

GHG Measurement Efforts Planned in So. America Renewable- Energy Activities in Brazil

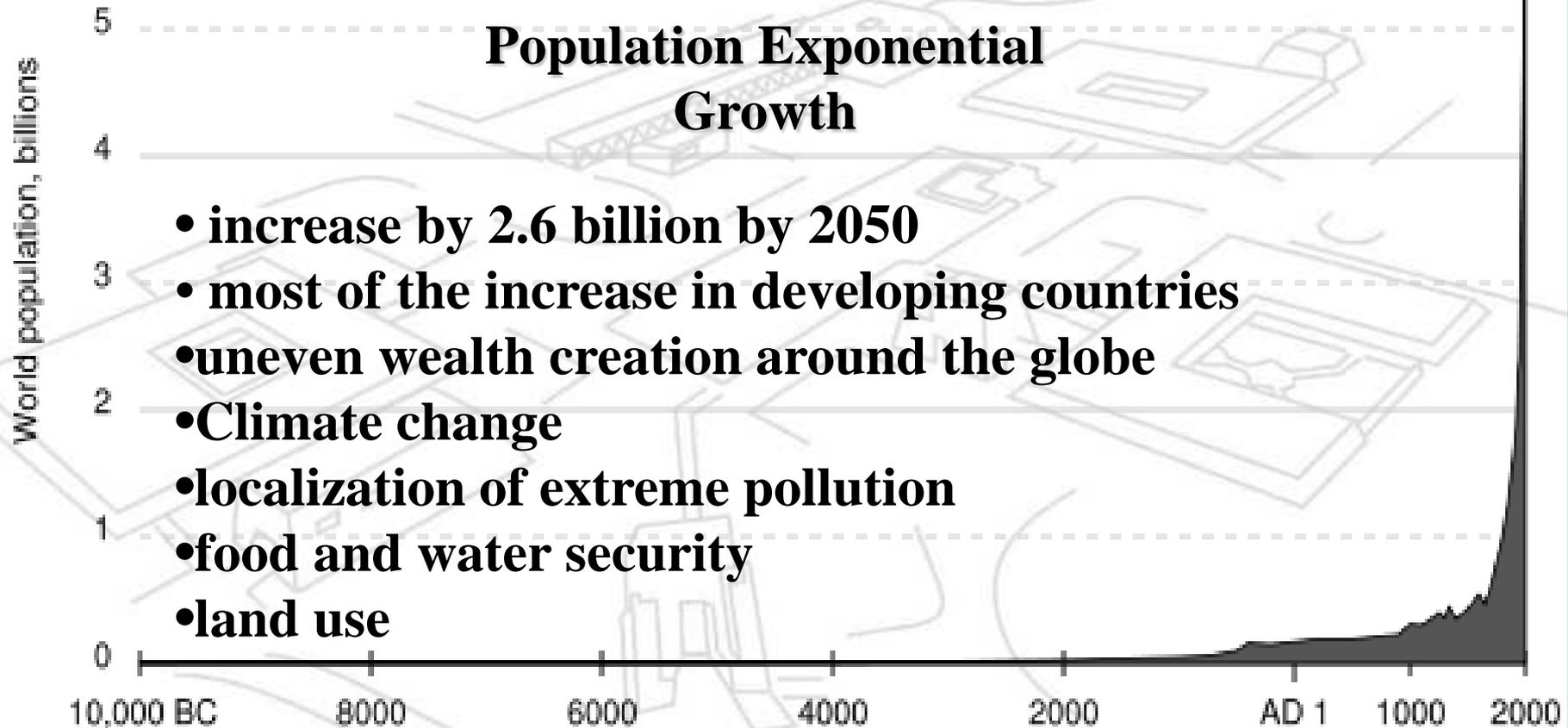
Humberto S. Brandi,

**Diretor de Metrologia Científica e Industrial
Inmetro**

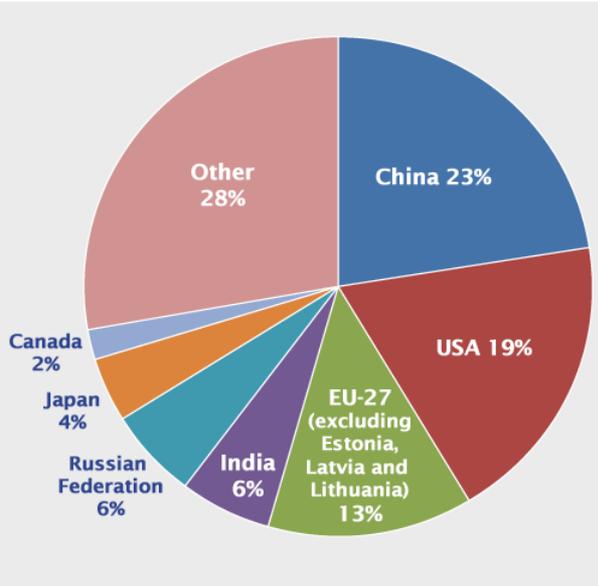
Why to be concerned

Population Exponential Growth

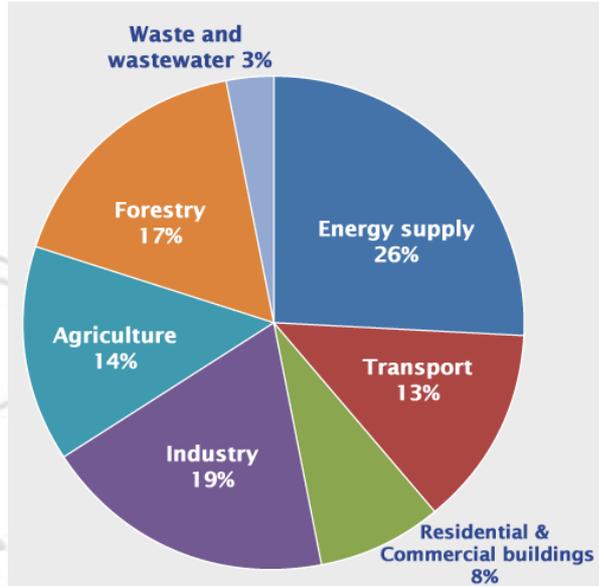
- increase by 2.6 billion by 2050
- most of the increase in developing countries
- uneven wealth creation around the globe
- Climate change
- localization of extreme pollution
- food and water security
- land use



