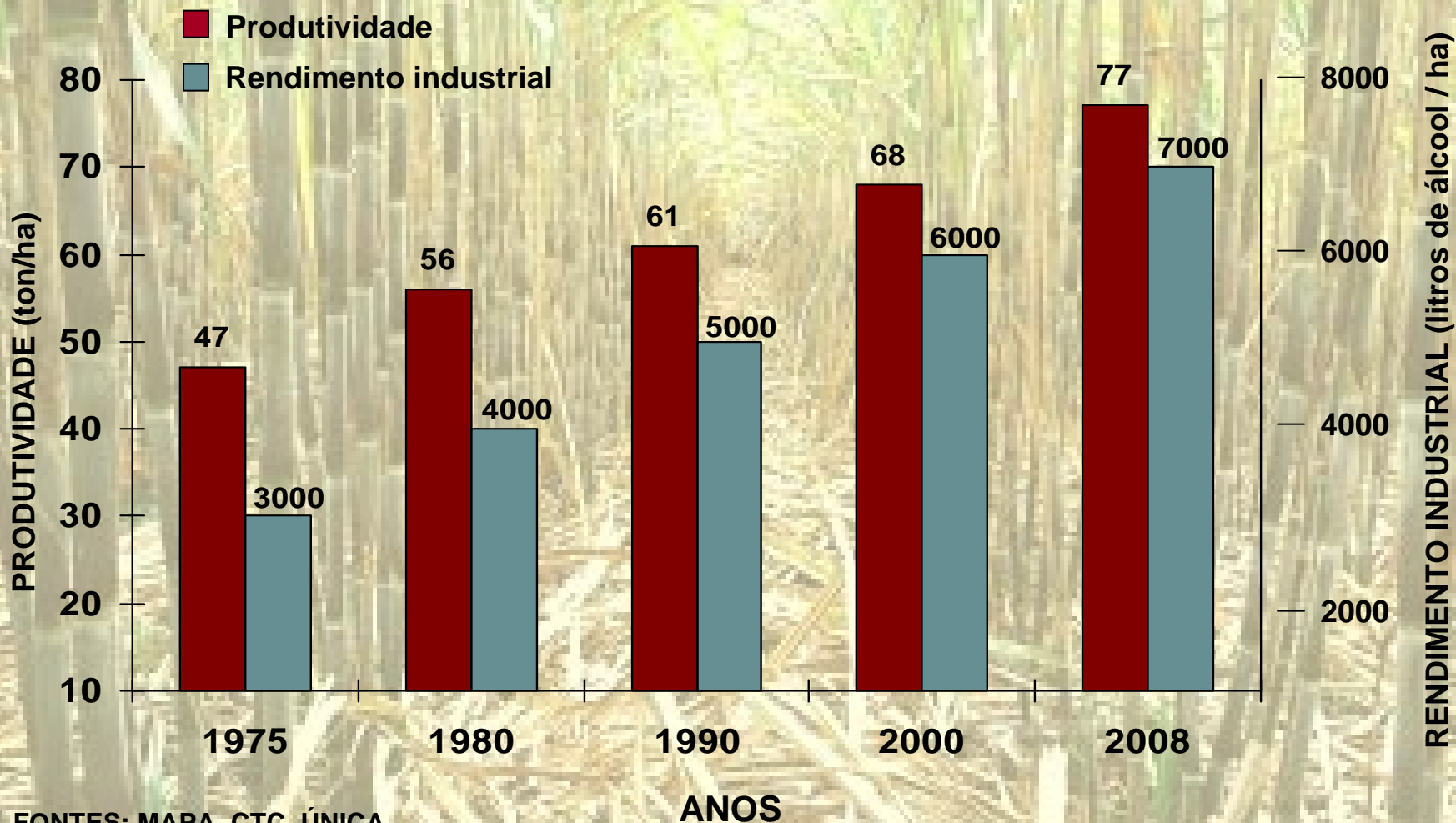
Trade

- 60% of world ethanol trade (2005)
- **growth in exports** a major driver
 - near tripling expected between 2008 and 2015 (mostly USA)

