LOW CARBON SOCIETY RESEARCH NETWORK
4TH MEETING

17-18 September 2012
Venue: St. Anne's College, Oxford, UK

Sustainable energy development in Brazil

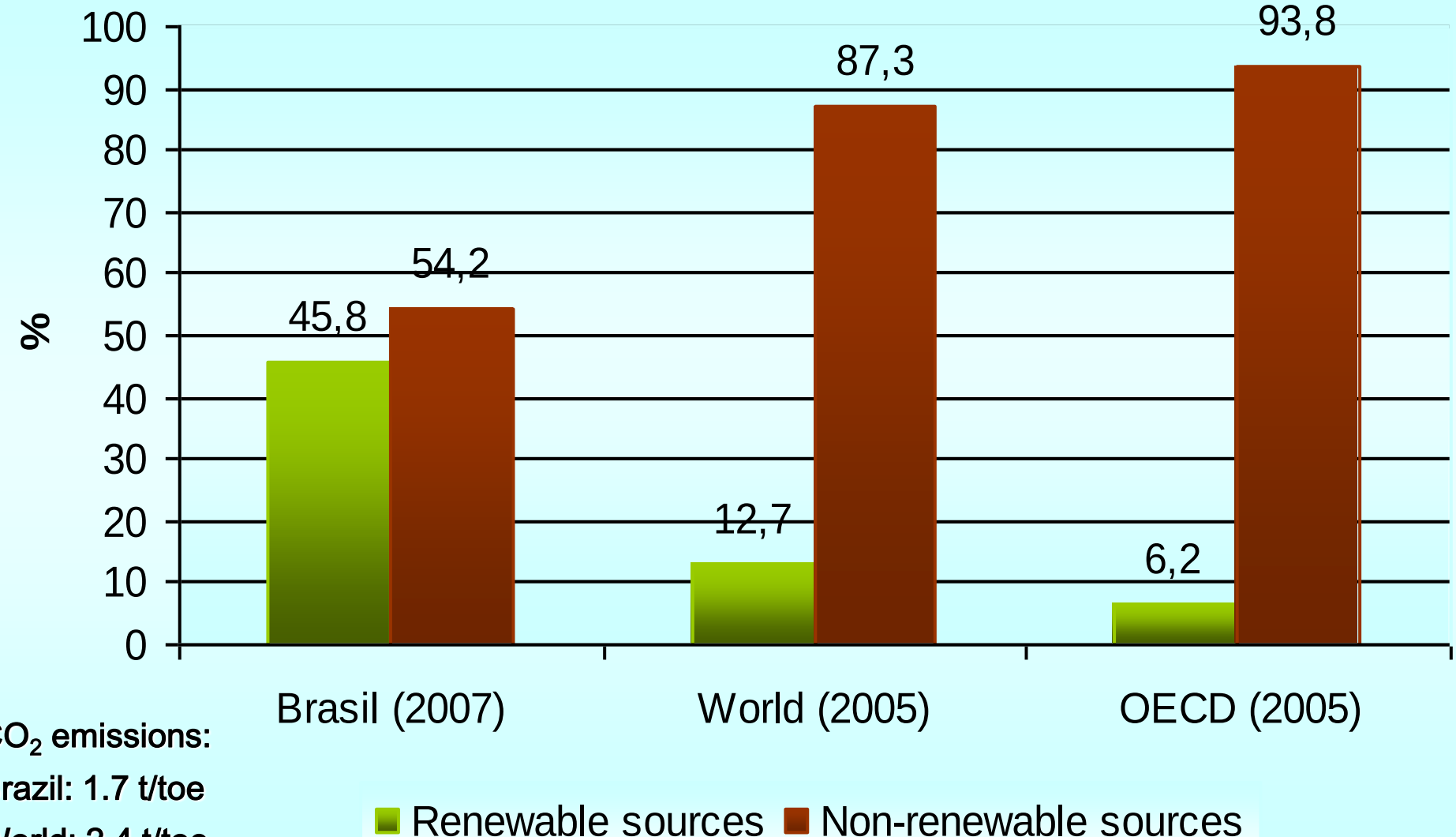
Marcelo Poppe

Center for Strategic Studies and Management

CGEE

World

Global energy sources share



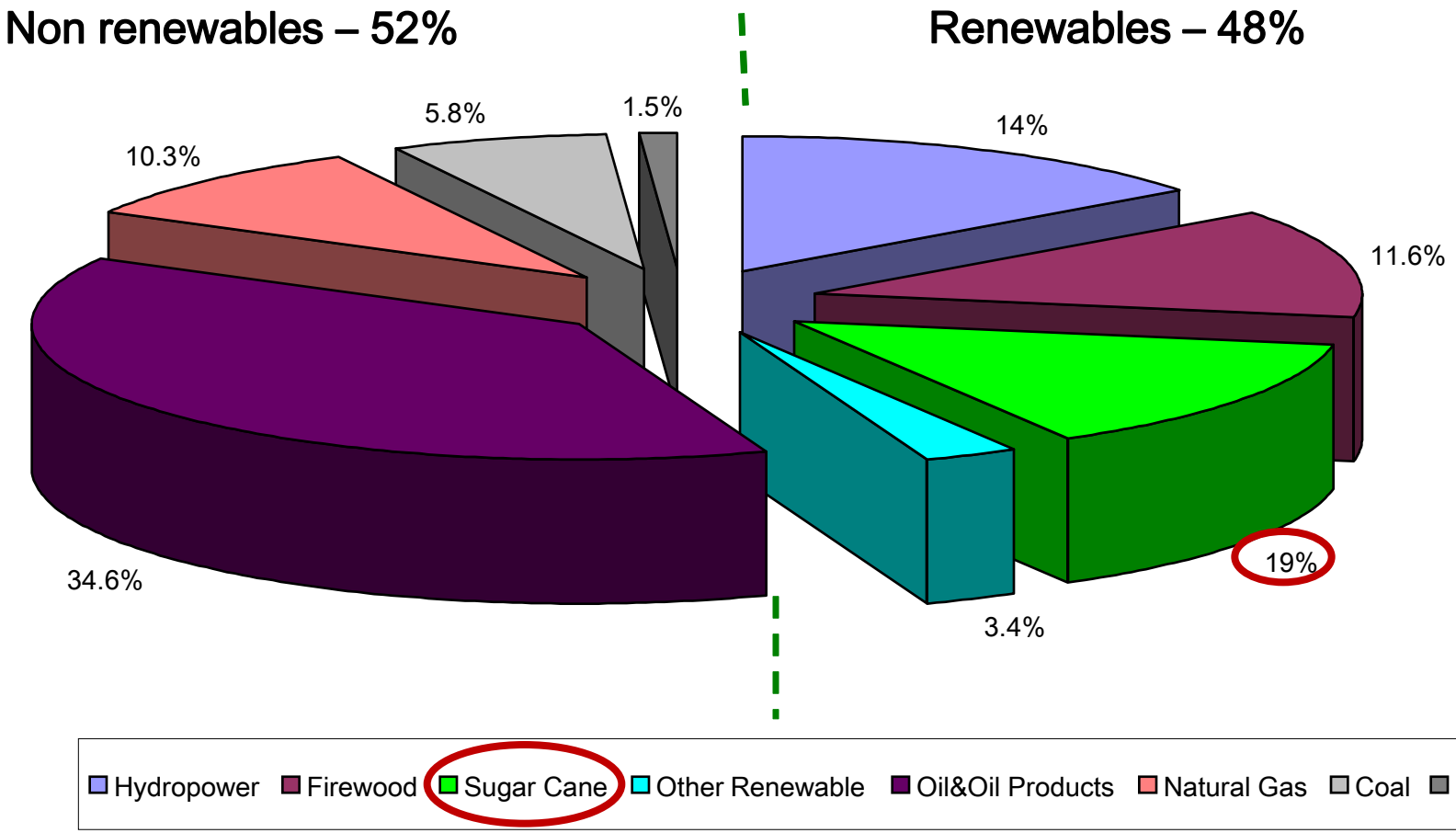
CO_2 emissions:

Brazil: 1.7 t/toe

World: 2.4 t/toe

Brazil

Energy supply

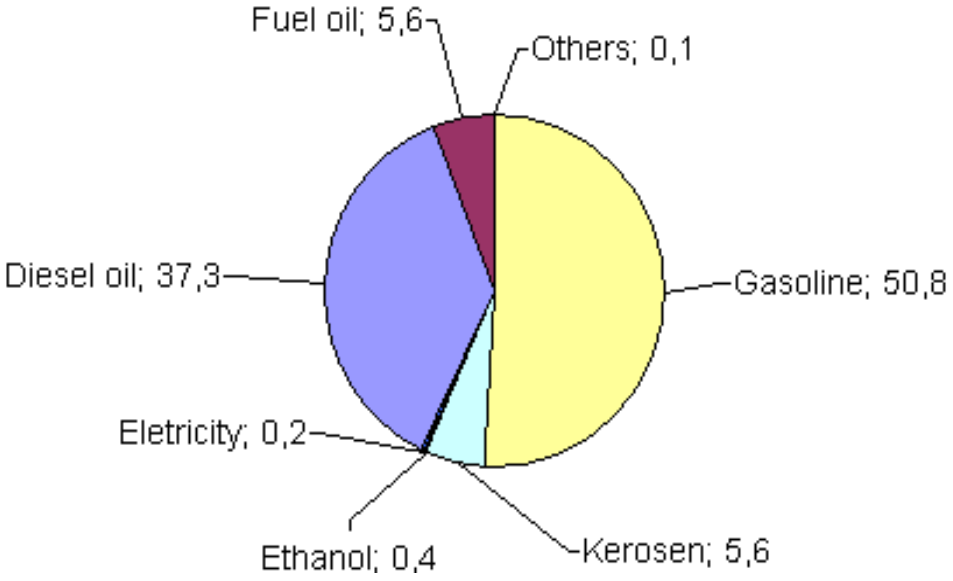


Source: Brazilian Energy Balance 2010

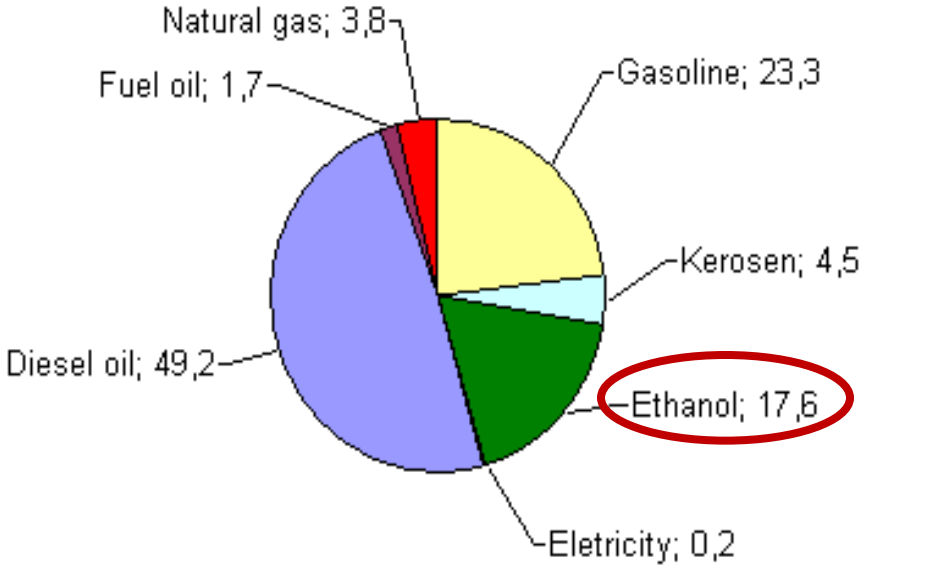
Brazil

Energy pattern transport sector

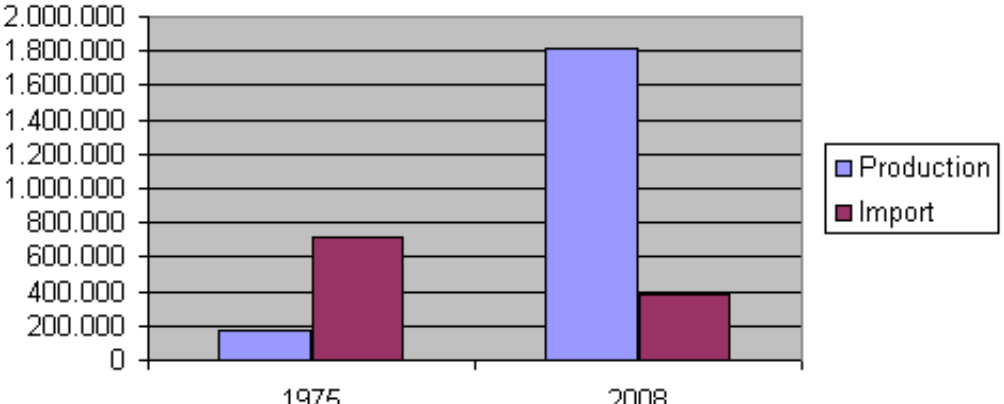
Energy ConsumptionTransport Sector - 1975 (%)

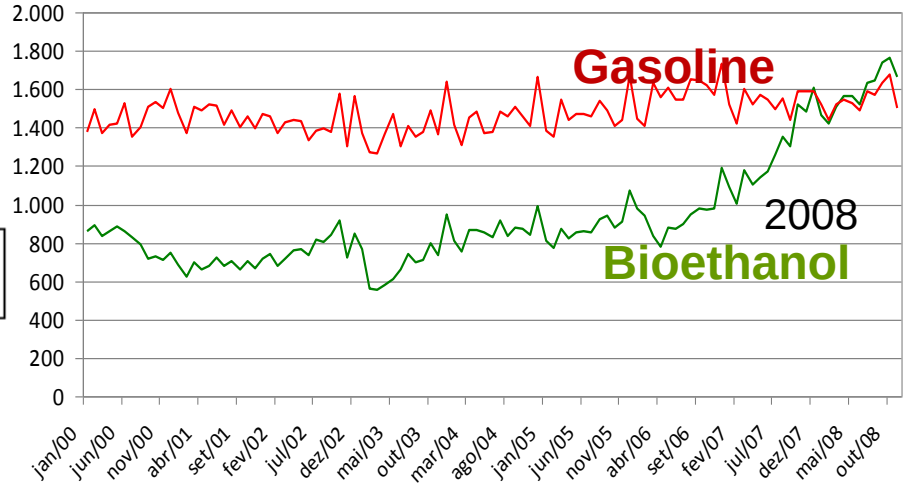


Energy ConsumptionTransport Sector - 2008 (%)



Production and Import of Oil (million b/d)

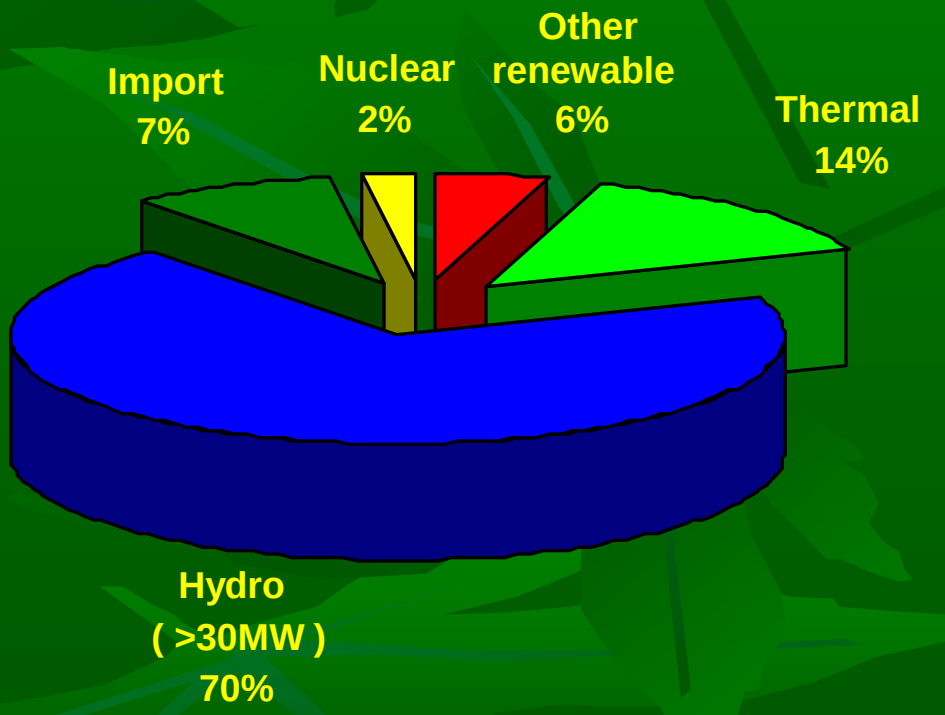




Brazil

Power installed capacity
(Interconnected and isolated systems)