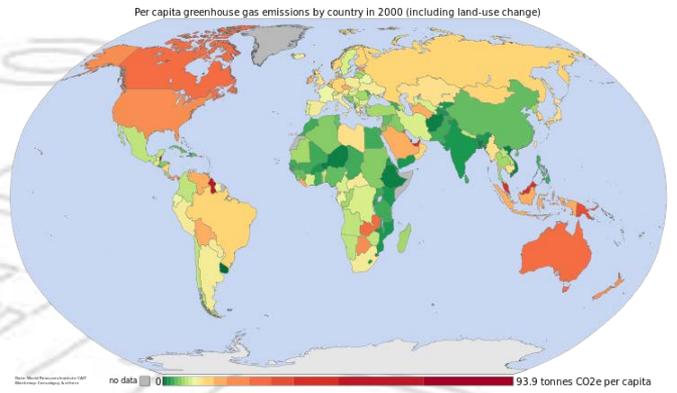
Why to be concerned?



2008 Global CO2 Emissions from Fossil Fuel Combustion and some Industrial Processes (million metric tons of CO2)Source: [National CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2008.](#)



Global Greenhouse Gas Emissions by Source Source:IPCC (2007); based on global emissions from 2004. Details about the sources included in these estimates can be found in the [Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change](#).



Per capita anthropogenic greenhouse gas emissions by country for the year 2000 including land-use change.

Effects of CO₂ Increase

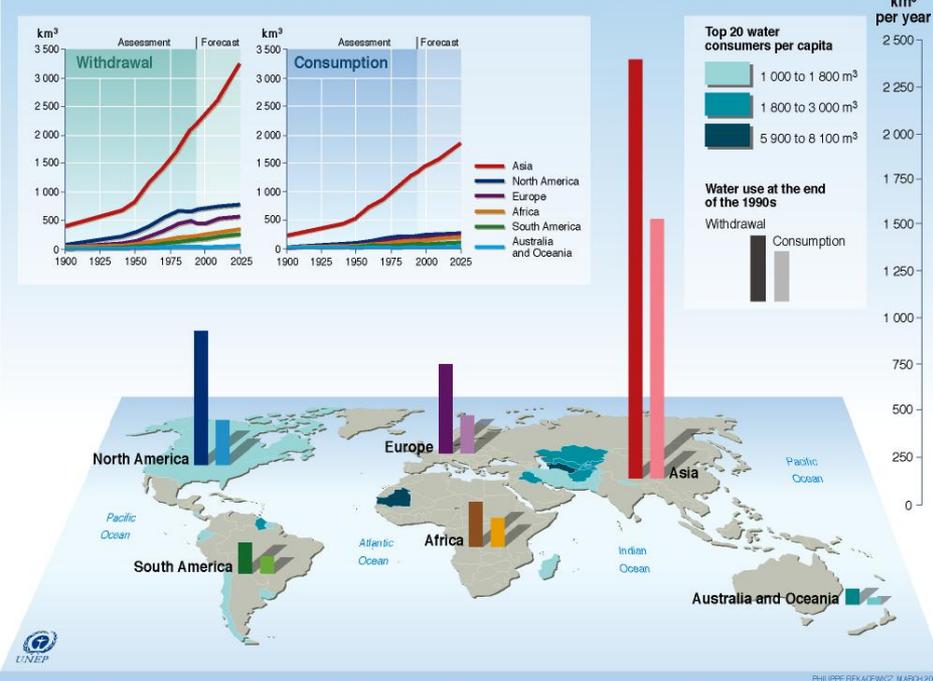
Year (#)	CO ₂ (ppm)	Temp. (°C)	Sea level (cm)	Traffic Light
1 900	290	0	0	● Green
2 000	380	0.8	10	● Yellow
2 100	1 200	6.0	100	● Red ?



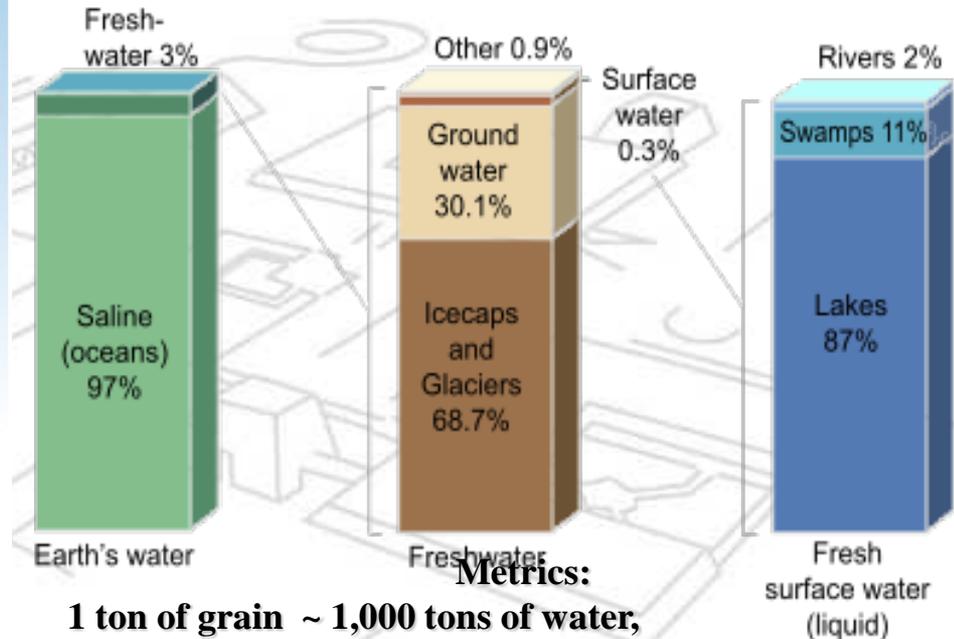
Why to be concerned?