Brazil's future ambition

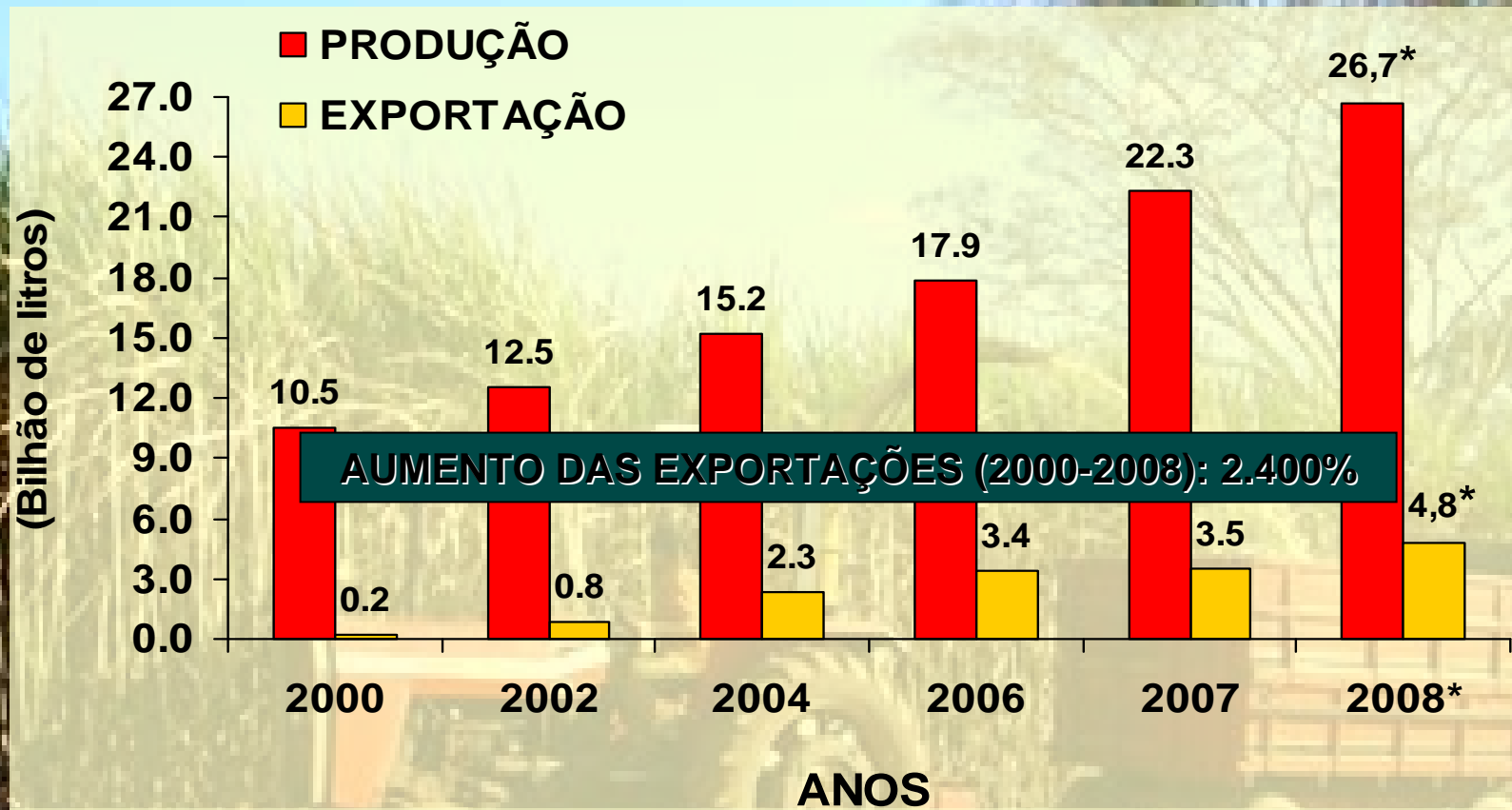
- create a global biofuel market
- become a major exporter of biofuel **and biofuel technology**

GANHOS TECNOLÓGICOS DE PRODUTIVIDADE E DE RENDIMENTO INDUSTRIAL DA CANA-DE-AÇÚCAR NO BRASIL



FONTES: MAPA, CTC, ÚNICA.