Hydro (> 30 MW)	76,500 MW
Thermal [1]	16,300 MW
Nuclear	2,000 MW
Biomass [2]	4,000 MW
Wind	1,000 MW
Small hydro (< 30 MW)	2,000 MW
Solar [3]	20 MWp
Import [4]	8,000 MW



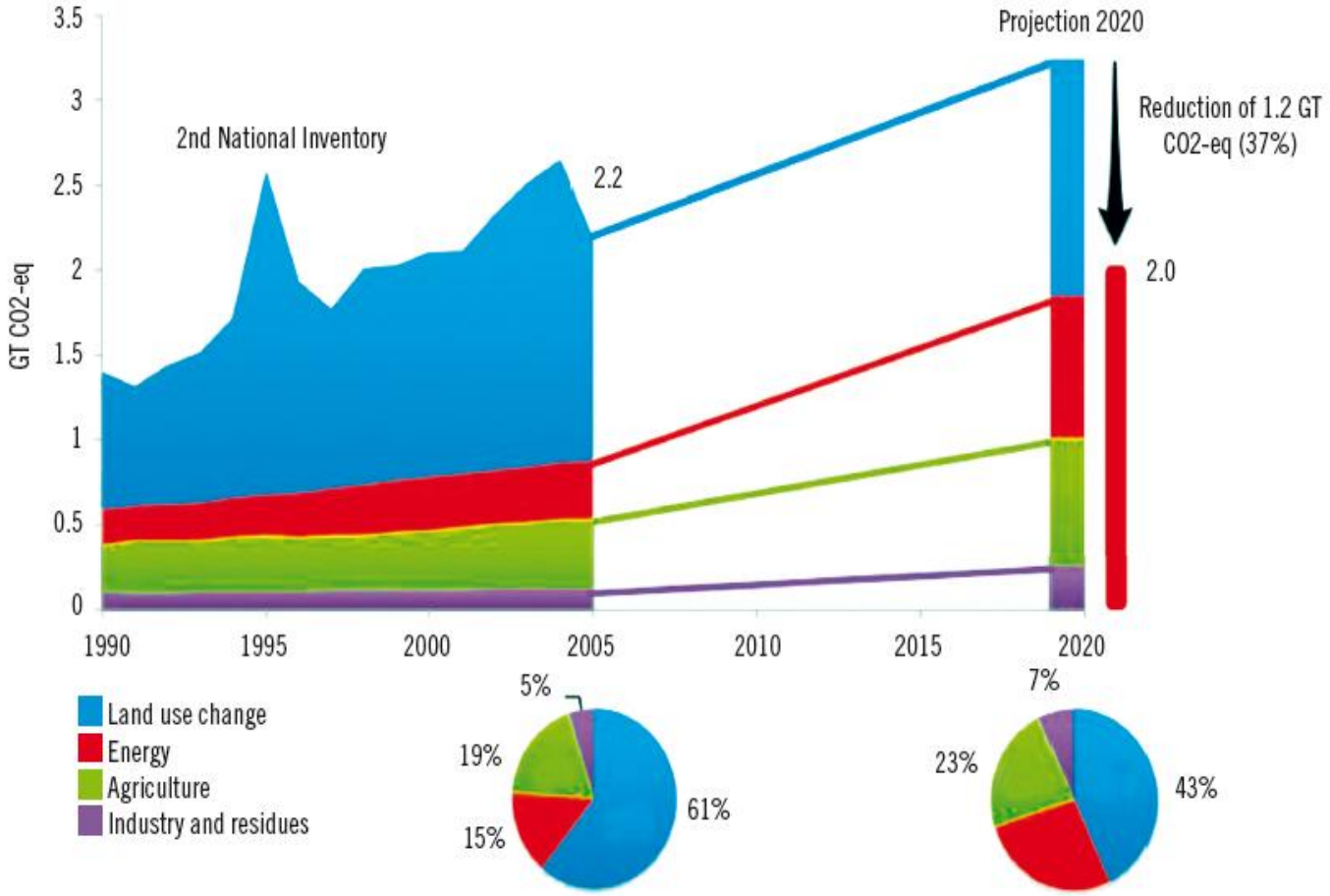
(1) NG, oil and coal
(2) 90% sugar cane bagasse
(3) Around 30,000 stand alone PV systems
(4) hydro from Paraguay (Itaipu bi-national)
Number of customers: ~ 60 million

Source: Aneel, 2010

Brazil

GHG emissions

Figure 1. Expected evolution of Brazilian GHG emissions up to 2020

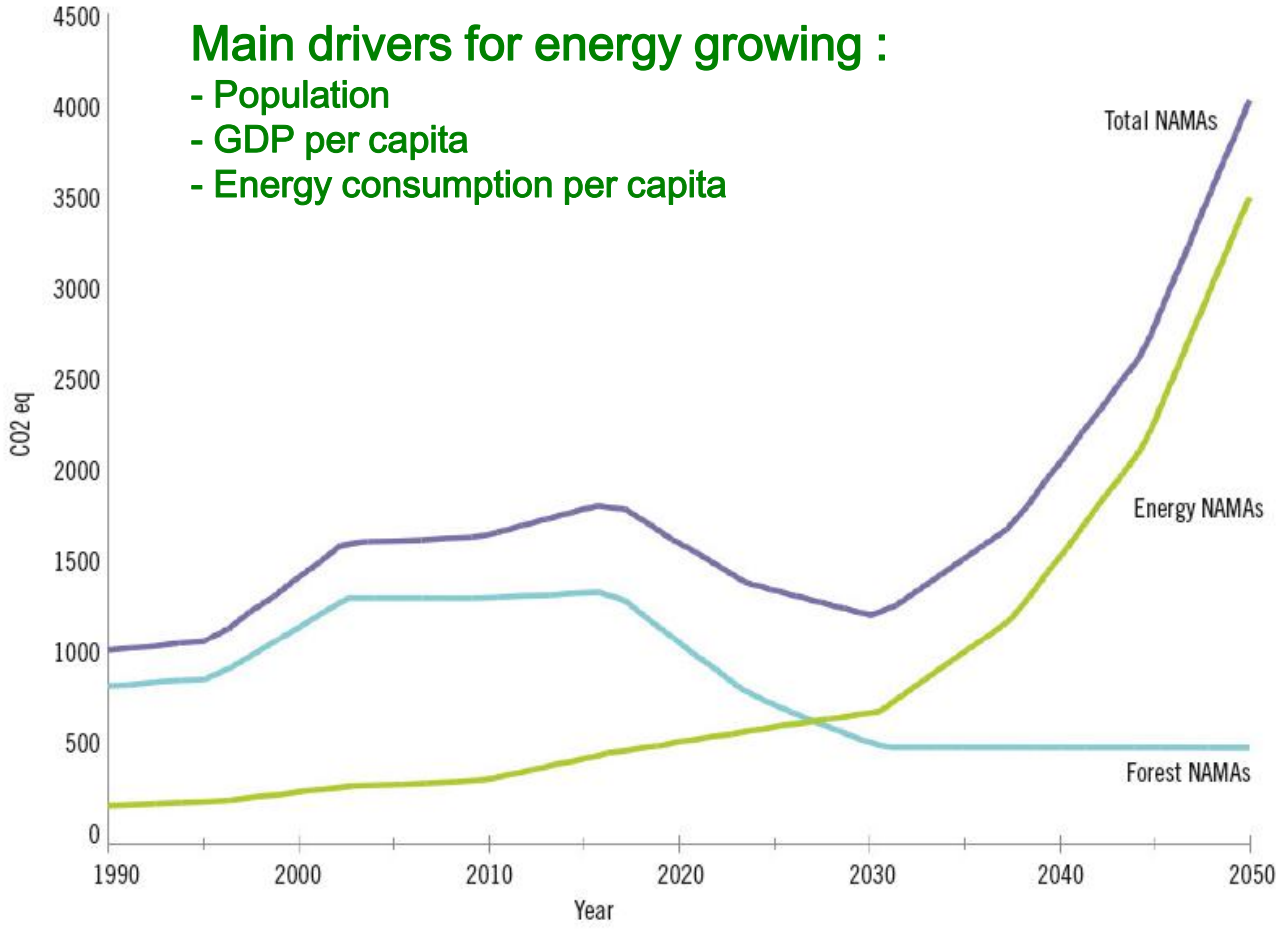


Source: Suassuna, K., MMA, 2011

Brazil

GHG emissions

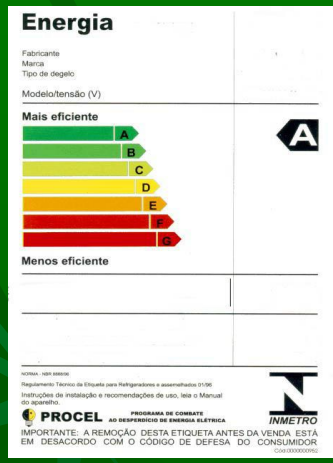
Figure 2. Projected Brazilian GHG emissions to 2030 and extrapolation to 2050



Sources: La Rovere et al, 2011 (up to 2030); La Rovere and Raubenheimer, 2011 (2030 to 2050).

Brazil

Energy efficiency



Brazil

Energy efficiency

- **National programs**
  - PROCEL – Electricity (1985)
  - CONPET – Oil & Gas (1991)

- **Appliances and equipments**
  - 1986 – Labelling
  - 1993 – Awards

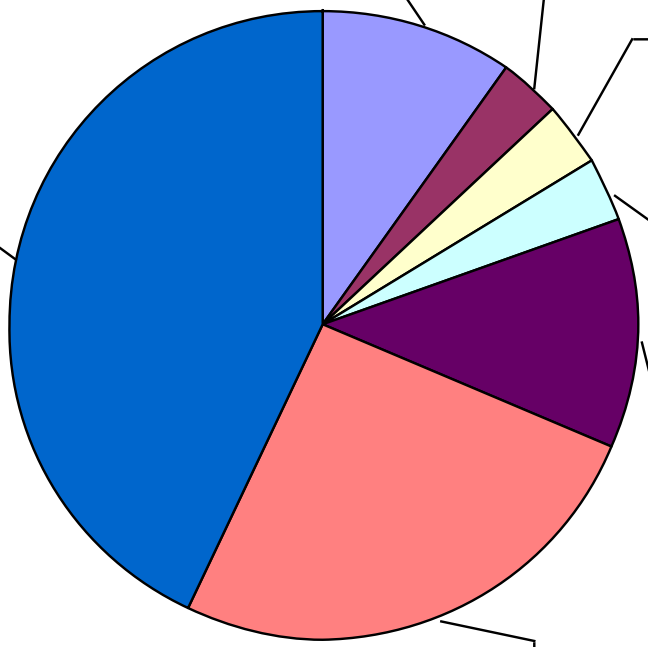
  } voluntary
  - 2001 – Minimum performance standards (mandatory)

- **Market**
  - Financial resources: utilities energy efficiency obligation (1998), pilot projects support instruments, CDM income, Proesco, …
  - ESCOs deployment and Industry commitment

Brazil

PROCEL

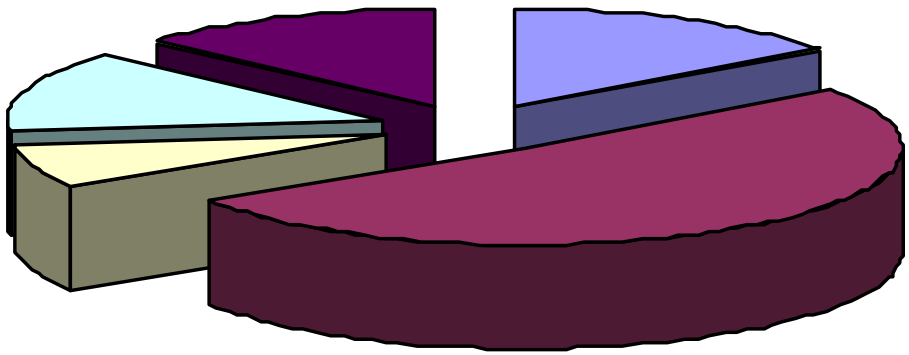
2003: 300 TWh



Fonte: Eletrobrás – DE/DME

Brazil

CONPET



Fonte: BEN 2004

Projeto ECONOMIZAR

PROJETO TRANSPORTAR

Programa ETIQUETAGEM

Projeto Petrobras

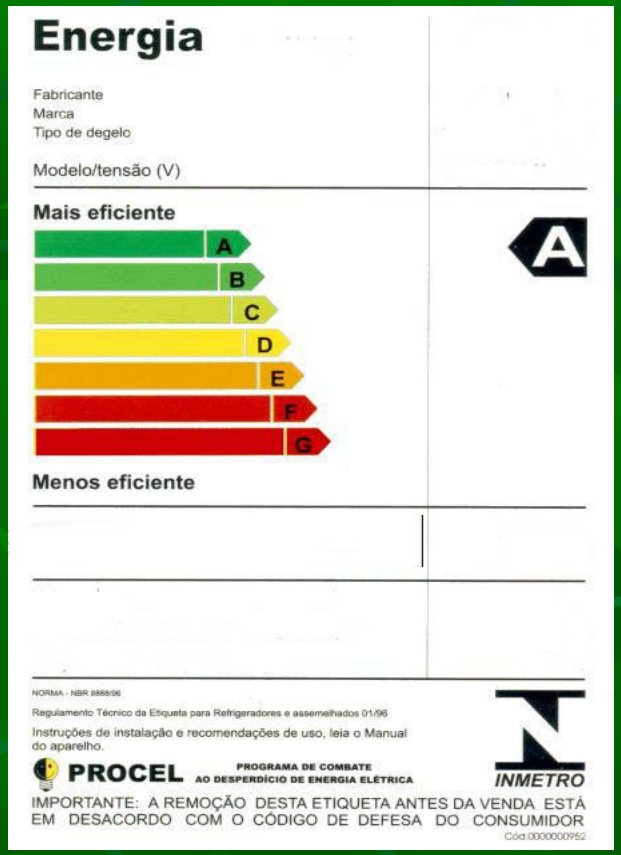
Ônibus a Gás

conpet na escola

PRÊMIO NACIONAL DE CONSERVAÇÃO E USO RACIONAL DE ENERGIA

Brazil

Labeling & awards



Partnership with INMETRO

Brazil

Minimum energy performance standards

CGIEE
(Government, Regulatory Agencies and Society)

Decision level

TECHNICAL COMMITTEES
(Research centres, Universities, PROCEL, CONPET, INMETRO, etc.)