08

Global Water Withdrawal and Consumption



Distribution of Earth's Water



Metrics:

**1 ton of grain ~ 1,000 tons of water,
1 slice of cantaloupe ~ 150 l of water,,
225 g of serving of steak ~ 4,665 l.**

**1 kg of pork requires 13,600 l
2,000-5,000 liters of water each day to produce one
person's daily food.**

**Agriculture can consume 75 to 90% of a region's
available water**

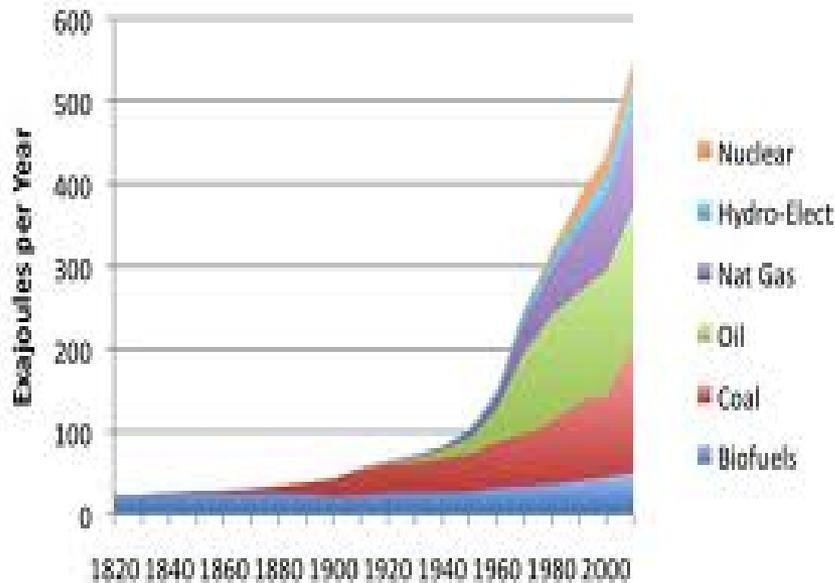
Sources: The Economist, the National Geographic Society, USAID studies, The Pacific Institute, Global Development Research Center and the United States Geological Survey.

Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational Scientific and Cultural Organisation (UNESCO Paris), 1999; World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life, World Resources Institute (WRI), Washington DC, 2000; Paul Harrison and Fred Pearce, AAAS Atlas of Population 2001, American Association for the Advancement of Science, University of California Press, Berkeley.

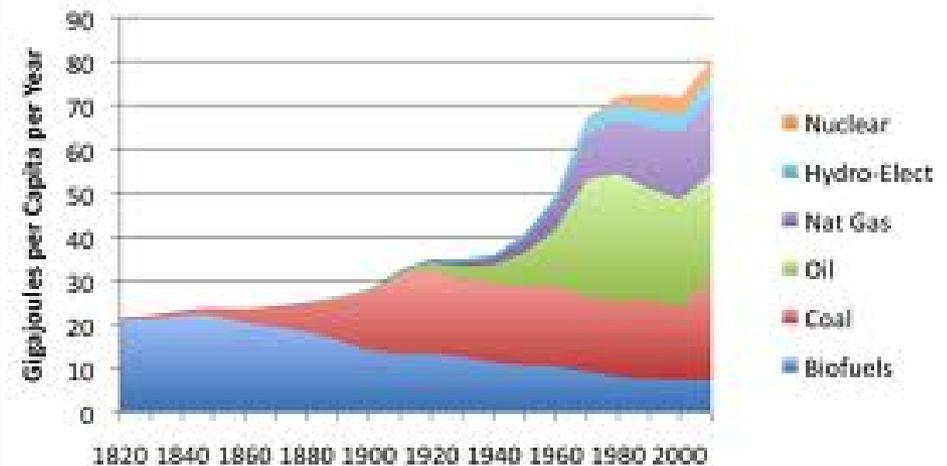
Water consumption rate is doubling every 20 years, outpacing by two times the rate of population growth
By 2025 water demand will exceed supply by 56%
Since 1950 the world population doubled and water use tripled
Only 20% of the world population enjoys access to running water; over one billion people in developing countries have inadequate access to water
Average American uses 380 to 670 liters of water per day; the average African family uses 20 liters of water per day

Why to be concerned?

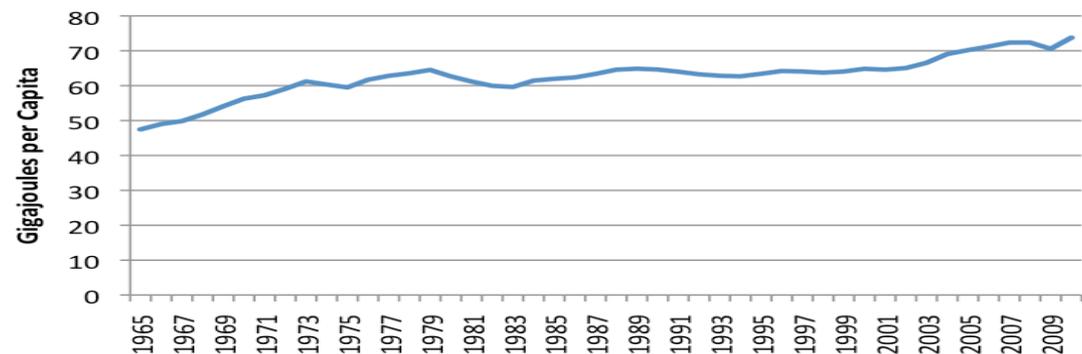
World Energy Consumption



World per Capita Energy Consumption



Per Capita Energy Consumption



Why to be concerned?