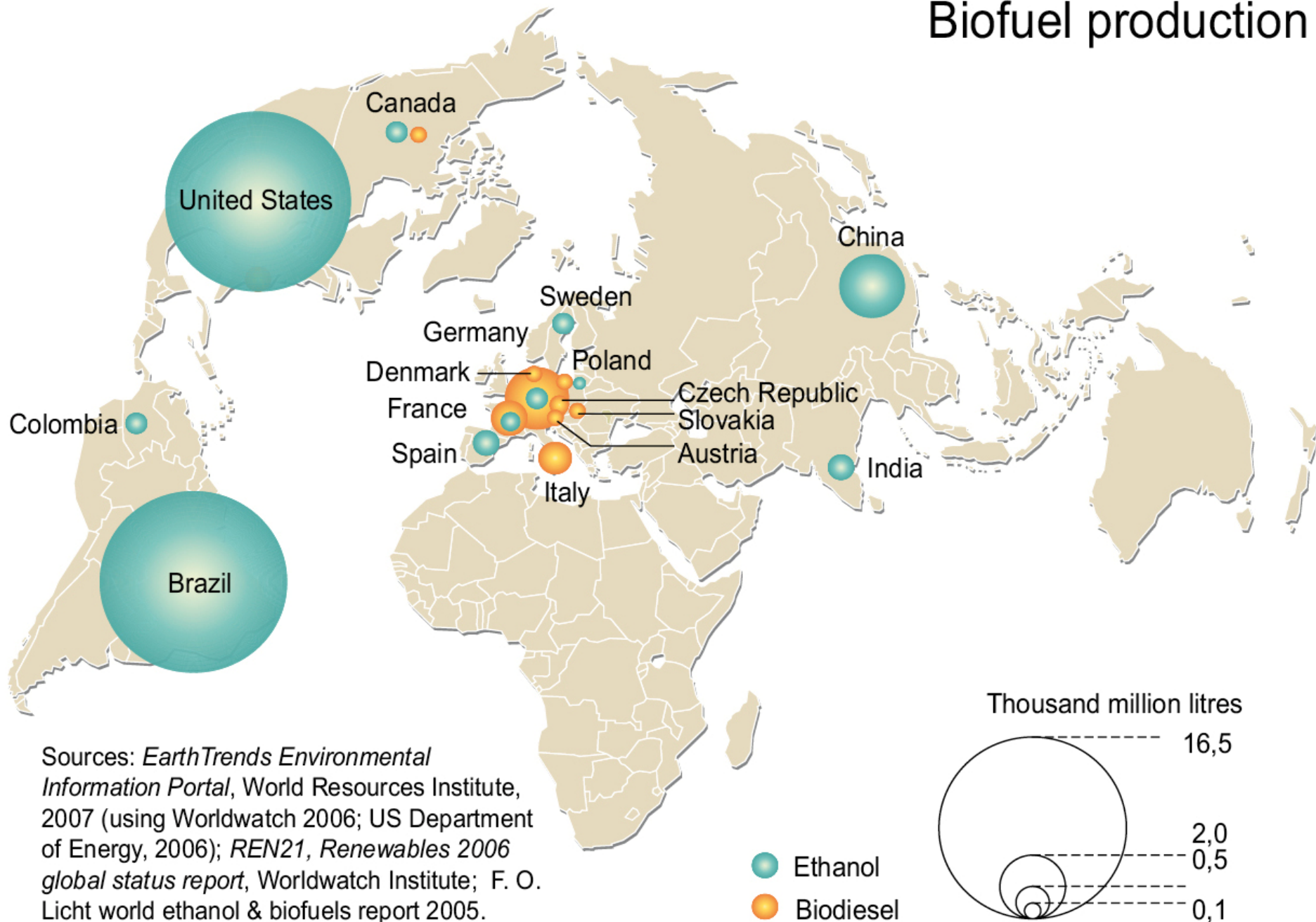
PRODUÇÃO E EXPORTAÇÃO DE ÁLCOOL BRASILEIRO



* PREVISÃO

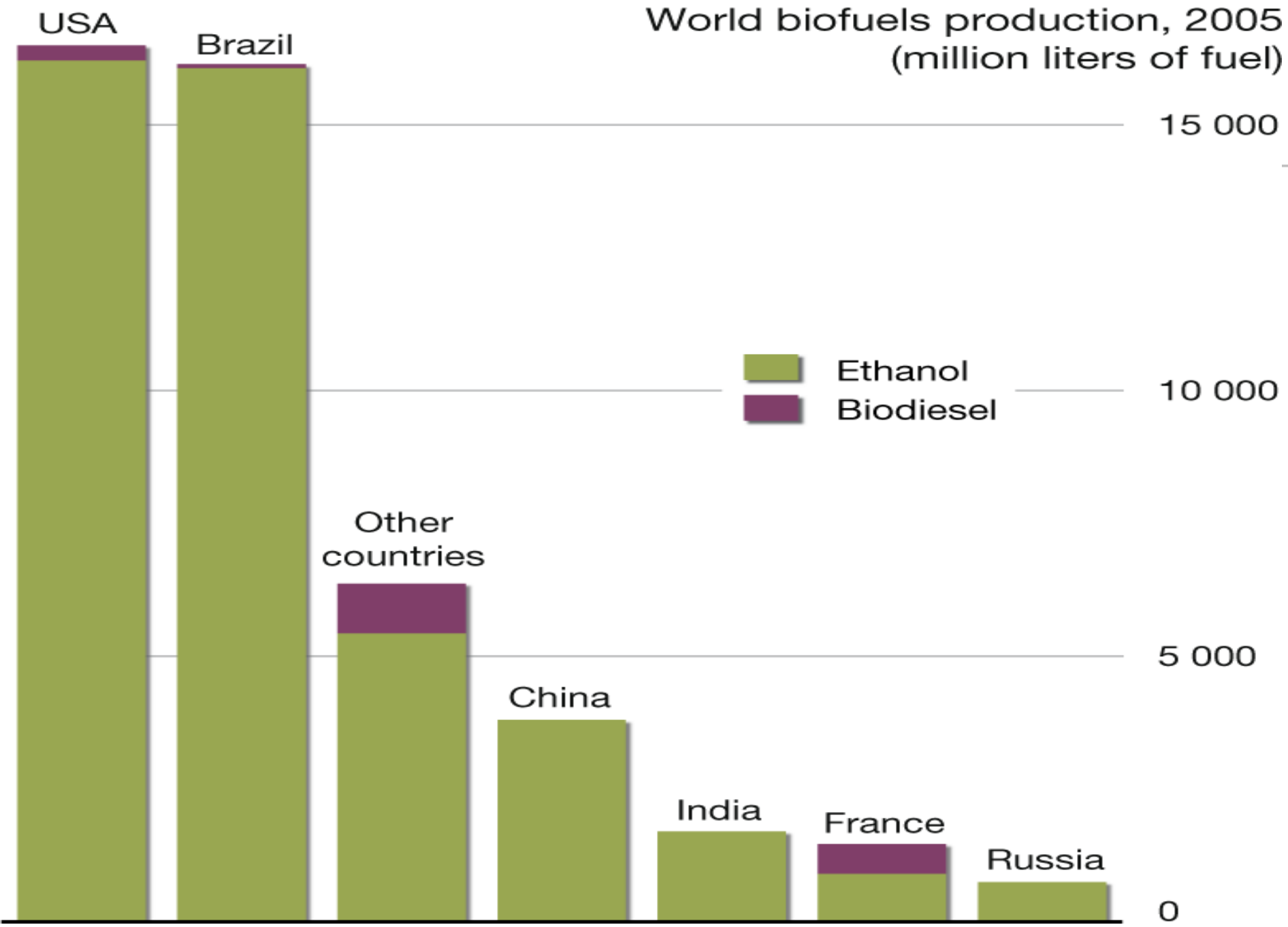
FONTE: MAPA, MDIC, CONAB.