Technical level

NEGOTIATION GROUPS
(Industry and Government)

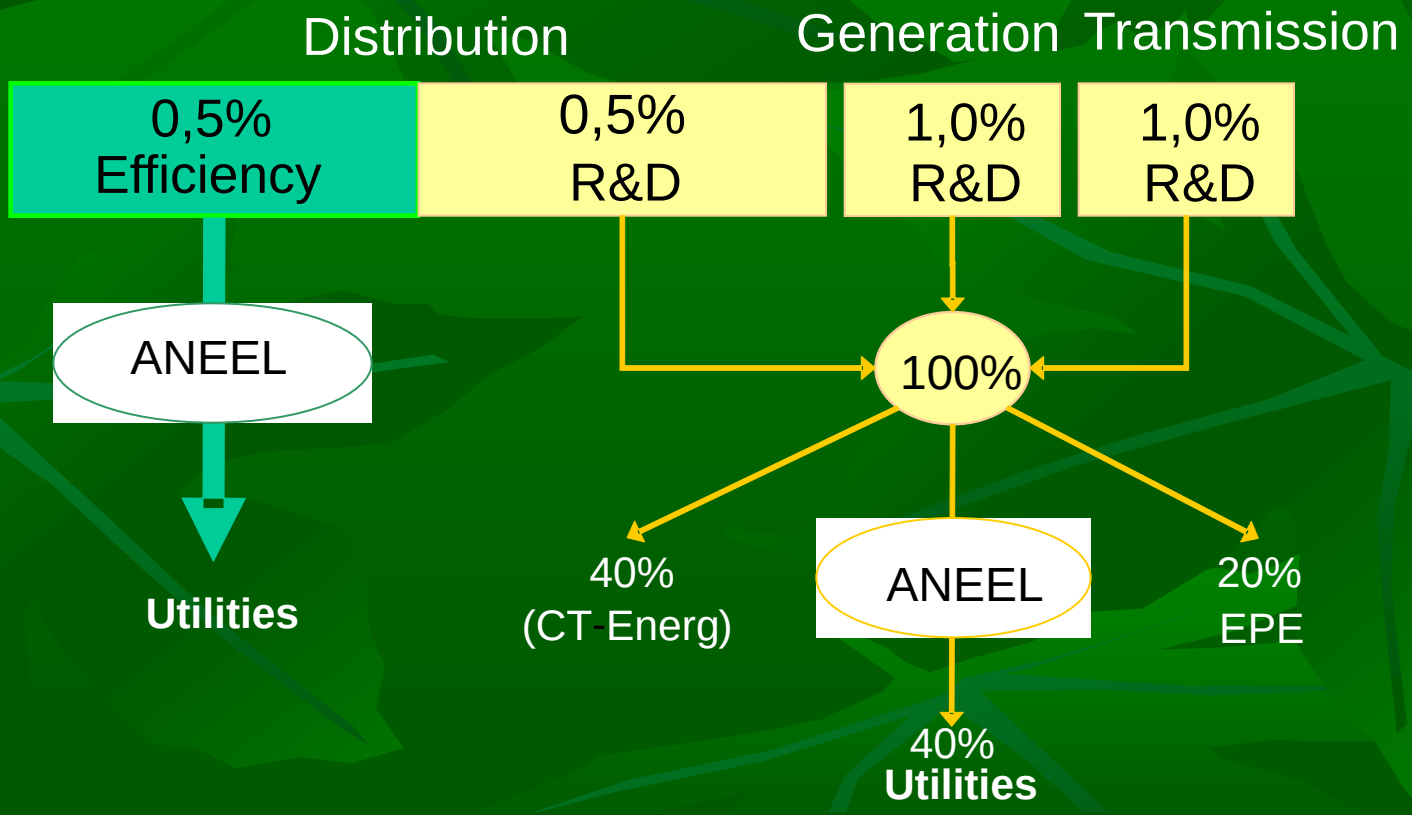
Negotiation level

Brazil

Financial resources

Utilities energy efficiency & R&D obligation

1% of the net income of utilities for R&D and EE (≈ US$ 300 million/year)



Brazil

ESCOs development

- > 70 companies
- Most small (≤ US$ 250 mil)
- Increasing business activities
- Energy conservation potential in the Industry: 10 TWh/year

Brazil

New renewables

Brazil

Proinfa (2002-4)

- 3,300 MW grid connected facilities starting operating up to 2006/9
  - 700 MW biopower
  - 1,400 MW wind energy
  - 1,200 MW small hydro power (SHP)
  - no solar PV power
- 20 years power purchase agreements (PPA) signed with Eletrobrás
- Fixed prices for each source
- 60% minimum national supply of equipment and services

Brazil

Biopower market

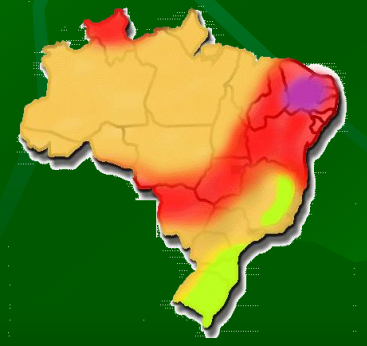
- **Biopower (4,000 MW)**

Estimated	
Sugar cane	**15,000 MW**
Rice and paper-cellulose	**1,300 MW**
Wood	**?**
Authorized	**1,200 MW**
Under construction	**400 MW**

Sources: MME, CEPEL, ANEEL, CENBIO.

Brazil

New renewables market



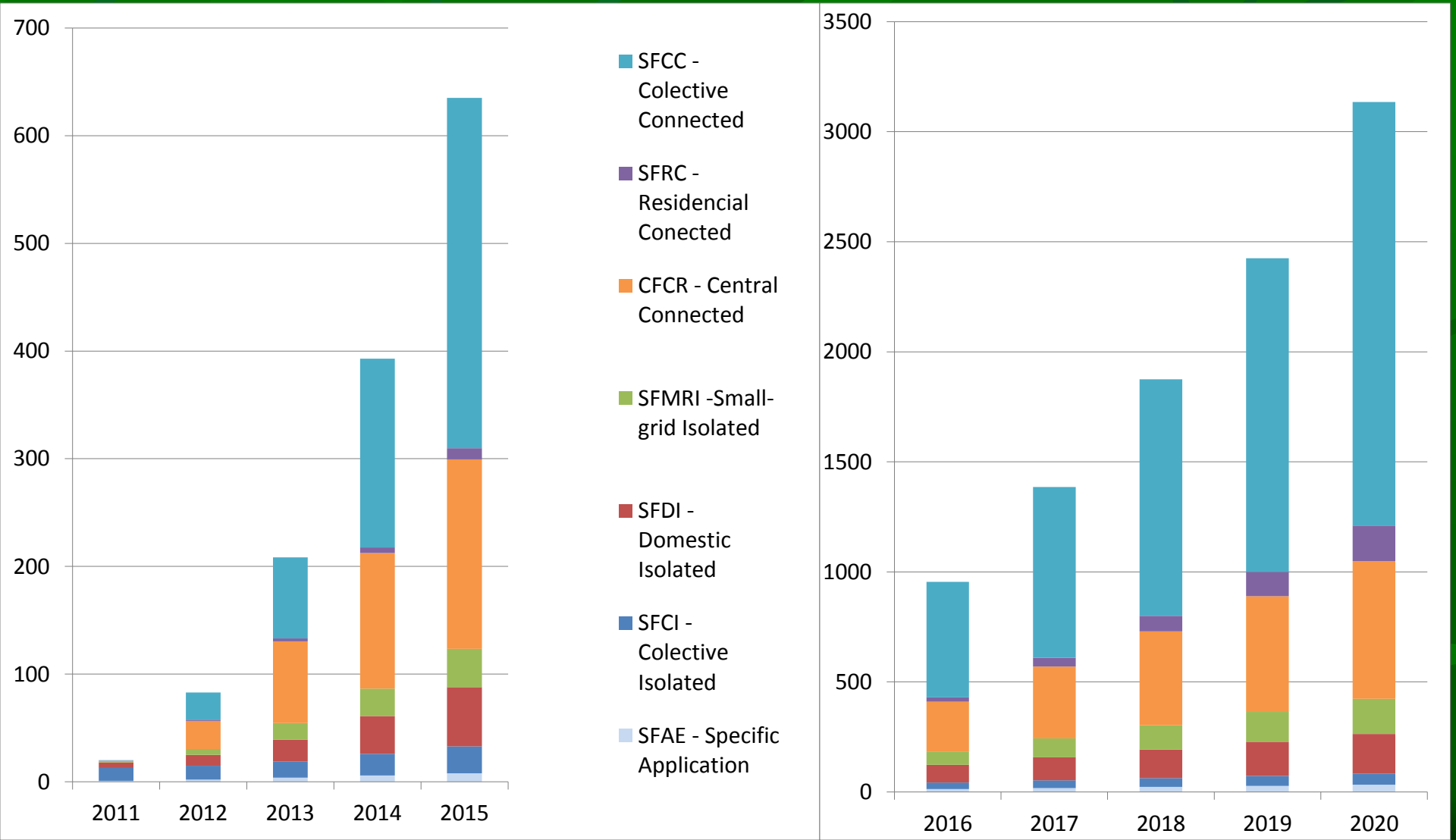
- **Small hydro (2,000 MW)**
  - Identified 10,000 MW
  - Authorized 2,500 MW
  - Under construction 1,000 MW
- **Wind power (1,000 MW)**
  - Estimated 140,000 MW
  - Authorized 4,500 MW
  - Under construction 1,000 MW
- **Solar power (20 MWp)**
  - Estimated ?,000 MWp

Sources: MME, CEPEL, ANEEL, CENBIO.

Brazil

Possible PV market

Accumulated expansion of PV's internal market by sector in MW



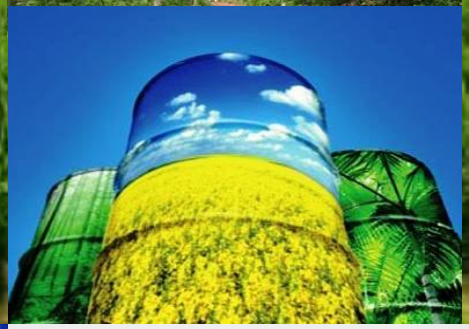
Brazil

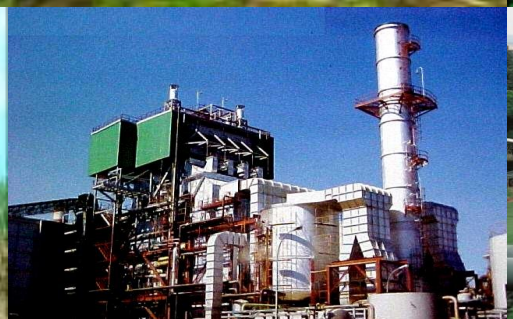
New renewables today

- To provide some % of the annual increase of the electricity consumption, in order to diversify power supply and to promote energy security
- To limit impacts in the energy tariff
- To reduce GHG emissions
- To encourage other renewable sources (solar PV)
- Bidding process / green certificates / distinct top prices by source and technology / …
- Minimum % of national supply of equipment and services

Brazil

Liquid biofuels





World

Liquid biofuels

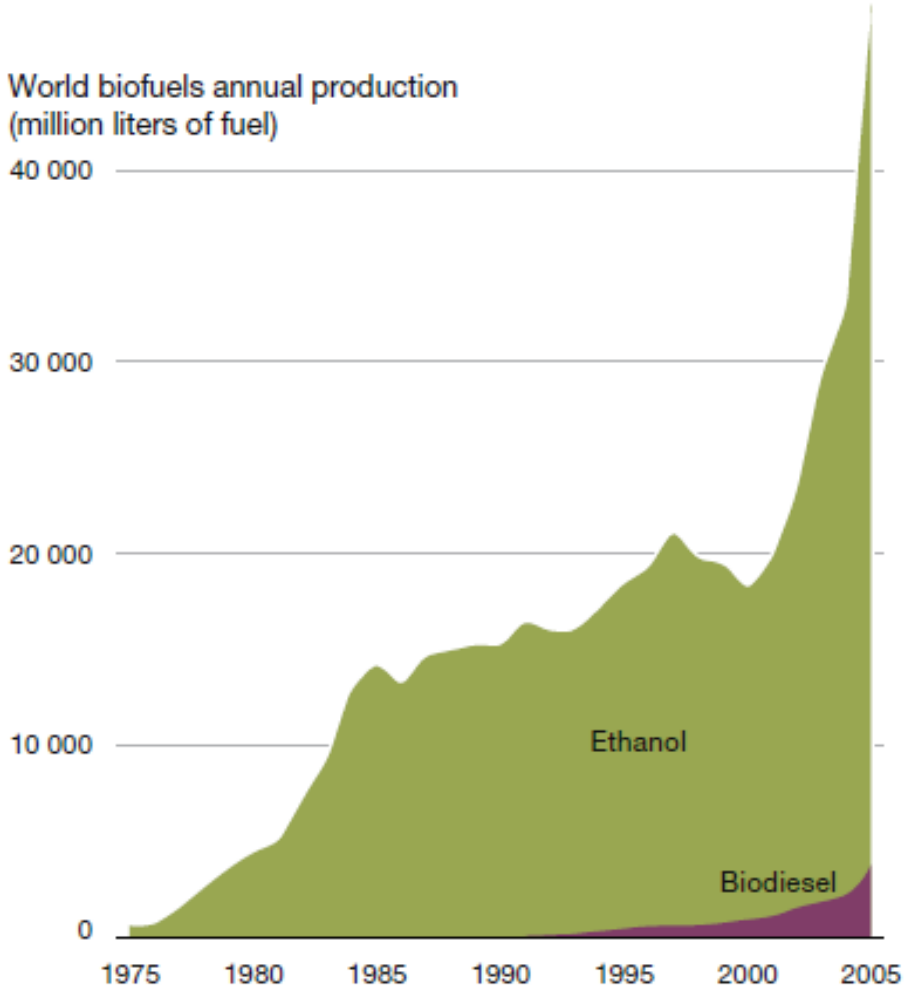


Figure 14: The production of biodiesel and ethanol has increased substantially in recent years. (Source: Earth Policy Institute, 2006).