Country (GNP Rank)	Total energy consumption/capita.annum (GJ)
 USA (1)	300.10
 Japan (3)	163.73
 Germany (4)	168.14
 France (5)	169.28
 UK (7)	136.67
 China (2)	75.88
 Brasil (6)	57.23
 Russia (10)	207.61
 India (9)	23.76

Energy use per capita: *World Development Indicators*. World Bank.

Policy making and energy facts

1kg gasoline delivers the energy of approximately

TNT	Coal	Methanol	Ethanol	Butanol	Natural Gas	Hydrogen Gas/liquid	U/Pt fission	H fusion
15 kg	2 kg	2 kg	1.5 kg	1.1 kg	0.77 kg	0.38 kg	500 ng	170 ng
1kg gasoline delivers the energy of approximately		1kg gasoline delivers the energy of approximately		1kg gasoline delivers the energy of approximately		1m ² of sun delivers the energy of approximately		
1000 x 1 kg of flash light batteries		100 x 1 kg sophisticated computer batteries		4.5 l of liquid Hydrogen		1 hp in the ground 1hp ~ 746 W		

Energy costs

Coal is 25 x cheaper than gasoline, for the same energy delivered

Energy from nonrechargeables batteries costs about 10.000 x that from wall plug

GHG Measurement Effort in Brazil and So. America



Challenges and Motivation

Climate change is a global problem and maybe is one of the most important challenges of this century

It must be treated in global basis and requires strong international cooperation

Must be science based and the results must be trusted by all players

International cooperation to increase the capabilities in the field

Harmonized methodologies and data basis

W
S
Q
O



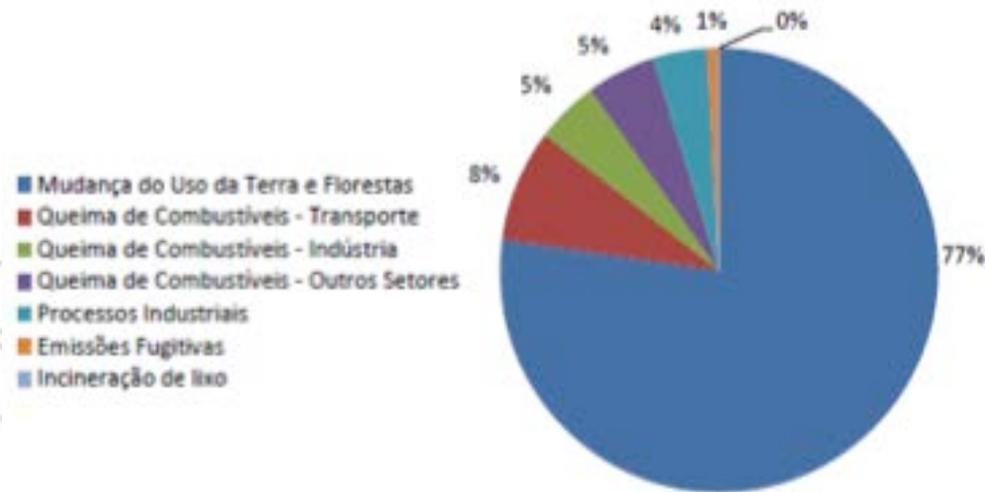
50% Global Tropical Forest

~ 120Pg above ground biomass

Amazon river discharge represent around 20% of Global
fresh water input to ocean

~20% Global biodiversity

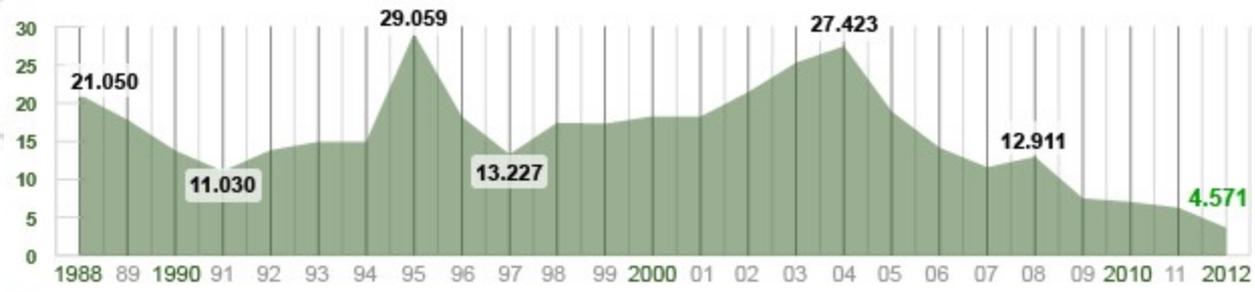
CO₂ - 2005
1.637.905 Gg



Fonte: MCT, 2010

Veja o desmatamento da Amazônia ao longo do tempo

Medição anual (em Km²)