Biofuel production



Sources: *EarthTrends Environmental Information Portal*, World Resources Institute, 2007 (using *Worldwatch 2006*; US Department of Energy, 2006); *REN21, Renewables 2006 global status report*, Worldwatch Institute; F. O. Licht world ethanol & biofuels report 2005.

World biofuels production, 2005
(million liters of fuel)



1975-1985

- oil and sugar sector crises: sugar lobby & economic miracle
- considered “economic madness” in the 1970s and 80s

1986-2000

- declining oil prices
- democracy and liberalisation: phase-out of subsidies
- productivity improvements and the “ethanol learning curve”

2002-

- flex-fuel cars and the revival of ethanol
- beginnings of a global biofuel market

Sustainability of Brazilian bioethanol: the controversies

- Lively debate within Brazil on the sustainability of biofuels (ethanol in particular)
- Forced consensus among Brazilians in international arenas?
 - National pride
 - Commercial interests
- Role of experts in the controversy; pluralist expertise?

Is the production of liquid transport biofuels the *best use of biomass* to

- combat climate change?
- strengthen energy security?
- provide viable jobs in the rural areas?

Who pays and who benefits?

- Car-owning elites vs. the poor sugar and ethanol sector workers

The Environment

Environmentally the most sustainable among current biofuels

- 86% less GHG than petrol (Macedo et al. 2008)
- Water, fertiliser and pesticide use lower than for most biofuels
- Distillery effluents recycled to the fields for ‘ferti-irrigation’
- Burning of sugarcane fields being banned
- Sugarcane replaces pasture and agricultural land; very little forest (some concerns over ‘cerrados’ – savannah lands)
- Abundant land available in Brazil (cane 2% of agric. area)

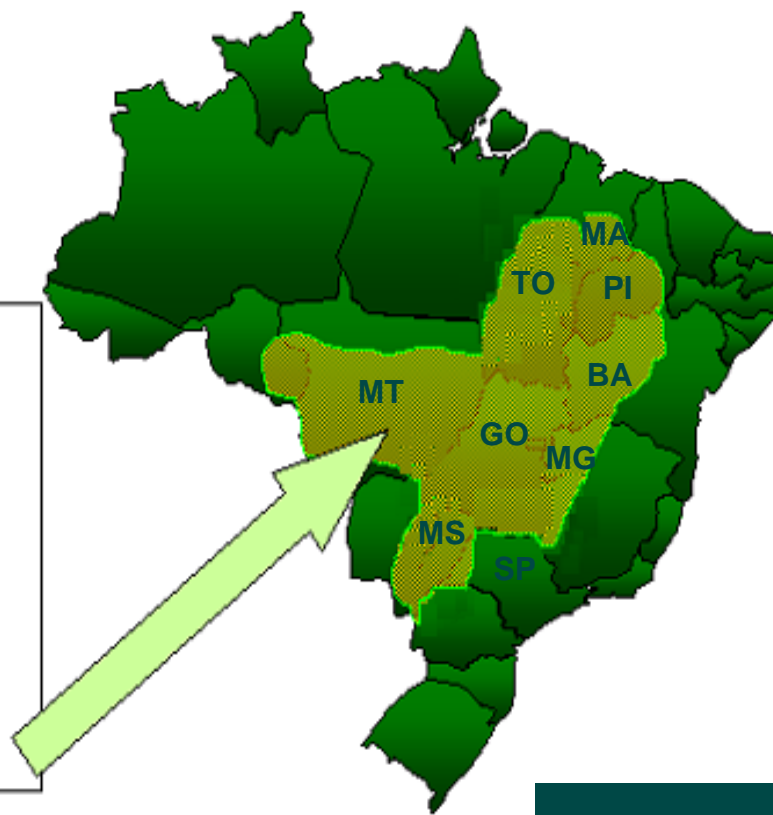
Problems exist, but they are manageable

Potential for expanding production in Brazil

Área de Expansão do Cerrado Brasileiro

(milhões hectares)

- Área Total	204
- Área Agricultável	137
- Pastagem	(35)
- Culturas Anuais	(10)
- Culturas Perenes e Florestas	(2)
- Área Disponível	90



The consensus view: a convenient technocratic illusion?