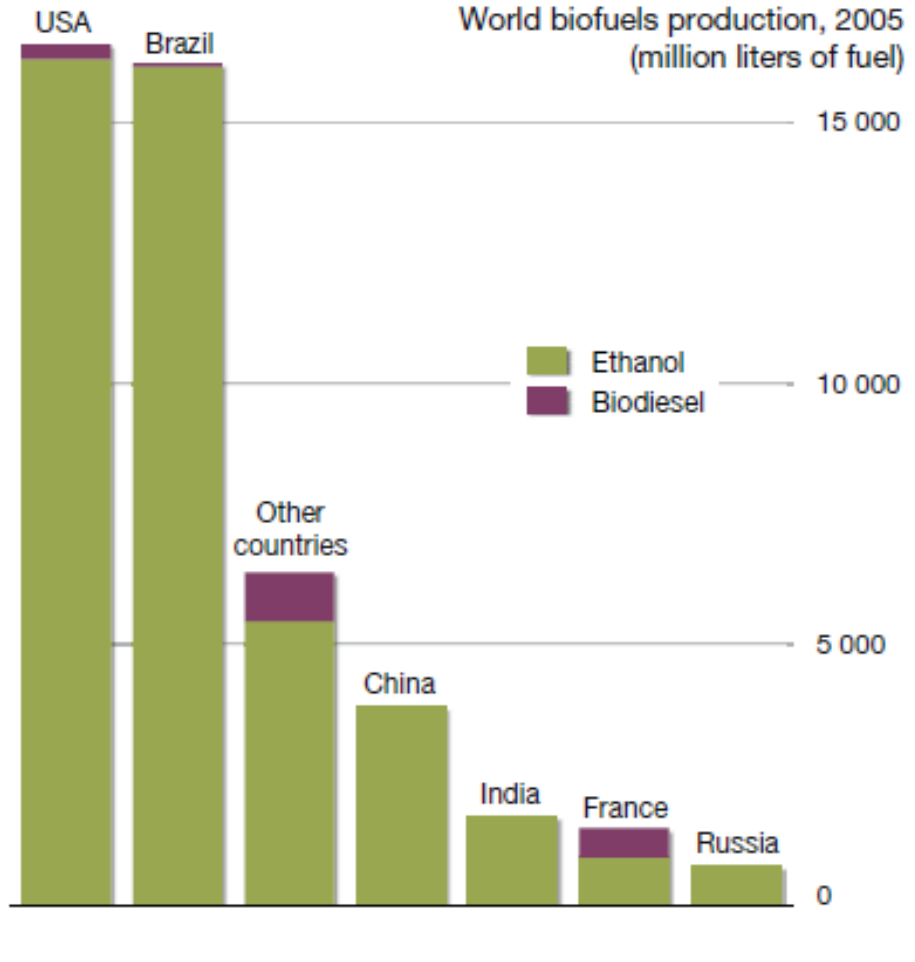


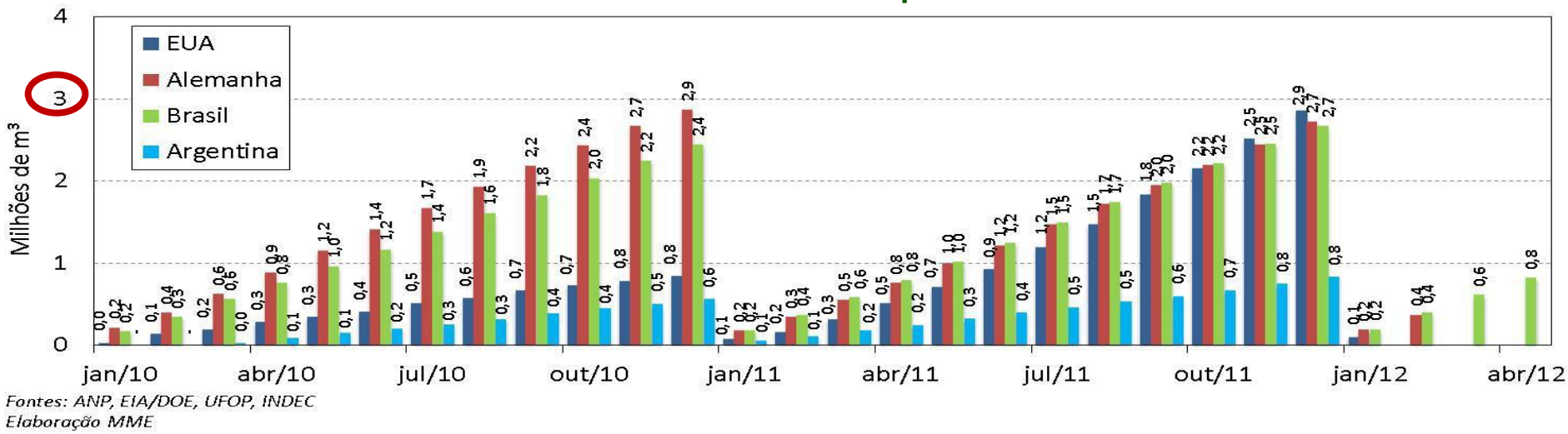
Figure 15: United States and Brazil are among the greatest producers of biofuels today. (Source: Earth Policy Institute, 2006).

Reproduced from Unep, February 2009. *The environmental food crisis*

World

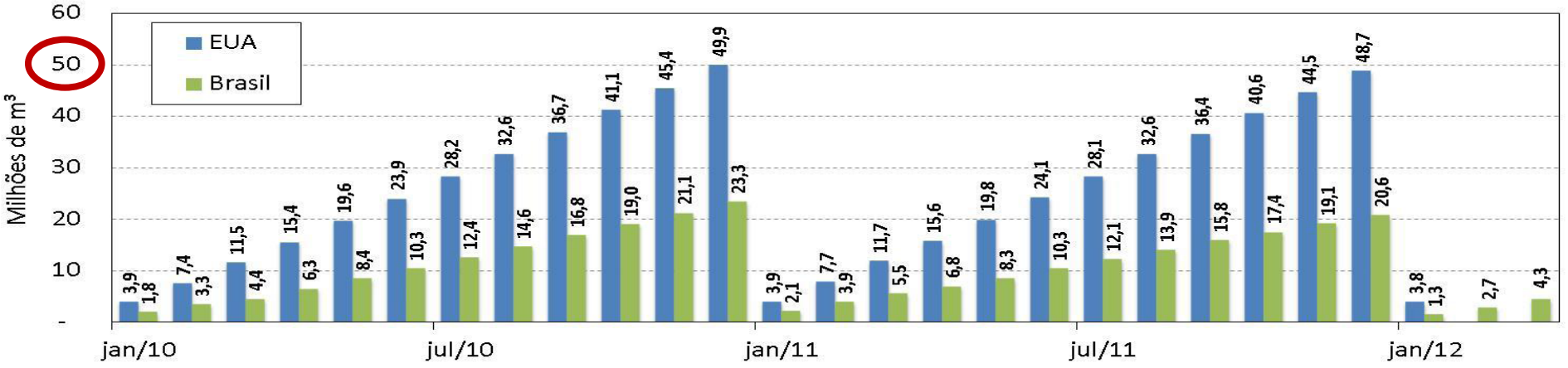
Liquid biofuels

Biodiesel consumption



Fontes: ANP, EIA/DOE, UFOP, INDEC
Elaboração MME

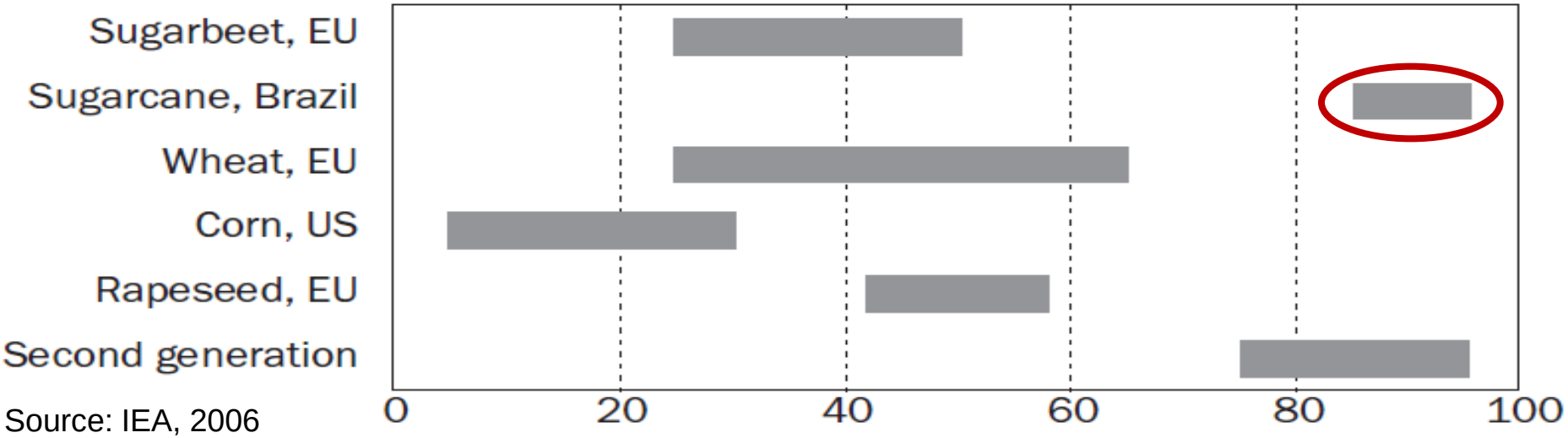
Bioethanol consumption



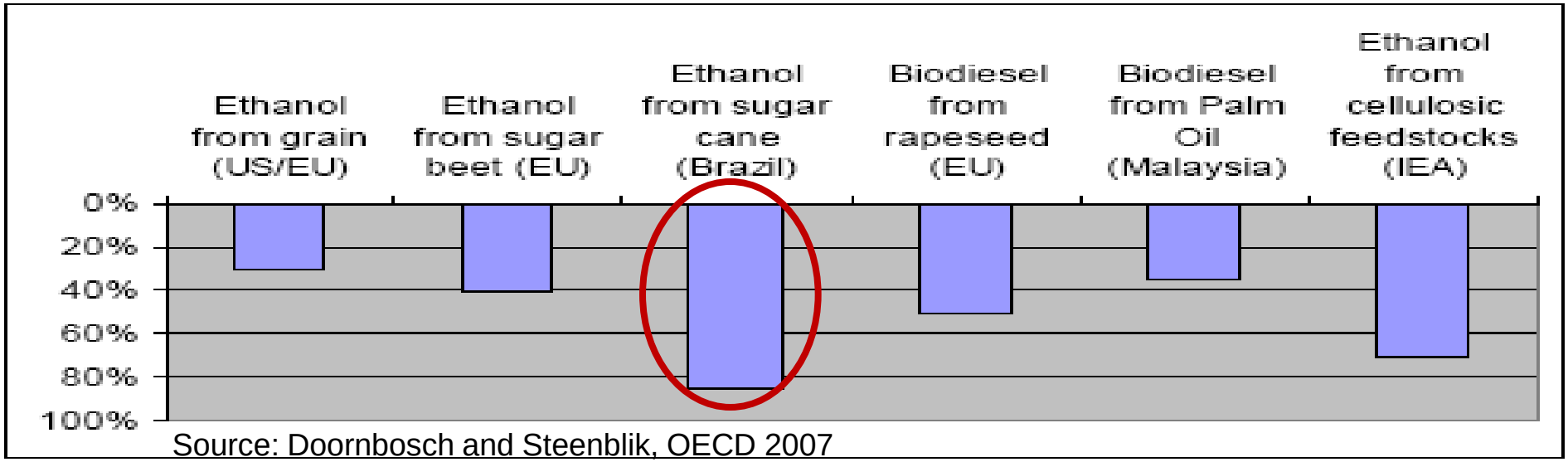
Fontes: MAPA, EIA/DOE
Elaboração MME

World

Biofuels
GHG emissions reduction



Source: IEA, 2006

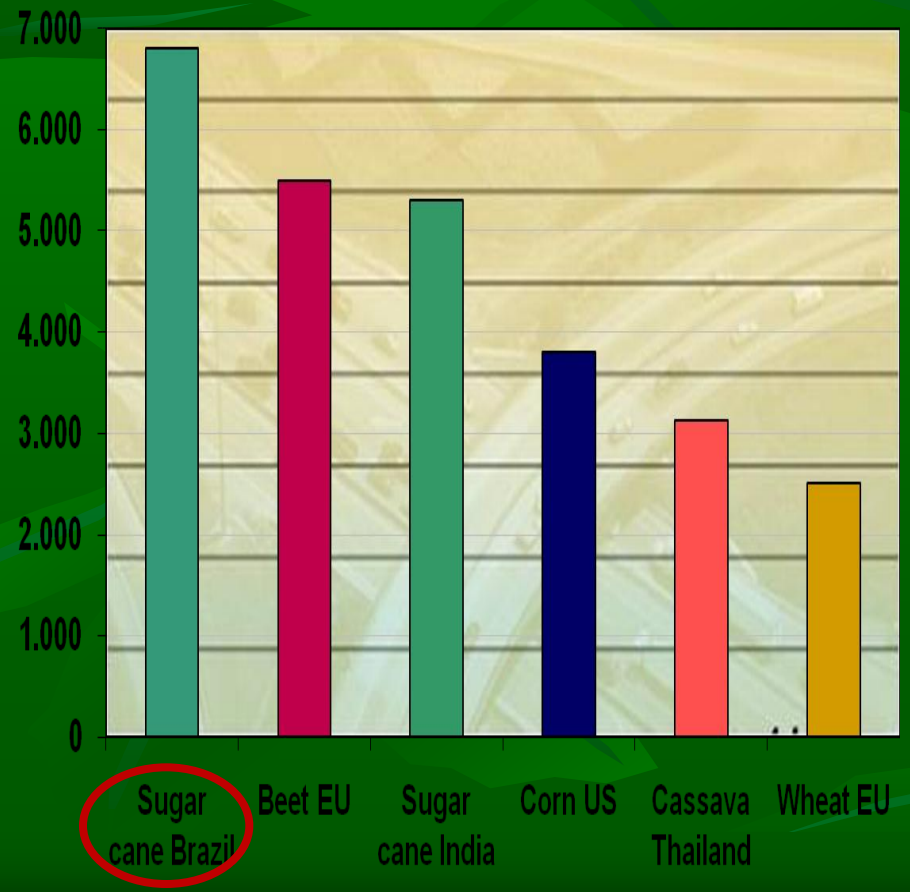


Source: Doornbosch and Steenblik, OECD 2007

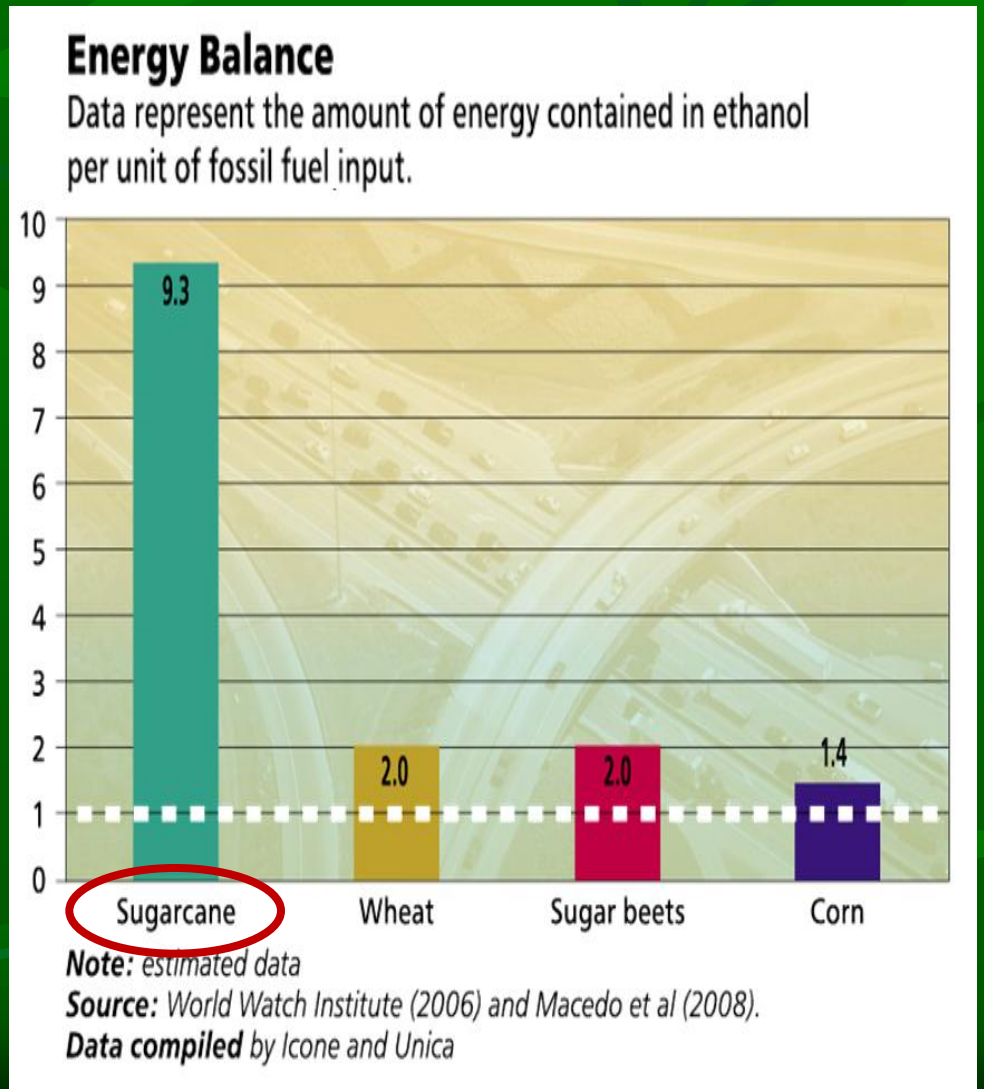
World

Bioethanol productivity and energy balance

Biothanol yields (liters per hectare)