Building the Brazilian Observation System of Climate Change-GHG Measurements

Workshop
SIM-GA
Querétaro, México
October 8-9, 2013



Ministério de
Desenvolvimento, Indústria
e Comércio Exterior



- Vertical Profiles
- CO₂, CH₄, N₂O,
CO and SF₆



Courtesy Luciana Gatti

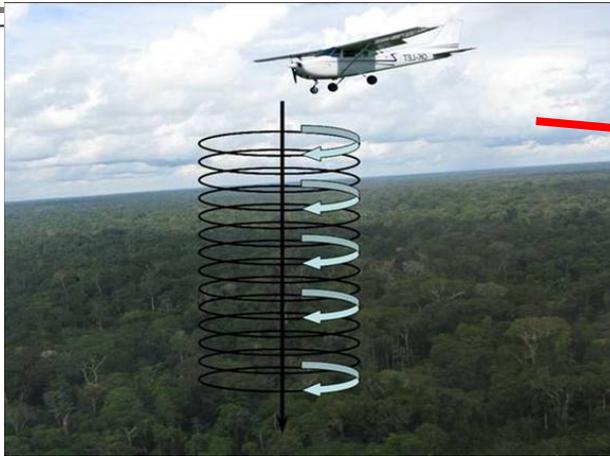
Sampling with Aircraft Vertical Profiles in Amazon Basin

Workshop
SIM-GA
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October 8-9, 2013

INMETRO

Ministério do
Desenvolvimento, Indústria
e Comércio Exterior

REPUBLICA FEDERAL
BRASIL
PAÍS RICO É PAÍS SEM POBREZA

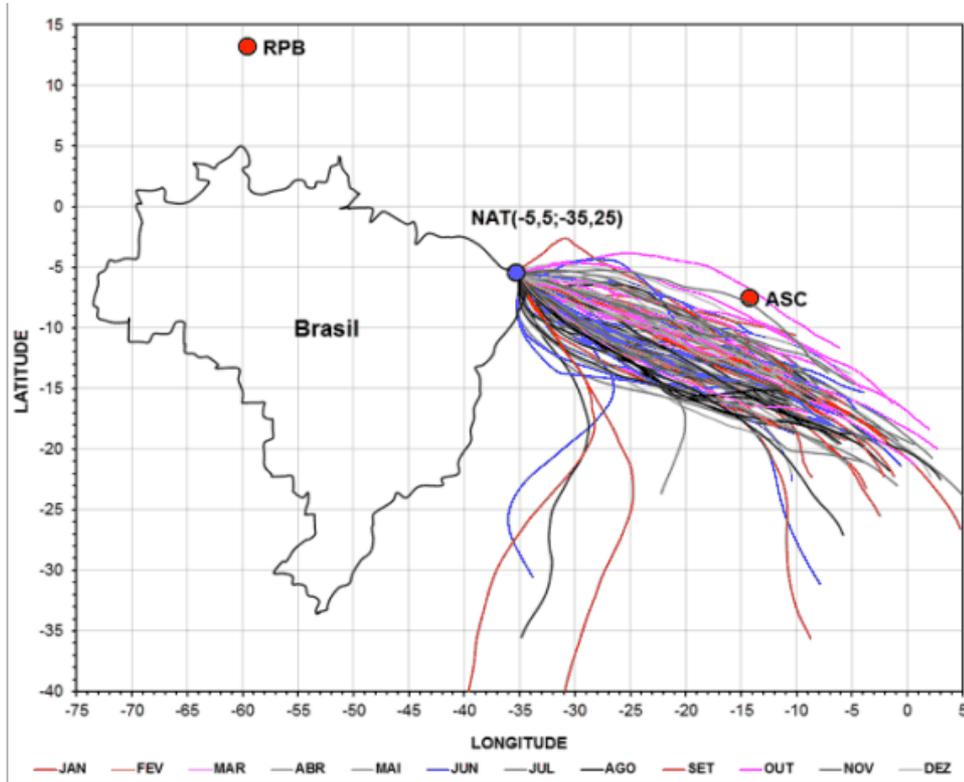


MAGICC System

PFP and PCP

Courtesy Luciana Gatti



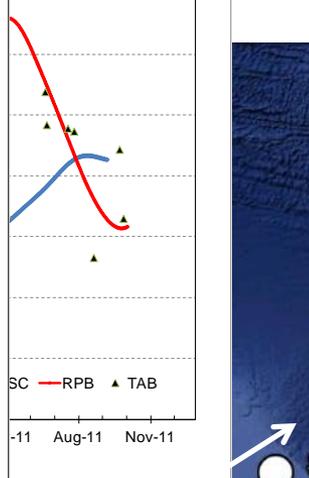
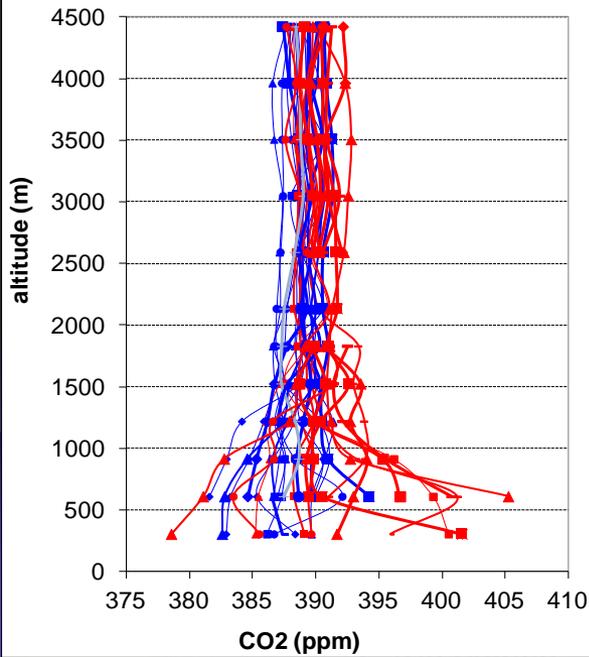