- **GHG**: three studies as the sole basis – indirect impacts uncertain
- **Water**: irrigation increasing together with demand & profitability
- **Ferti-irrigation & nitrogen**: debate over the uptake of N by cane
- **Herbicides**: inappropriate handling, chemicals forbidden in EU...
- **Cane field burning**: implementation and enforcement; costs, topography; the Northeast!
- **Biodiversity**: indirect and induced impacts from sugarcane expansion? – implementation & enforcement of e.g. forestry code...
- **Land** available, but *whose land?*

Economics

Brazilian ethanol – the only economically viable biofuel?

- Competitive at oil \$35-45 / barrel
- Savings in avoided oil imports: £61 billion in the last 8 years
- Technological and institutional capacity in bioethanol cluster
- But:
 - no subsidies, but huge funding to the sector by **BNDES**
 - **opportunity costs** (e.g. foregone sugar export revenue)
 - WWI 2006: savings \$10.4 bn but costs \$9bn 1975-1987
 - technological and institutional **lock-in**?
 - **30 years of support** to reach economic viability; R&D \$207 million
 - **tax differential** petrol / hydrous ethanol; mandatory blend

Social

Social inequality persists, but is not caused by ethanol...

- More jobs for **skilled** workforce
- Workers' **health**: higher daily cutting requirements, pesticides & chemicals, child labour, air pollution from sugarcane burning...
- **Mechanisation**: Quality vs. number of low-skilled jobs:
- **Food vs. fuel**: no direct substitution, but Brazil a major food exporter: land prices, land ownership, global food prices...
- Sugarcane inherently **large-scale**?
- **Regional disparities**: innovative, prosperous São Paulo vs. **stagnant**, poor Northeast

	Total Popul- ation, 2006 (000s people)	GDP per capita, 2004 (R\$)	Urbanization Rate, 2006 (%)	Illiteracy Rate, people 15+, 2006 (%)	Households benefiting from social assistance programs, 2006 (%)
North		6,500	75.6	31.6	37.6
North-East	15,080	4,927	71.4	45.5	29.4
Central- West	51,713	10,324	86.3	9.6	4.2
South-East	13,313	12,540	92	3.5	6.7
South	79,753	8326	82.9	2.8	11.8
BRAZIL	27,368	9,729	83.3	7	10.4

Source: IBGE.⁸²

Regional variation in science and technology

Region	Innovative activity (Patents per million people)	Technological penetration (Internet users per 1,000 people)	Human Capital		Financing	
			Enrolments in higher education per 1,000 people	Share of total number of higher education students	Number of incubators, 2006	Share of government S&T spending
North	2.45	90.5	16.6	5.7	14.0	1.99
North-East	2.98	95.0	13.2	15.7	63.0	10.08
Central-West	2.85	188.6	28.9	9.7	28.0	0.89
South-East	31.08	219.3	25.8	49.7	127.0	70.32
South	48.27	213.0	29.0	19.0	127.0	16.72

Power and landownership in the Northeast

- Today ~20% of Brazilian sugarcane (>50% in the 1950s)
- ‘Sugar barons’: economic and political elite – ‘feudalism’

Subsidies under Proálcool:

- benefited the rich and powerful aristocracy
- prevented diversification of agriculture
- allowed unproductive producers to stay in business

Consolidation of the centre-periphery relationships?

- 1975-86: state subsidies
- 1987 - : subsidy removal – concentration and polarisation in NE
- 2000s: investments by NE elite in São Paulo

The role of the ‘North’: technological development and certification

Demand for sustainable biofuel in EU & USA – Brazil to the rescue?

Ethanol – US (and EU) demand
(Soy) biodiesel – demand from the EU

Debates on:

- GHG and energy balances
- direct and indirect land use change
- biodiversity & other environmental impacts
- food vs. fuel dilemma

On all these counts, Brazilian ethanol fares rather well, but...

...is ethanol a part of the problem or part of a solution?

Biofuel (ethanol) does not explain inequality, but will further expansion aggravate or help to alleviate it?

Improved conditions in São Paulo; stagnation or decline in the Northeast – whose progress?

It is not only the expansion (marginalist analysis), but the broader picture that counts – 500 years of Brazilian sugarcane history...

Technological innovation: the next generation promise

Will they deliver?

- Near consensus: 15 years to commercial viability
- Uncertainty & expectations: in whose interest?
- Next generation technologies or the next biofuel bubble?

Who benefits if they do deliver?

- Can NE rise as a result of innovation? Does it have the capabilities?
- Pro-poor next generation innovation – an illusion?

Brazil's role in a next generation world?