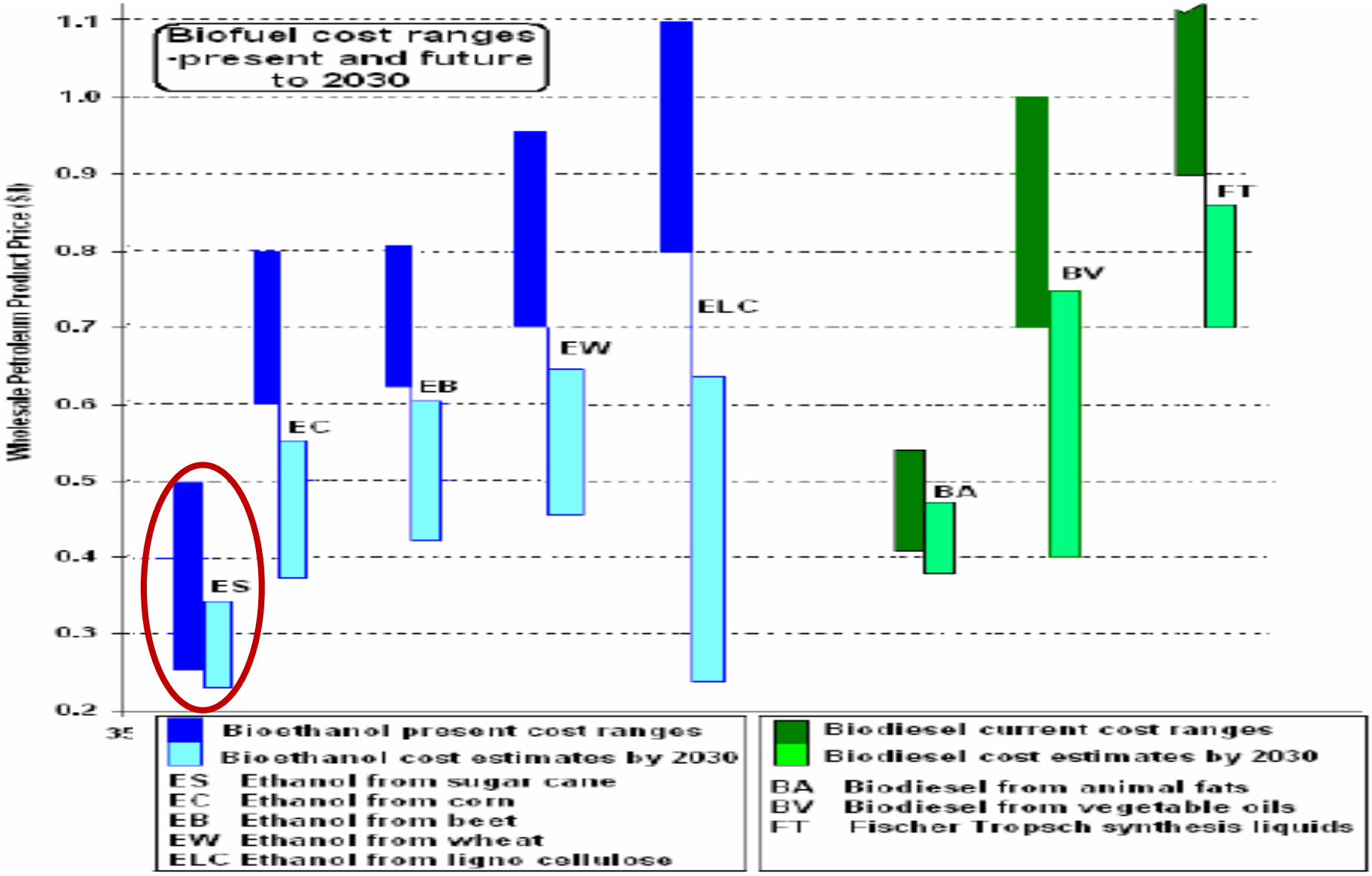


Source: IEA 2005



World

Cost perspective of biofuel technologies



Source: IEA, 2006

Brazil

Biodiesel

Clean fuel programme

- Fuel diversification and green fuel promotion
- Job creation, land use and economic upswing in rural areas
- Reduction of diesel imports

Main steps

- Quality standards
- Price management
- Production chain: crop growing, transformation and trade

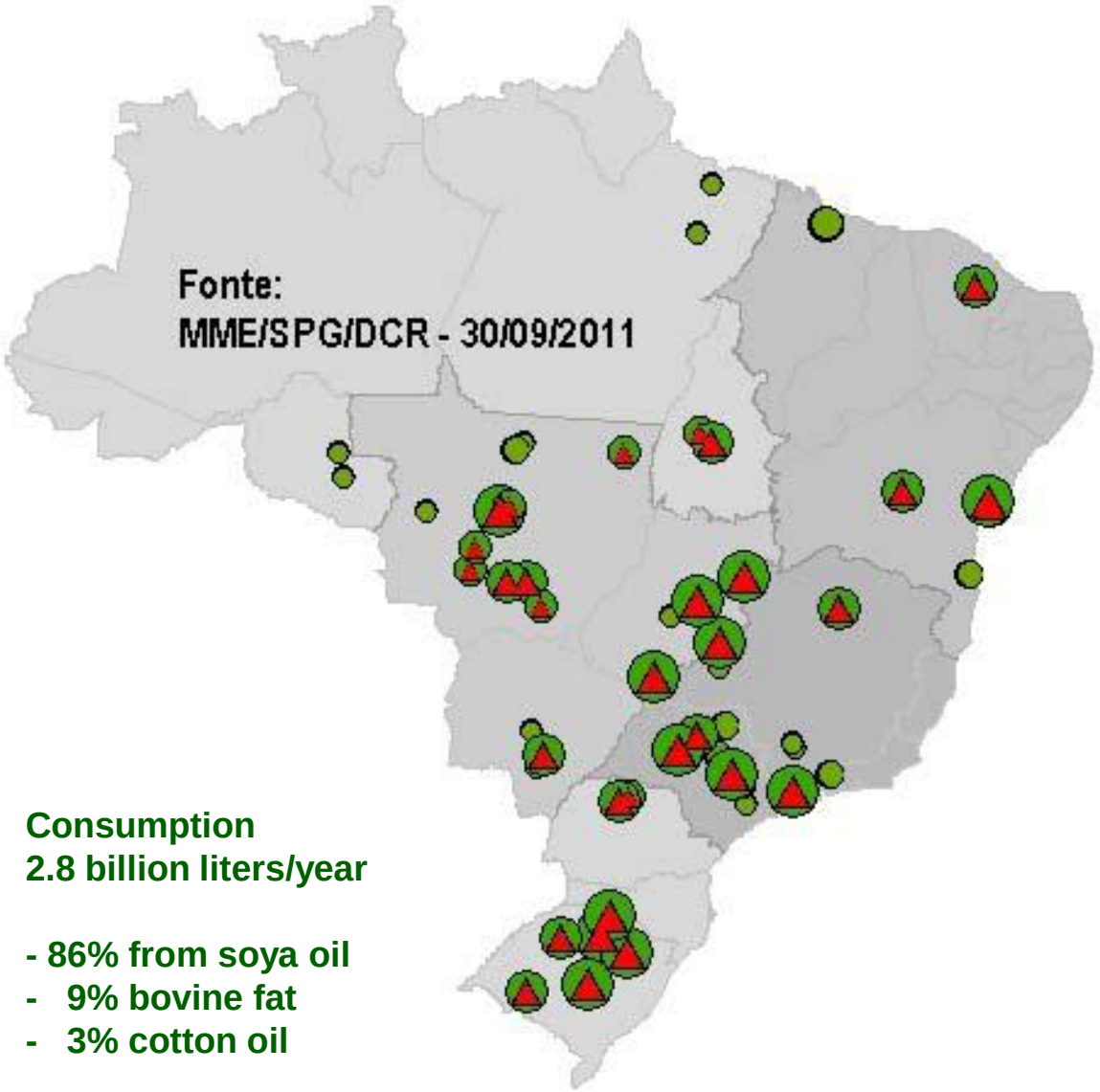
	2005	2006	2007	2008	2009	2010
Diesel substitution target	2,00%	2,75%	3,50%	4,25%	5,00%	5,00%

Brazil

Biodiesel production plants and installed capacity

		Installed capacity	
Region	Facilities	mil m^3/year	%
N	6	193	3
NE	6	741	12
CW	25	2,395	40
SE	13	1,144	19
S	8	1,534	26
Country	58	6,007	100