12 mass trajectories/month

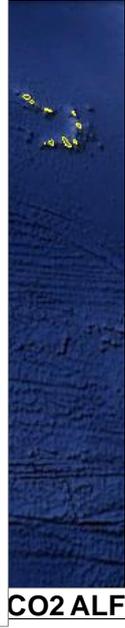
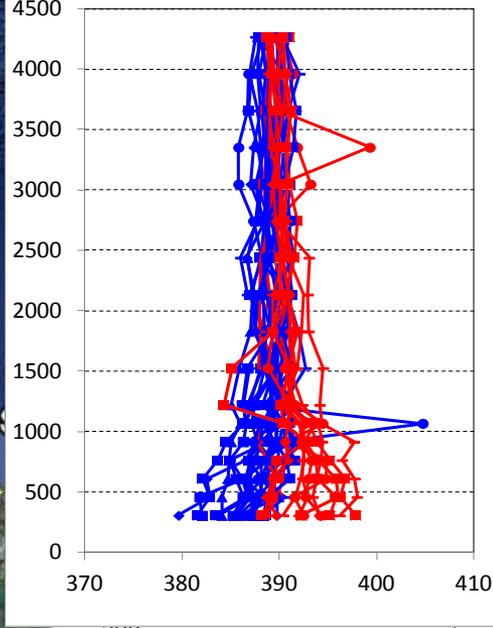


Courtesy Luciana Gatti

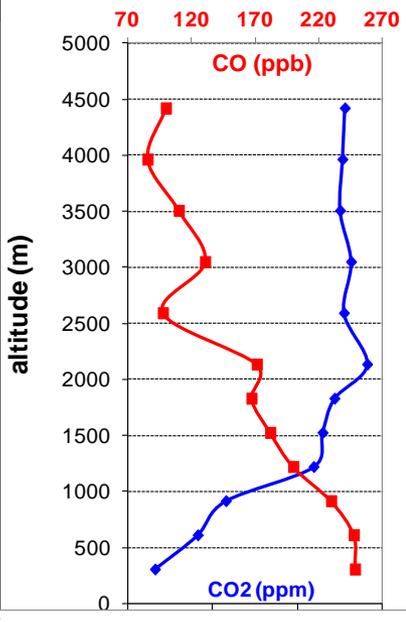
Tabatinga



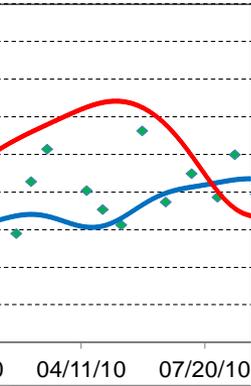
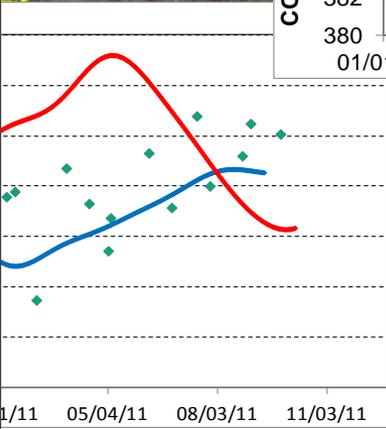
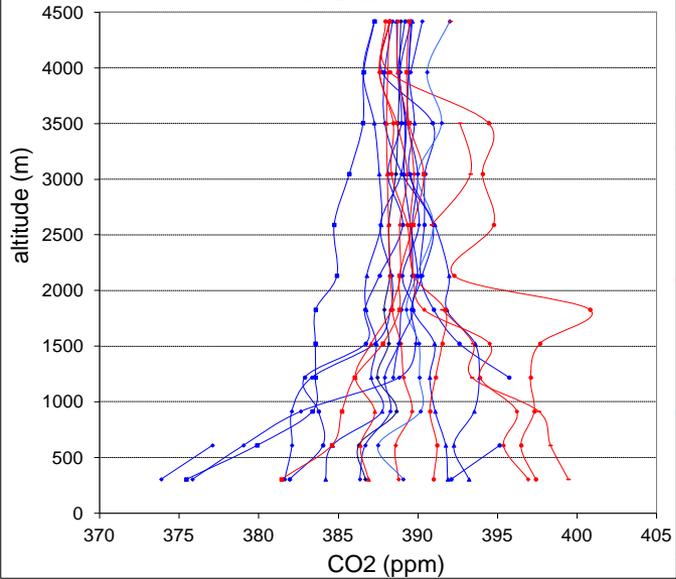
SAN



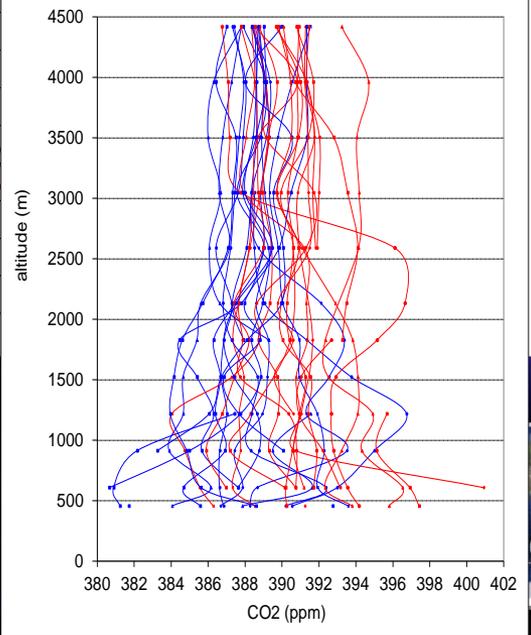
TAB (8/26/11)



Rio Branco



Alta Floresta



Courtesy Luciana Gatti

MCTI

Ministério da Ciência,
Tecnologia e Inovação

www.mct.gov.br

3254 actions on GHG inventory

- 1.100.0% [Ação: Inventário Nacional de Emissões de Gases de Efeito Estufa](#)
- 7.100.0% [Emissões de Gases de Efeito Estufa no Tratamento e Disposição de Resíduos](#)
- 8.100.0% [Emissões de Gases de Efeito Estufa no Transporte Rodoviário](#)
- 9.100.0% [Emissões de Gases de Efeito Estufa no Transporte Aéreo](#)
- 10.100.0% [Emissões de Gases de Efeito Estufa na Queima de Resíduos Agrícolas](#)
- 11.100.0% [Emissões de Gases de Efeito Estufa nos Processos Industriais: Indústria Química](#)
- 14.80.0% [Emissões de Gases de Efeito Estufa no Setor Energético por Fontes Móveis](#)
- 19.80.0% [Primeiro Inventário Brasileiro de Emissões e Remoções Antrópicas de Gases de Efeito Estufa](#)

High-Performance Computing - Project South American Emissions, Megacities and Climate (Saemc).