- US, Europe and Brazil: who holds the technological lead?
- South-South technology transfer & Brazil's 'ethanol diplomacy'?

Concentration of ethanol-related innovation in São Paulo (Bound 2008)



- **Universities:** São Paulo (USP), Campinas (Unicamp), UNESP
- **State research institutes:** Agronomics Institute of Campinas; Embrapa
 - Centre for Bioethanol Science and Technology – 2008 (Campinas)
 - FAPESP (SP state funding agency for S&T)
 - SUCEST: 50 laboratories – world's largest in sugarcane genomics
 - BIOEN: ~ 100 SP scientists & world's largest manufacturer of ethanol mills
- **Private sector**
 - The sugar cane technology centre (CTC), Piracicaba, SP
 - Petrobras: 5% of R&D budget (of US\$1billion) on biofuels
- **Northeast (Pernambuco)...**? IT, pharmaceuticals, wine industry

Biofuel sustainability certification

A chance to break the unequal power relations... or,
lost markets as a result of non-compliance?

Who defines the criteria & process of certification?

- Capture of certification by the NE (and SP) elite?
- Naivety of European (and Brazilian) experts?
- Certification as a violation of national sovereignty?

Evidence-base, participation and authority - local & global

- indirect impacts, uncertainty, lack of quantitative data

Certification process or criteria?

- Certification cannot solve all problems, hence:
 - manage the manageable, quantifiable, or
 - focus on the certification and decision-making process?
- Reformists vs. radicals

Conclusions

- Brazilian ethanol the most sustainable (or least unsustainable...) large-scale biofuel today, but...
- Debate in Brazil on social and environmental impacts
 - Whose development?
- 'Knowledge management' and discursive power: attempts to monopolise the production of authoritative knowledge
- Limits of certification and technocratic reformism?
- Small-scale vs. large-scale development visions
 - agri-business, GMOs, herbicide-resistant sugarcane...?

- Poverty reduction as the explicit objective
- A smokescreen to guard against criticism towards ethanol?
- Soy producers the real beneficiaries?
- “Social seal”: “social” defined and assessed by whom?
- avoiding the pitfalls of Proálcool? (manioc & mini-distilleries)

Challenges: ethics of economics, experts and Brazilian biofuel

1. **Sustainability transitions: can a democratic government achieve what the Brazilian military regime did in the 70s?**
 - **Next generation biofuels?**
2. **Criteria and time-scales of (economic) assessment?**
 - **Economic madness or long-term investment? Visions...**
3. **Whose knowledge? Whose expertise? Whose progress?**
 - **Aggregation vs. disaggregation**
 - **Pluralist methods, participation, multiple levels, power**
4. **Role of Europe**
 - **Technological development and innovation**
 - **Certification and global biofuel politics**

- 1970s-80s: Savings in foreign currency vs. the economic burden of the programme
 - “economic madness”
- Today, a source of innovation, economic prosperity, employment – spearhead of the “natural knowledge economy” (Bound 2008)
- **Criteria and time-scales of economic assessment?**

Ethics, transitions and politics of military government

Proalcohol = creation of the military government, but resulted in:

- 30 years of concerted innovation, active government and private sector investment in technological and institutional development
- economically & environmentally viable ethanol sector

Conclusion: military government needed to create conditions for ethics, justice and development?

Can a civilian government achieve a similar sustainability transition?

Ethics, expertise and (economic) appraisal

- “Neutral” and “objective” expert appraisals, providing unitary recommendations and measuring impacts on a single scale
- Aggregating impacts of different **types**, affecting differently the various **groups involved**, across various **temporal and spatial scales**?
- **Weightings**: relative importance of oil import savings & well-being of the poor in the Northeast?
- Country-averages hide significant **regional and local variation** (e.g. NE productivity stagnation)

- Methods and criteria of appraisal
- Whose knowledge?
- Need for pluralist approaches (pluralist expertise), but how?
 - Multiple scales, multiple resources & power
 - US, EU, Braz govt., biofuel industry, NGOs, farmers...
- Contrasting perceptions on the role of expertise (cf. UK nuclear waste controversies)
- Brazilian experts, state and “ethanol diplomacy”
 - International vs. national debates; national pride...

Conclusions: biofuel ethics, power and expertise

- Brazilian biofuel is the most sustainable in the world – or the least unsustainable...
- Power relations need to be taken into account in all appraisal and decision-making concerning biofuels
 - Power of knowledge, evidence, appraisal: whose knowledge counts?
- Need to go beyond marginalist thinking and adopt a broader view – not only biofuel expansion within the status quo
- Brazil is and will be a major player in global biofuel policy – power within Brazil and power of Brazil's elite
- “Who is Brazil?”

Problems with next generation technologies

Technical

- Infrastructure for collection and transport of feedstock
- Competition with other uses of biomass
- 'marginal' land?