Authorized to trade by ANP and registered at MF - position in 30/09/2011



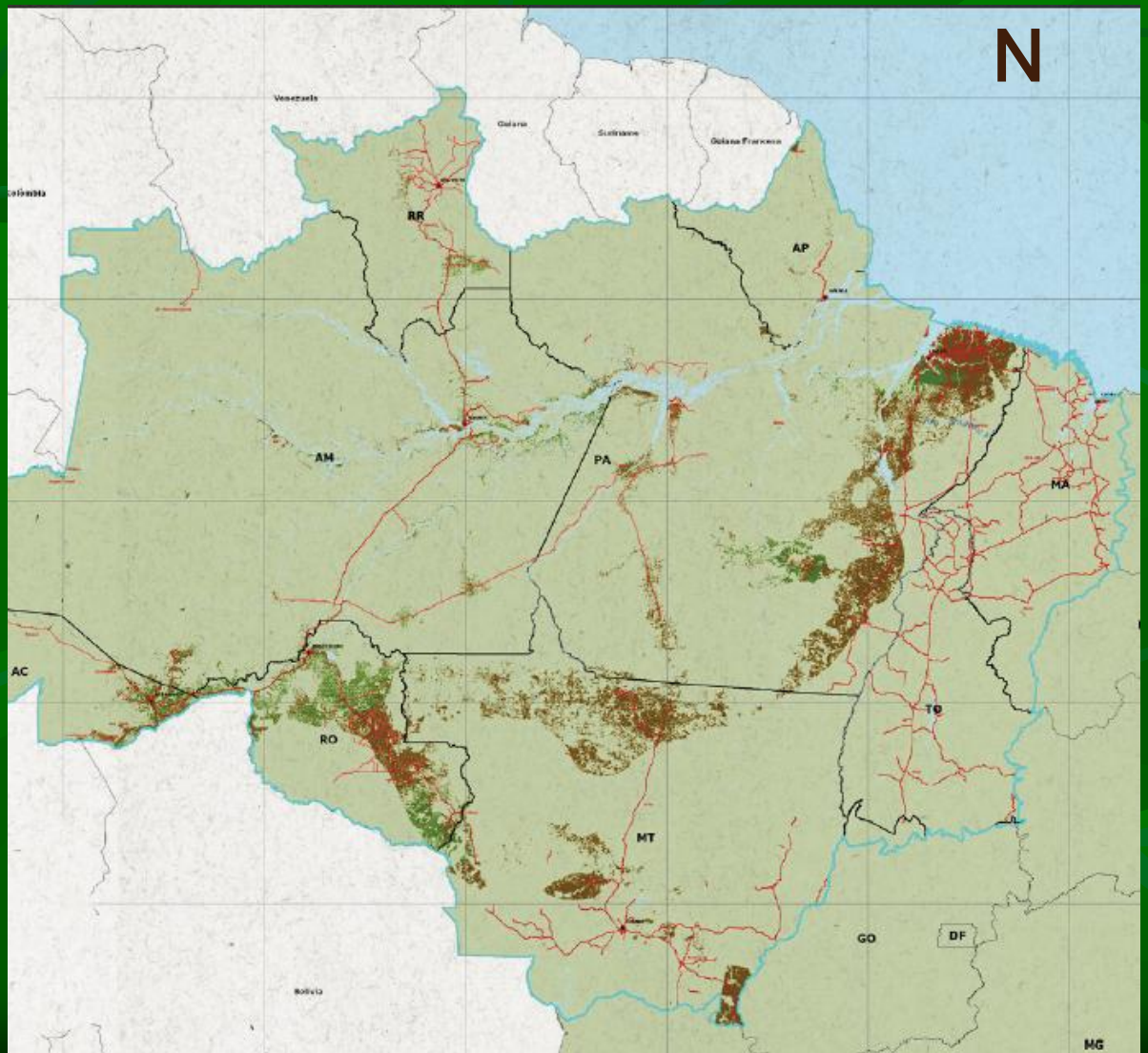
Consumption
2.8 billion liters/year

- **86% from soya oil**
- **9% bovine fat**
- **3% cotton oil**

Brazil

Agro-ecological zoning

for palm oil crops



Brazil

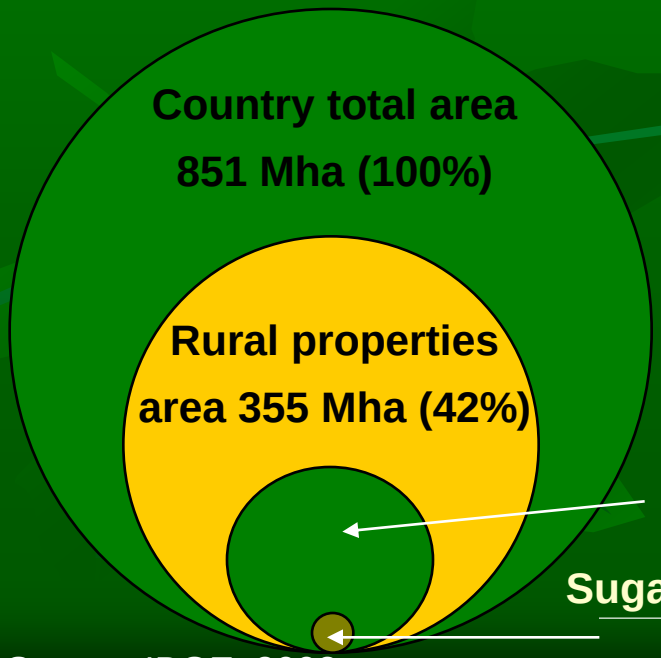
Sugarcane agroindustry

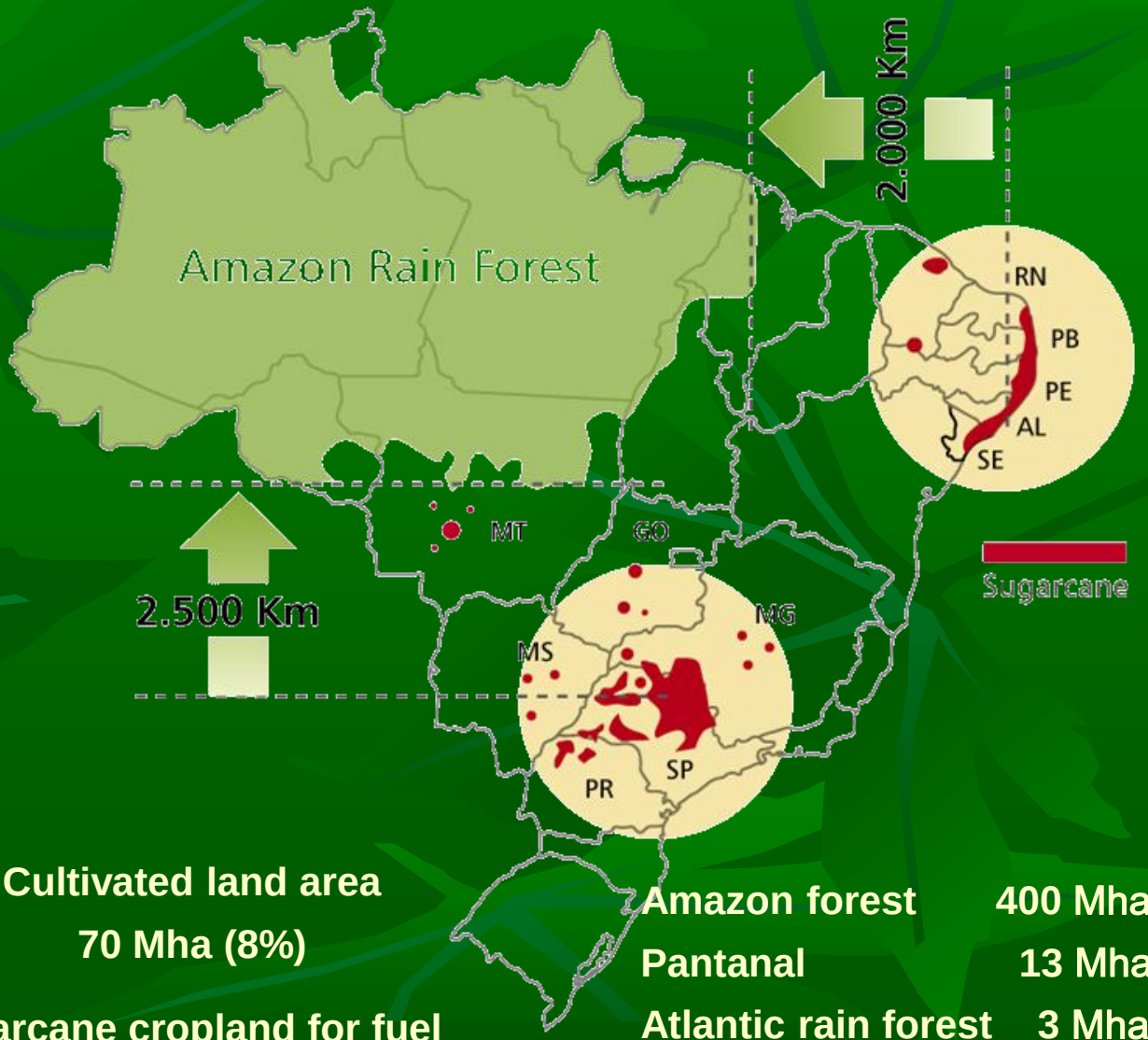
- **25 billion litters produced & 5 billion litters exported**
- **Energetic biomass cost = US$ 1.4/GJ** (industrial countries goal for 2020)
- **420 industrial units (100 new ones)**
- **>70,000 producers; ~1,000,000 jobs**
- **Knowledge frontier expansion :**
  genetics, biotechnologies, hydrolysis...

Brazil

Sugarcane land use

Farming (2007)	Area (Mha)
Soya	23
Corn	12
Sugar cane	7
Agriculture	70
Cattle	180





Cultivated land area
70 Mha (8%)

Sugarcane cropland for fuel
3,5 Mha (0.5%)

Amazon forest	400 Mha
Pantanal	13 Mha
Atlantic rain forest	3 Mha

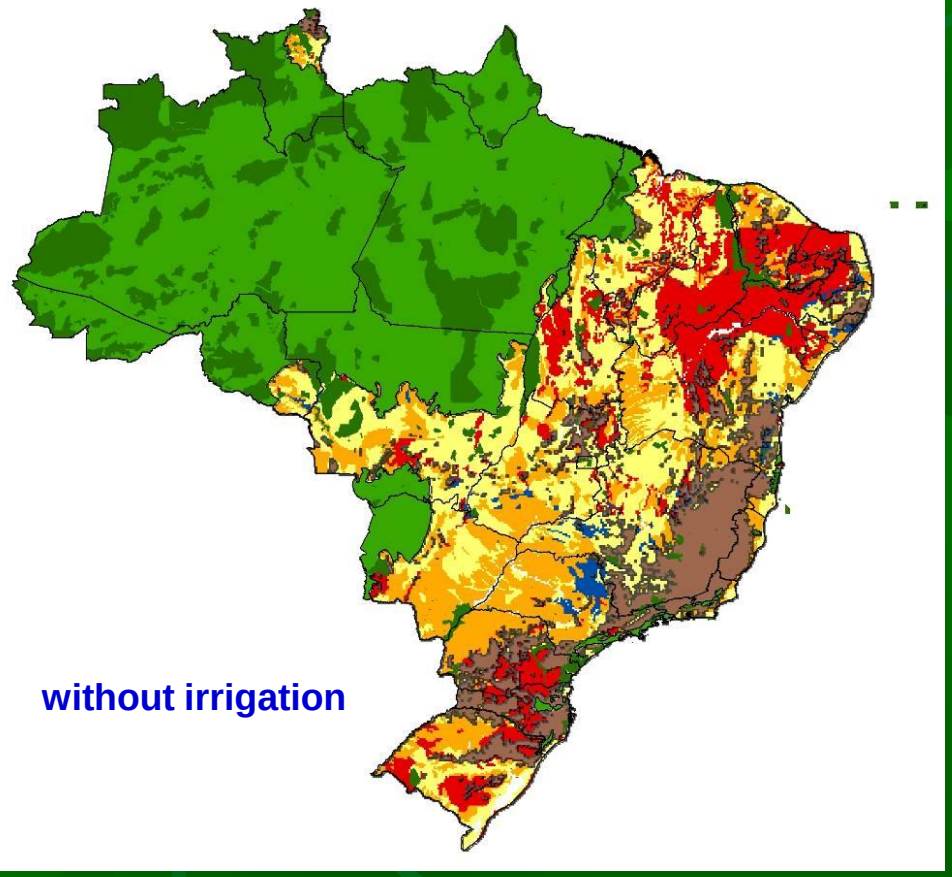
Source: IBGE, 2008

Sources: CGEE - NIPE-Unicamp, IBGE and CTC

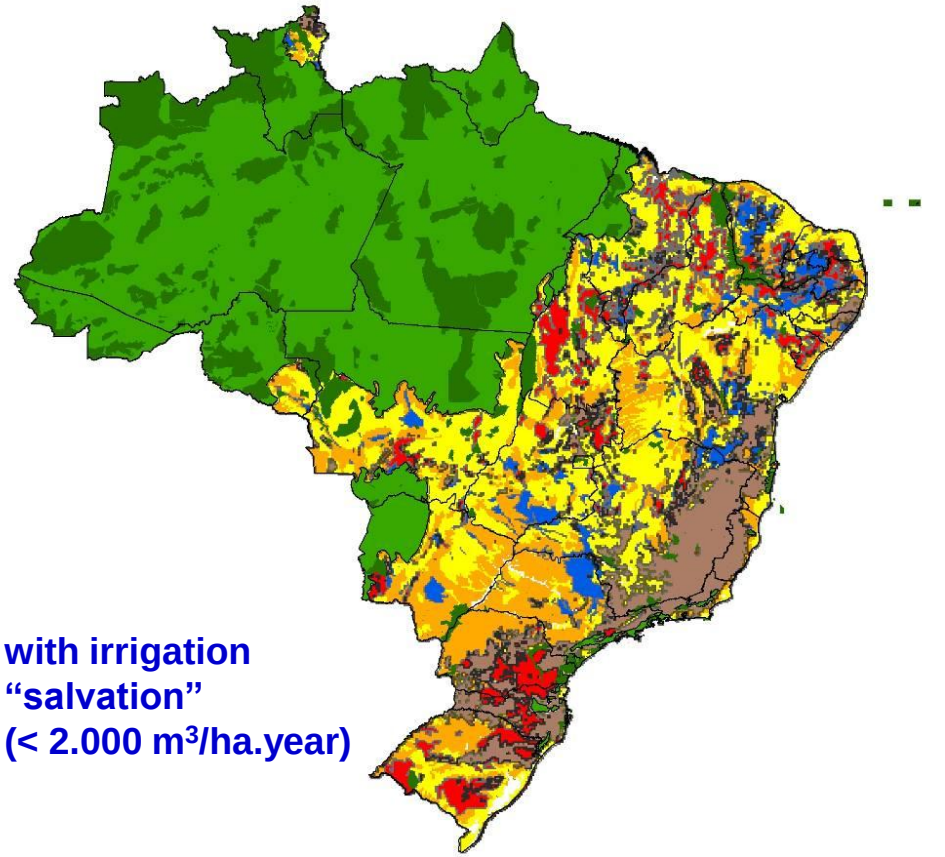
Brazil

Soil & climate potential

for sugar cane culture



without irrigation



with irrigation
"salvation"
(< 2.000 m^3/ha.year)

Amazon Rainforest
Pantanal
Atlantic Forest

Other important preservation areas

Above 12% slope area (75 Mha)

High (> 80 t/ha)

Good (> 70 t/ha)

Medium (> 60 t/ha)

Inadequate

Source: CGEE – NIPE/Unicamp & CTC

Brazil

Bioethanol for vehicle

- Large experience using bioethanol as mixed fuel for vehicle (1925) ~ 5%
- Proálcool (1975):
  - up to 25% of bioethanol blended in the gasoline (E 25)
  - 5 million pure bioethanol powered cars manufactured
- Flex-fuel motors using the E 25 blend, bioethanol, or a mix of both (2003)
  - 10 million flex-fuel cars manufactured; over 90% of the new car market
- Only E 25 & bioethanol delivered by all the 35,000 Country's fuel station

1925

1975

2003

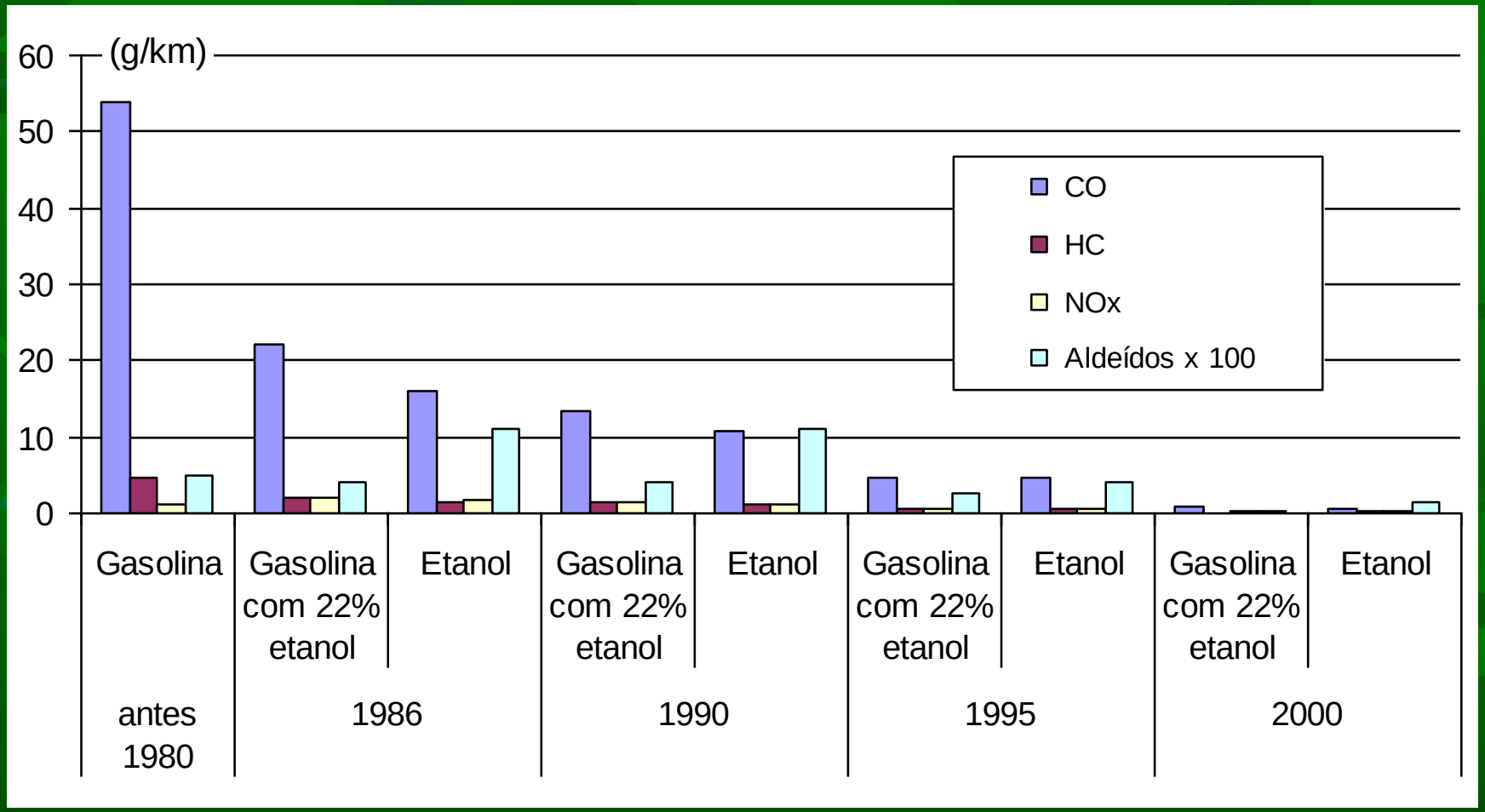
Brazil

Diversifying bioethanol use

Brazil

New cars air pollution

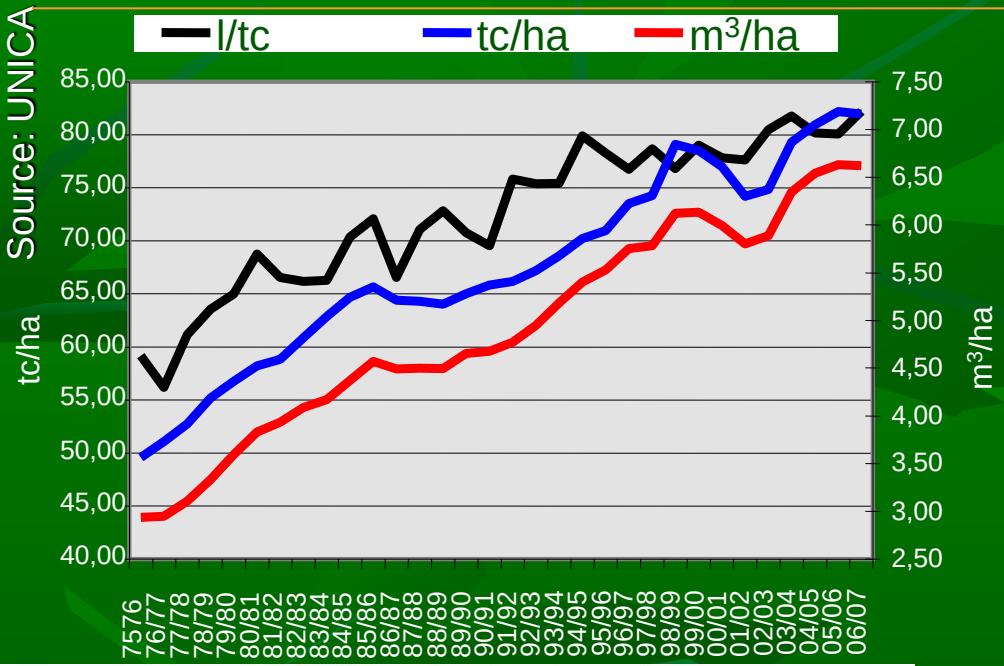
Bioethanol blend facilitate to reduce the local emissions of Otto cycle vehicles