Implemented by the Centre of Weather Forecast and Climate Studies (CPTec) and by the Centre of Sciences of Land (CCST), both from the National Institute of Space Research (Inpe/MCT), and by the Centre of Mathematical Modelling, from the University of Chile.

Clusters localized at the Centre of Mathematical Modelling, from the University of Chile, in Santiago, and at CPTec, Cachoeira Paulista (SP), interconnected to the networks Reuna (Chile), RNP (Brasil) and Clara (Latin America).

Saemc is supported by the Interamerican Institute for Research of Climate Change (IAI).

Collaboration of 13 research institutions from Latin and South America, as Inpe and the University of São Paulo (USP), from Brasil, U.Chile, U. Buenos Aires, Argentina, Peru and Colombia.

Participation of the National Oceanic and Atmospheric Administration (NOAA), from United States.

The gases included in the forecast are CO, CO₂, NO_x, aerosol particules from burning and urban and industrial emissions, ozone and its precursors.

<http://saemc.cmm.uchile.cl/>



Activities Related to GHG

Production of MRCs

New automotive center- -Emission, Energy Efficient, Crash-2013-2015

Planned workshop on GHG , Megacities, measurements – 2014

Cooperation with CENA-USP

Cooperation program with the Laboratory of GHG measurements of IPEN

Coordination of the PBACV- Brazilian Program of LCA

AGRIBUSINESS

CENA-USP



CROPS

Plant Biomass

Crop residues Decomposition

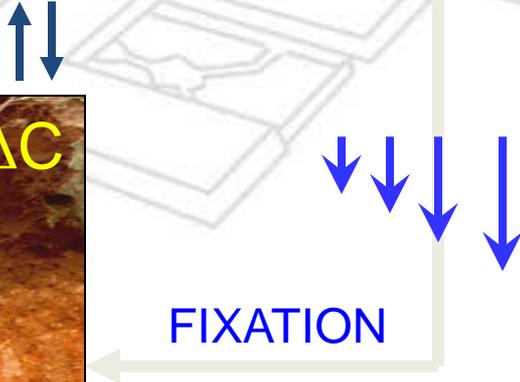
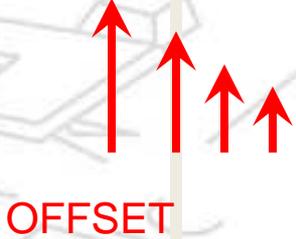
ENERGY

Biodiesel
Ethanol

Biofuel TEP

ΔC

Soil carbon sequestration



Significant role

Courtesy C. Cerri - CENA

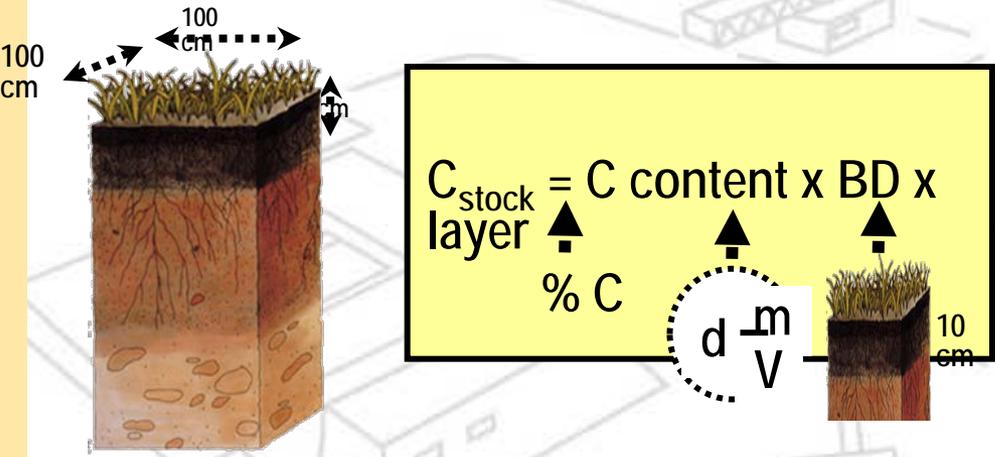
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Soil Carbon Stocks

Data needed for each soil

layer:

- Carbon content
- Soil bulk density (BD)