Political & institutional

- Next generation technologies inherently large-scale and capital-intensive?
- Available at commercial scale: 15 years? 3-6 years?
- Inflated expectations: hype-disappointment cycle?
- Algae the growing next biofuel bubble?
- GM crops, organic vs. intensive agriculture

Sustainability of biofuels: lessons for Africa

Environmental

- problems manageable, resources, know-how and adequate institutions

Economic

- Brazil's 30 years of investment in R&D, capacity building, institutions
- Brazilian 'development assistance'?

Social

- problems inherited from sugar industry dating back 500 years
- biofuel as an agent of or obstacle to desirable change?
- need for careful case-by-case analysis

- **Uncertain and variable climate benefits (land conversion)**
 - GHG reductions
 - Energy balance
- **Biodiversity**
- **Food security: ‘food vs. fuel’**
- **Economic costs – farming subsidies**
- **Competition with alternative energy uses of biomass (heat, electricity)**
- **Global availability of agricultural land**

- **Ligno-cellulosic ethanol: wood, farming and forest residues, waste**
- **Algae for biodiesel**
- **Multiplication of productivity per hectare**
 - Up to 30 times current biodiesel production from algae
- **No competition with food crops**
- **Cellulosic crops grown on marginal land**
- **Biorefinery, multiple outputs, bioenergy clusters**

Energy security & independence

Foreign currency savings

- but, loss of import tax revenue (from the import of fossil fuels)
- also, diversion of sugar exports to ethanol for domestic use – loss of export revenue

Employment – biofuels are highly labour-intensive

Technological and industrial development

- capacity building, skills development (technical and project management), appropriate policies throughout the supply chain, R&D

Biofuel sustainability: the environment

Climate, GHG emissions and energy balance

Urban air quality

Biodiversity

- Monoculture cropping & expansion to virgin land

Water consumption

Chemical inputs (fertilisers, pesticides, herbicides...)

Land use change (LUC)

- release of soil carbon (e.g. tropical wetlands)
- direct and indirect LUC

Biofuel sustainability: 'the social dimension'