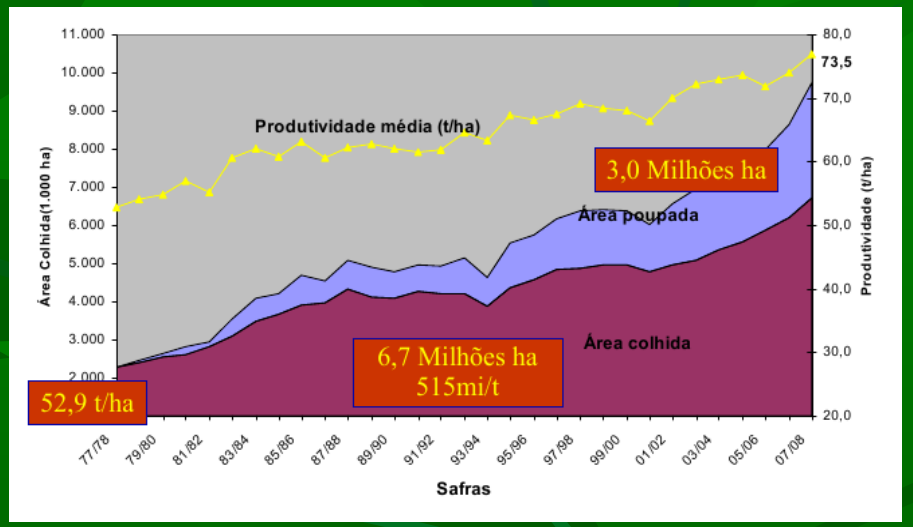


Source: based on IBAMA, 2006

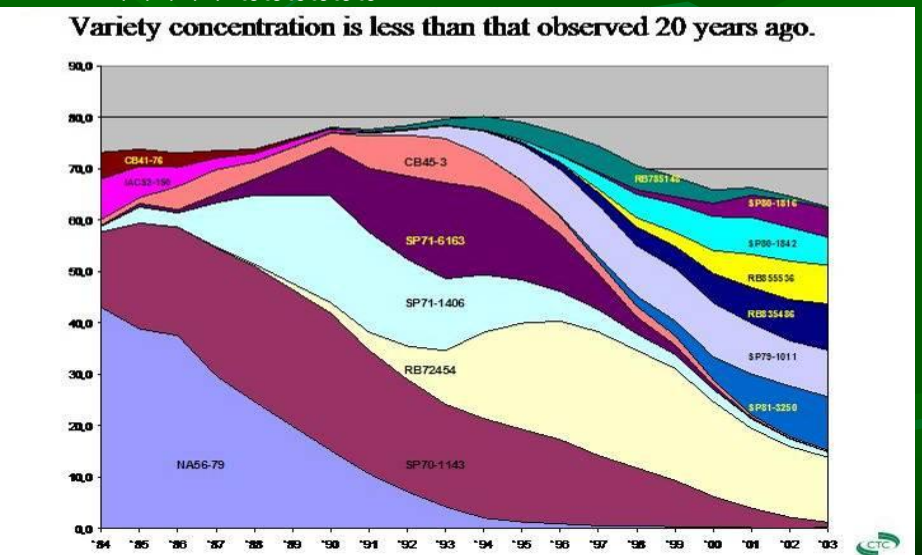
Brazil

Sugarcane technological progress over 35 years

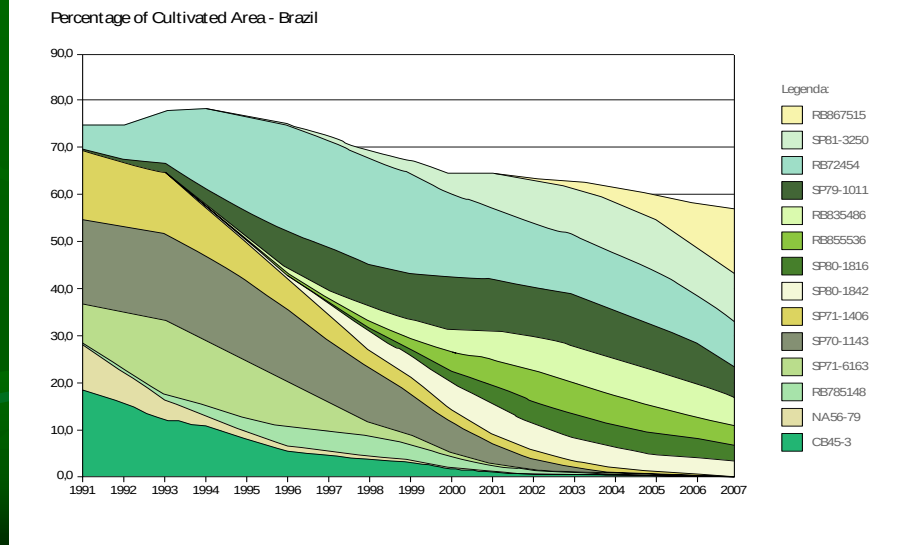




Source: Donzelli – CTC (2008)



Source: CTC



Brazil

Sugarcane genetics

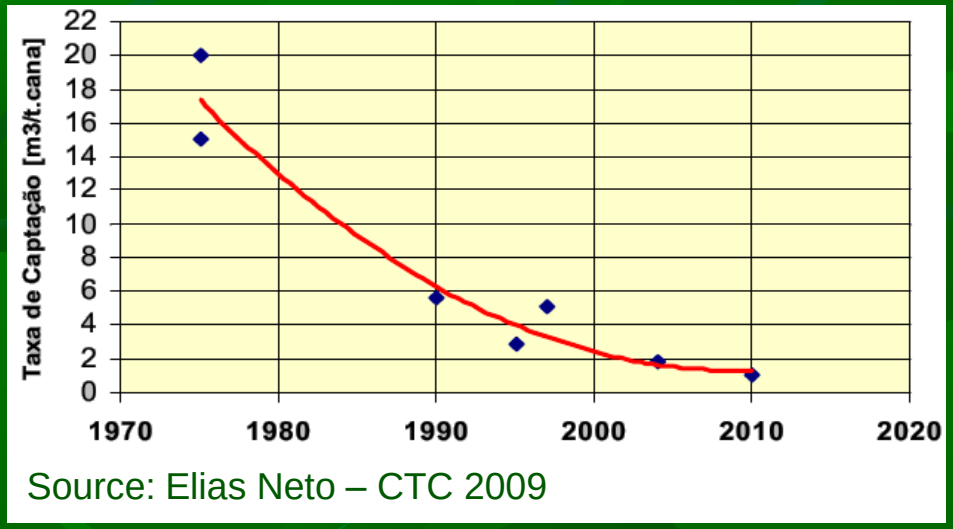
New varieties adapted to local soils and climate and resistent against diseases

Biofactory: quick multiplication

Sugarcane of high biomass: energy cane

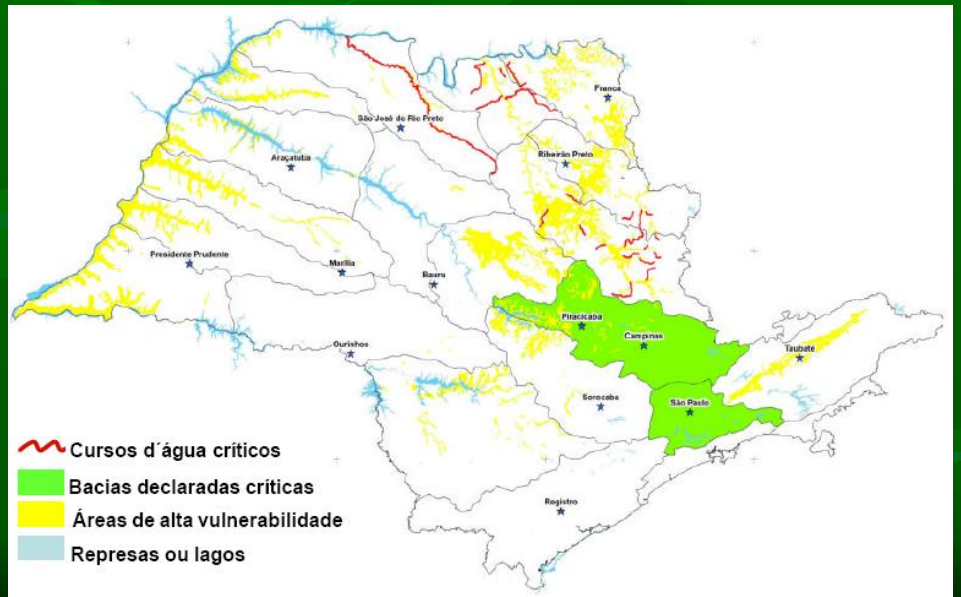
Brazil

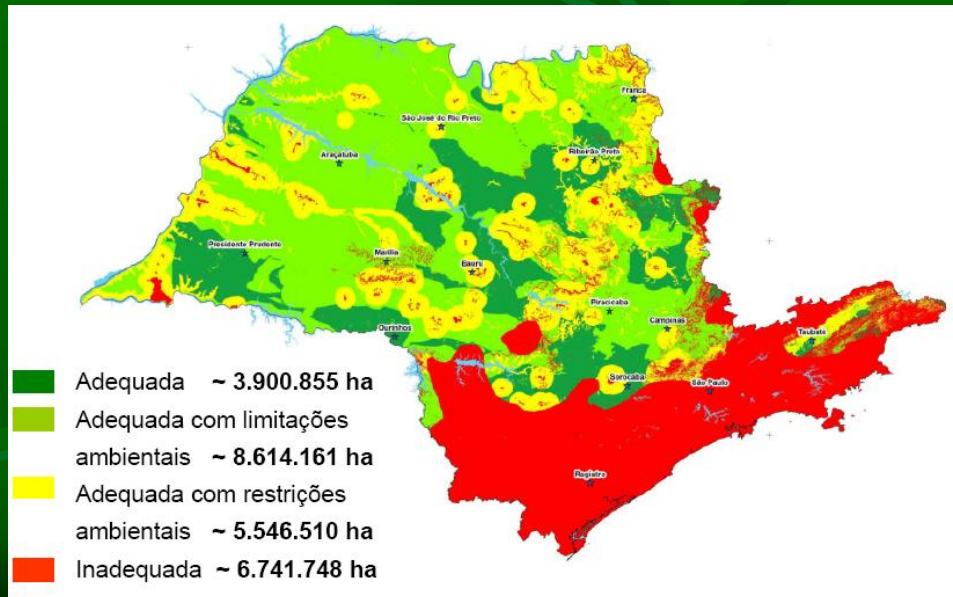
Sugarcane industrial water withdraw



Source: Elias Neto – CTC 2009

	≤ 1 m3/tc
	≤ 1 m3/tc
	≤ 0,7 m3/tc
	Proibidas instalações





Brazil

Next generation sugarcane bioenergy

cgee

Low impact mechanization

Recycle

Hydrolysis

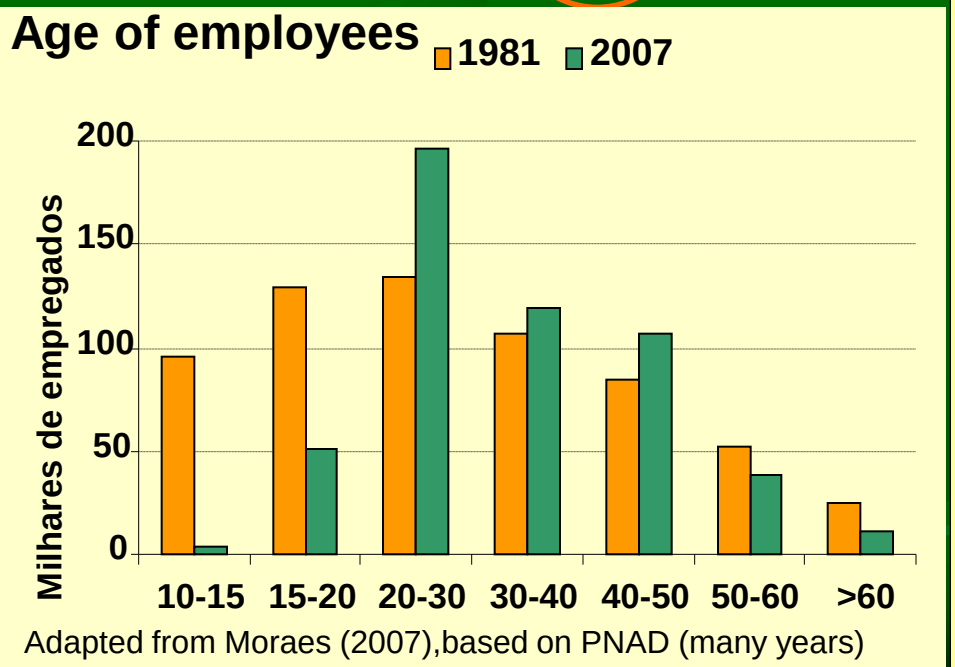
Gasification

Pyrolysis

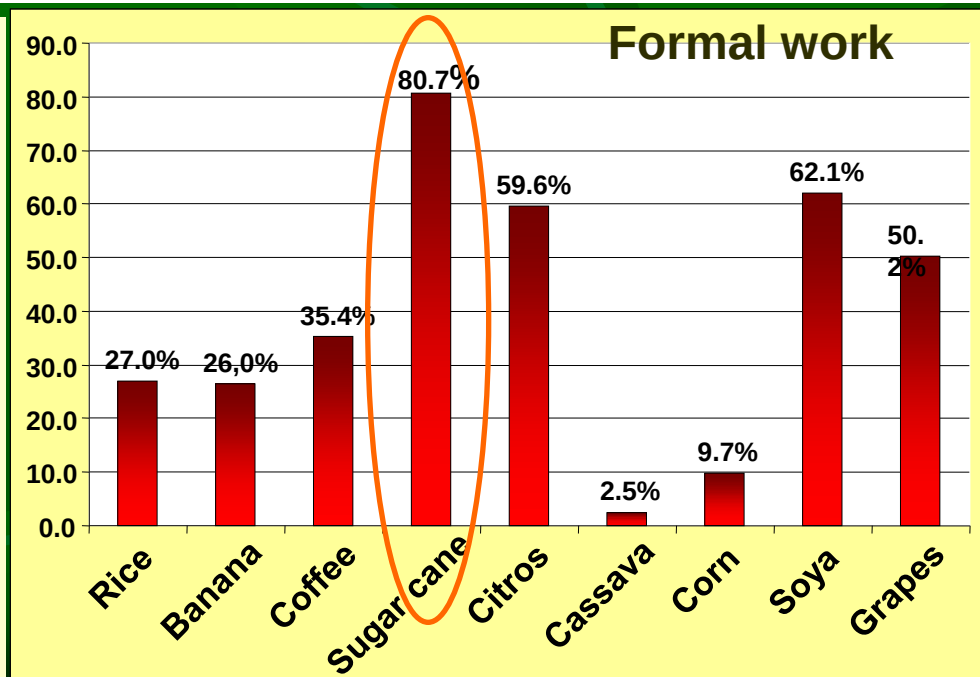
Biorefineries

Brazil

Sugarcane social indicators

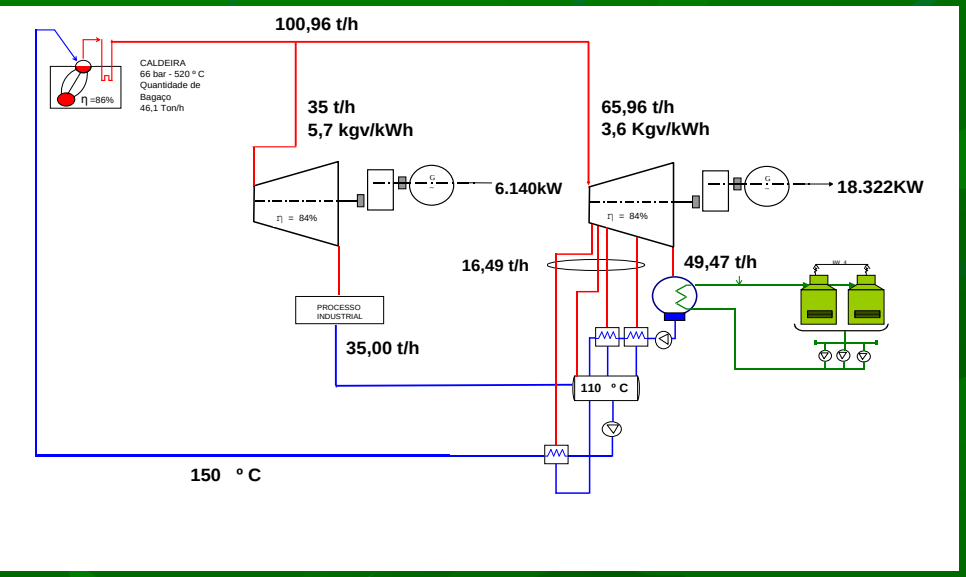


Adapted from Moraes (2007),based on PNAD (many years)



Brazil

Sugarcane bioindustry

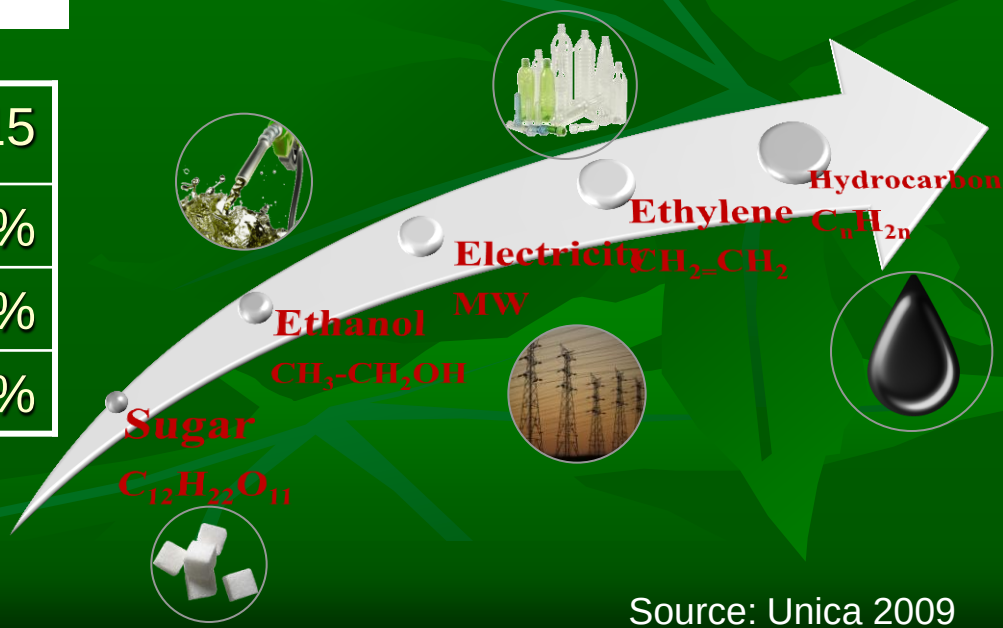


Biopower in Country's electricity generation

2007	3%
2012	6%
2020*	15%

* COGEN 2008

Business income	2005	2015
bioethanol	39%	54%
bioelectricity	1%	16%
energy	40%	70%



Source: Unica 2009

World

Bioenergy visionary perception

"I foresee the time when industry shall no longer denude the forests which require generations to mature, nor use up the mines which were ages in the making, but shall draw its raw material largely from the annual products of the fields"

[Henry Ford, Modern Mechanics (1934)]

Ford Model A (1896) fueled by pure bioethanol [Fuel Testers (2008)]

World

Green economy perceptions

In the context of the green economy debate, which are the main topics for developing countries among the following ones? (Select up to 2)

- **Poverty eradication**
- **Inequalities reduction**
- **Easy access to green technologies**
- **Innovation**
- **The right to a slower transition to green economy**
- **Increase of decent jobs**
- **Preference for technologies that avoid job loss**

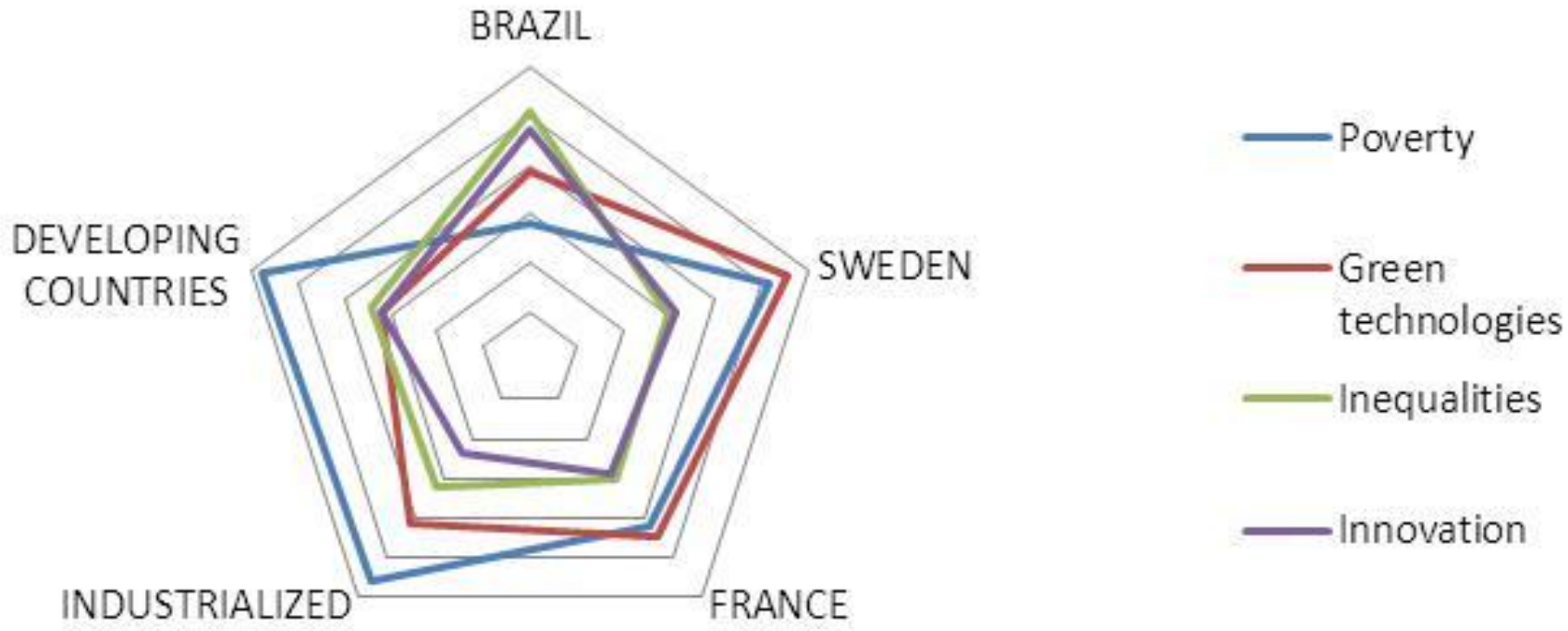
	Poverty	Inequalities	Green technologies	Innovation
BRAZIL	13,91%	25,46%	19,35%	23,72%
SWEDEN	25,74%	14,85%	27,72%	15,84%
FRANCE	21,13%	15,09%	22,26%	14,34%
INDUSTRIALIZED	27,93%	16,22%	20,72%	11,71%
DEVELOPING	29,03%	17,20%	16,13%	16,13%

Query CGEE – Growth Analysis – IDDRI, May 2012

World

Green economy perceptions

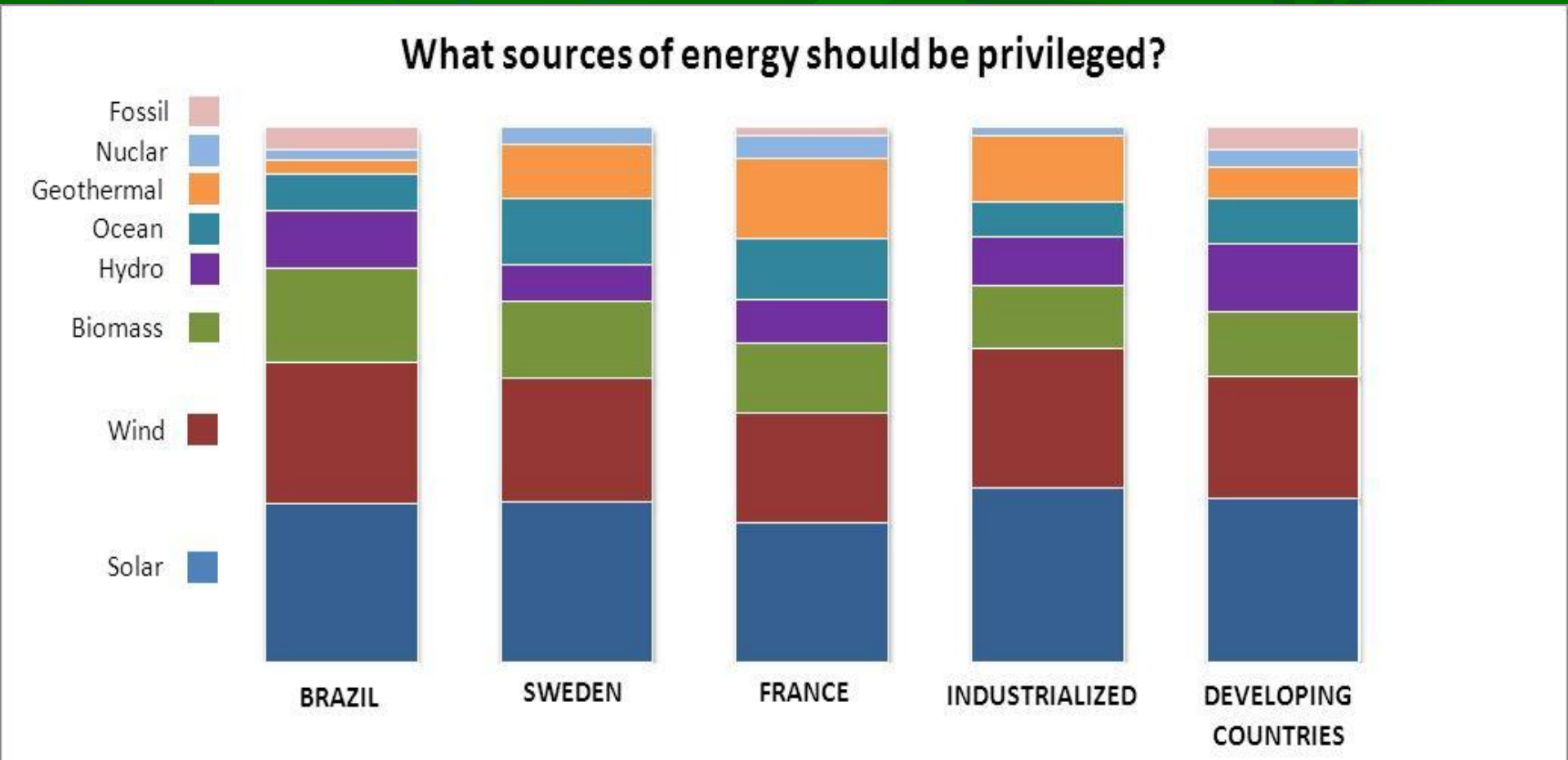
Which are the main topics for developing countries among the following ones?



World

Green economy perceptions

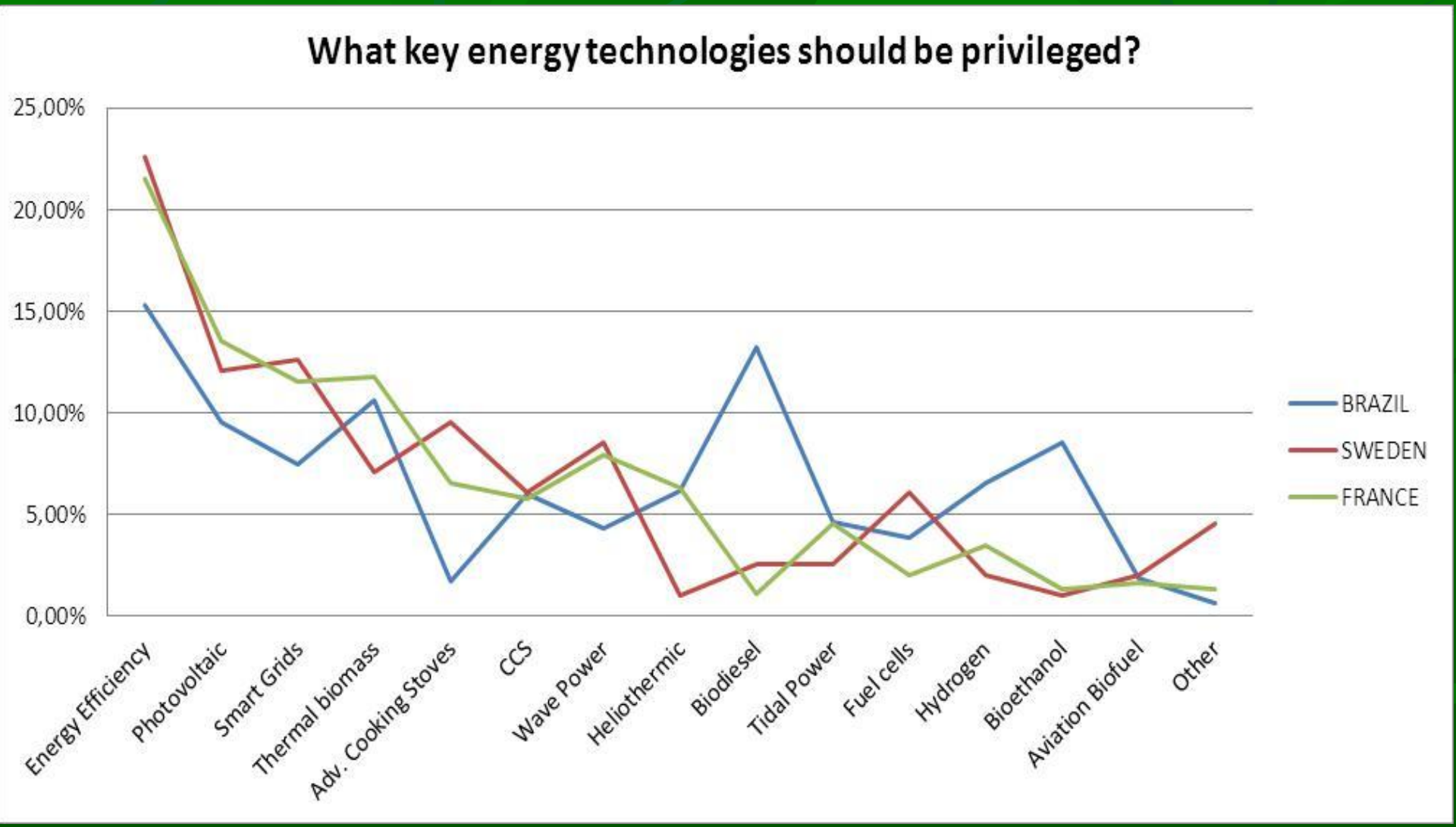
Concerning the promotion of a green economy,



World

Green economy perceptions

Concerning the promotion of a green economy,



World

Global challenge

- Three quarters of the world's energy supply come from fossil fuels, responsible for large local pollution loads and for most of the greenhouse gases emissions.
- The scale on which they are being used will quickly lead to their depletion.
- The world energy consumption should grow as a result of the progress of many of the world’s developing regions.
- Industrial countries have not succeeded in reducing energy use without compromising the quality of life, even though it is known that this can and must be done.

- **The challenge, therefore, is to seek renewable energy sources and to increase efficiencies in energy production and use on an unprecedented scale.**

Thank You !

Marcelo Poppe

mpoppe@cgee.org.br

www.cgee.org.br