Food vs. fuel

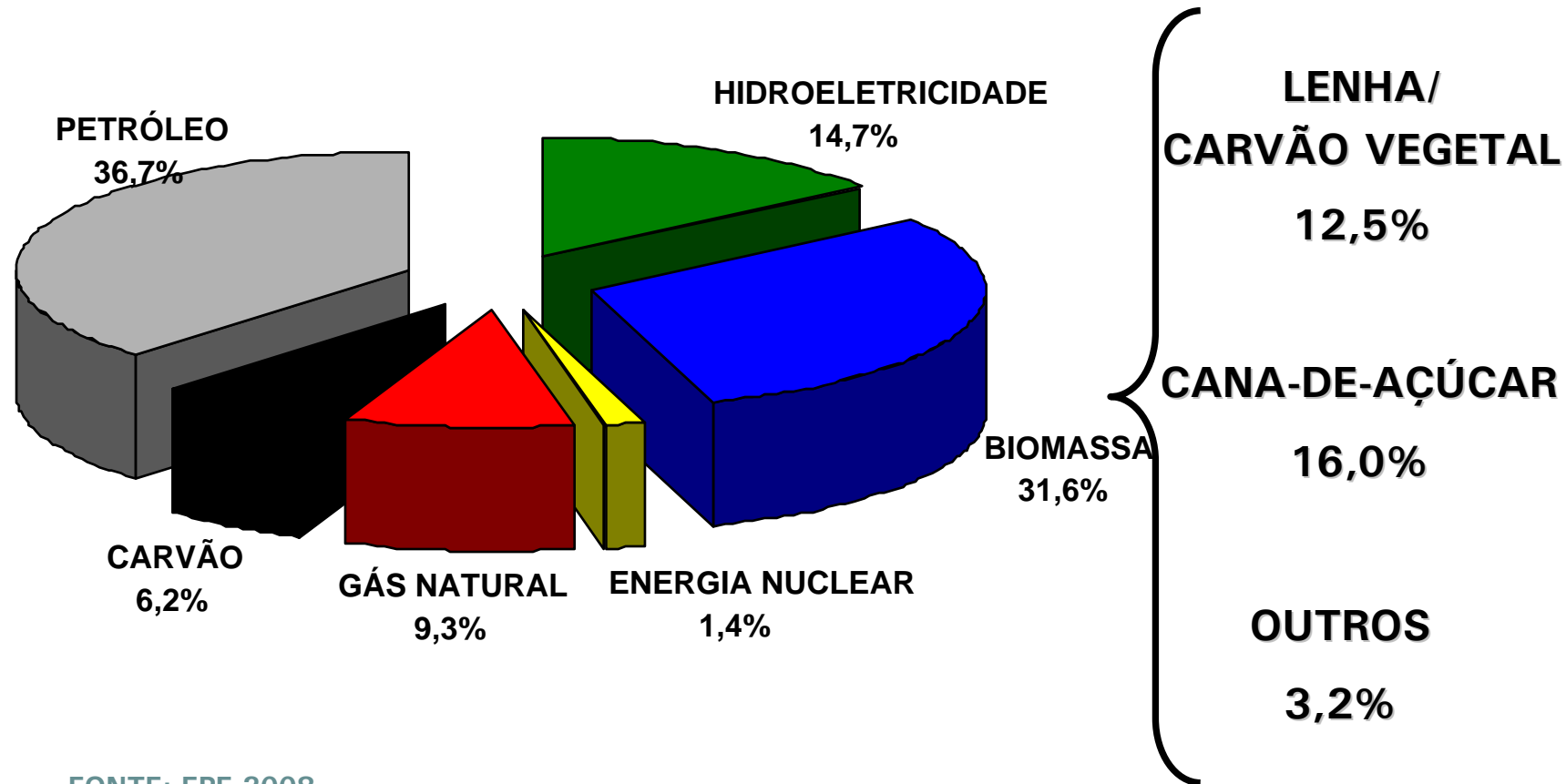
- Food prices
- Land use change

Subsidies to industries: who are to benefit?

Access to land

Power relations and access to decision-making

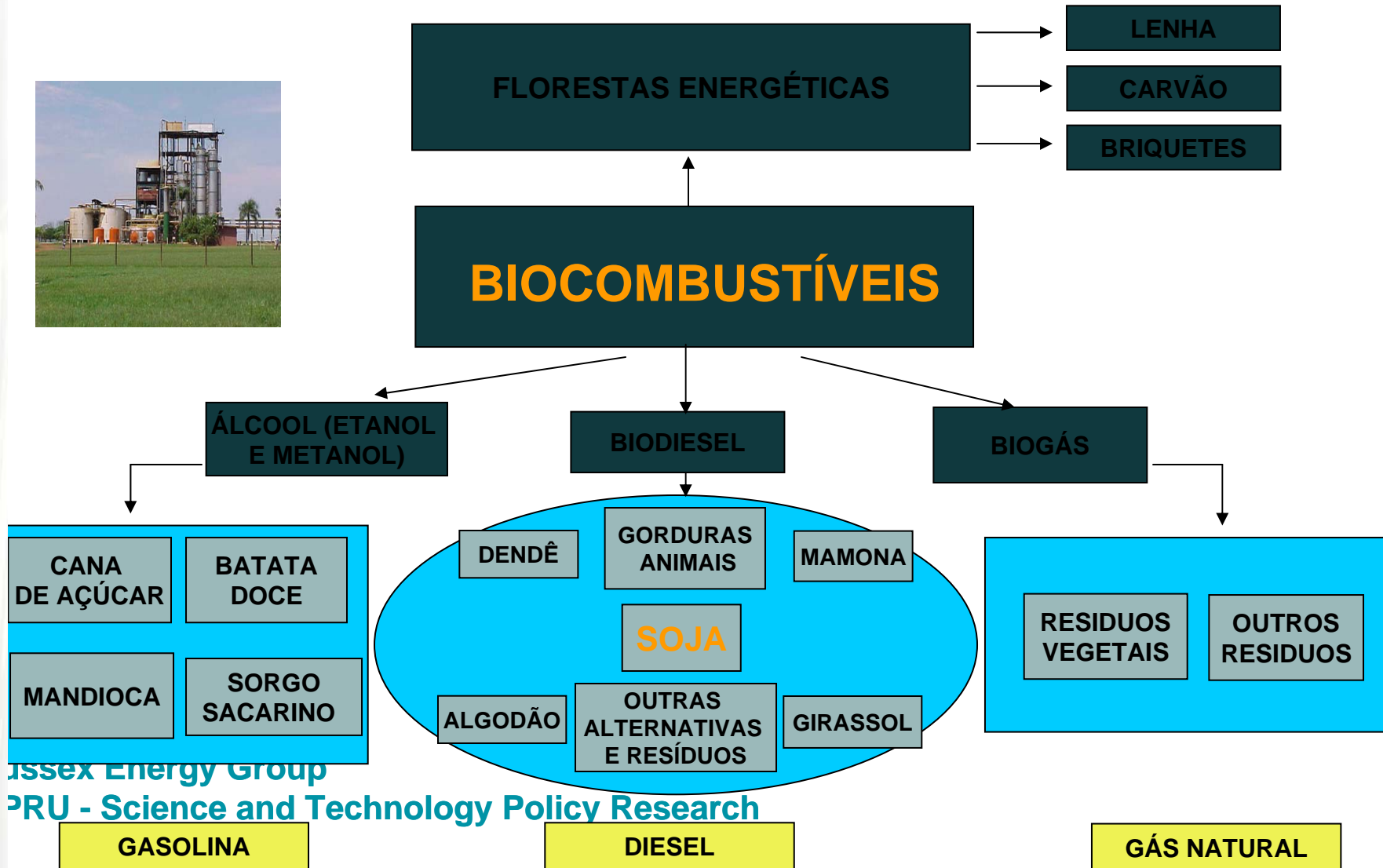
Brazil's energy mix 2007



FONTE: EPE,2008.

**2005: Governo lança o Plano Nacional de Agroenergia,
liderado pela Embrapa;**

Matriz de Produção de Agroenergia



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