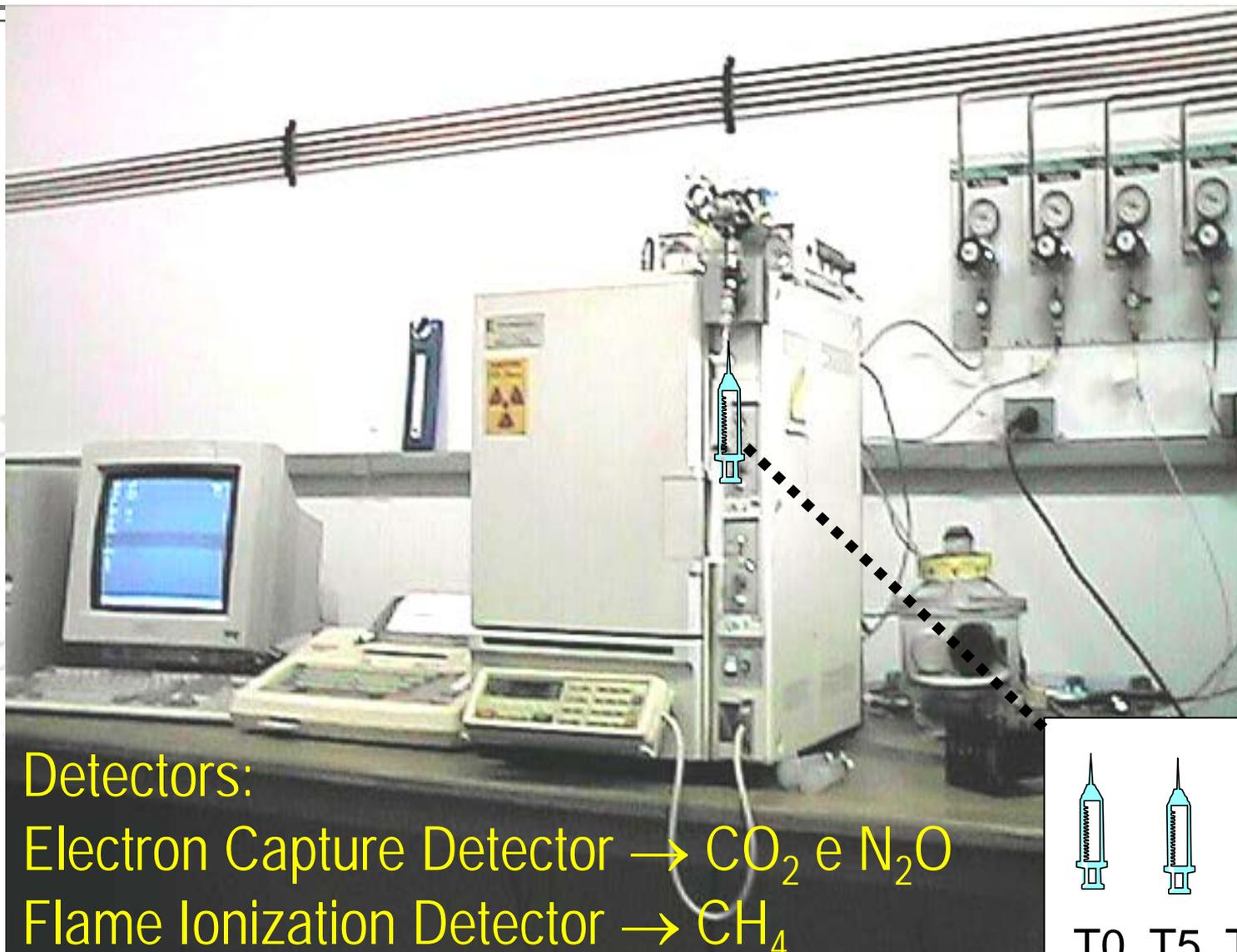
Sampling greenhouse gas emissions



VALIDATION

Courtesy C. Cerri - Cena

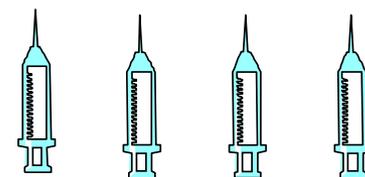
Chromatographic analysis of GHG



Detectors:

Electron Capture Detector → CO₂ e N₂O

Flame Ionization Detector → CH₄



T0 T5 T10 T20

Courtesy C. Cerri - Cena

LCA for Biofuels

traces and evaluates the environmental and energy impacts over the “life cycle” of a given “product”

The Inmetro LCA Collaboration

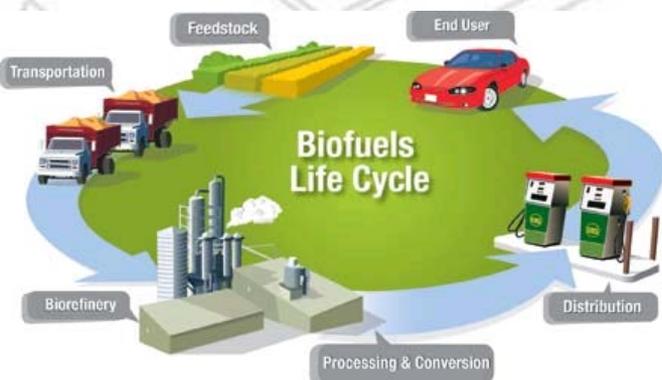
A proposal of a model LCA for bioethanol:

LCA methodology

A questionnaire / worksheet model for Brazilian producers, in order to construct a database for its different regions.

To gather information and studies from reliable sources in order come up with a standard LCA for ethanol production, not only for Brazil, but also for other potential producers.

To have the producers themselves using INMETRO model LCA, in order to rate and improve their processes.



EXs: GHG Working Groups in Brazil

The Groups in Brazil are working in two types of measurements:

Fluxes measurements that are relative without calibration, mainly in CO₂

USP, INPE, INPA, Federal University of Amazonas, Federal University of RGS, Federal University of Mato Grosso, Federal University of Rondonia, Federal University of Para.

CENA works on Methane and CO₂ fluxes in the Amazon rivers.

Absolute measurement of the GHG :

IPEN/LQA – measurements of CO₂, CH₄, N₂O, CO, SF₆ and H₂.
Two flights monthly over four places (8 flights monthly): Santarem (PA), Rio Branco (Acre), Tabatinga (AM) and Alta Floresta (MT).

Examples of International Cooperation:

IPEN- Instituto de Pesquisas Energética e Nuclear, with:

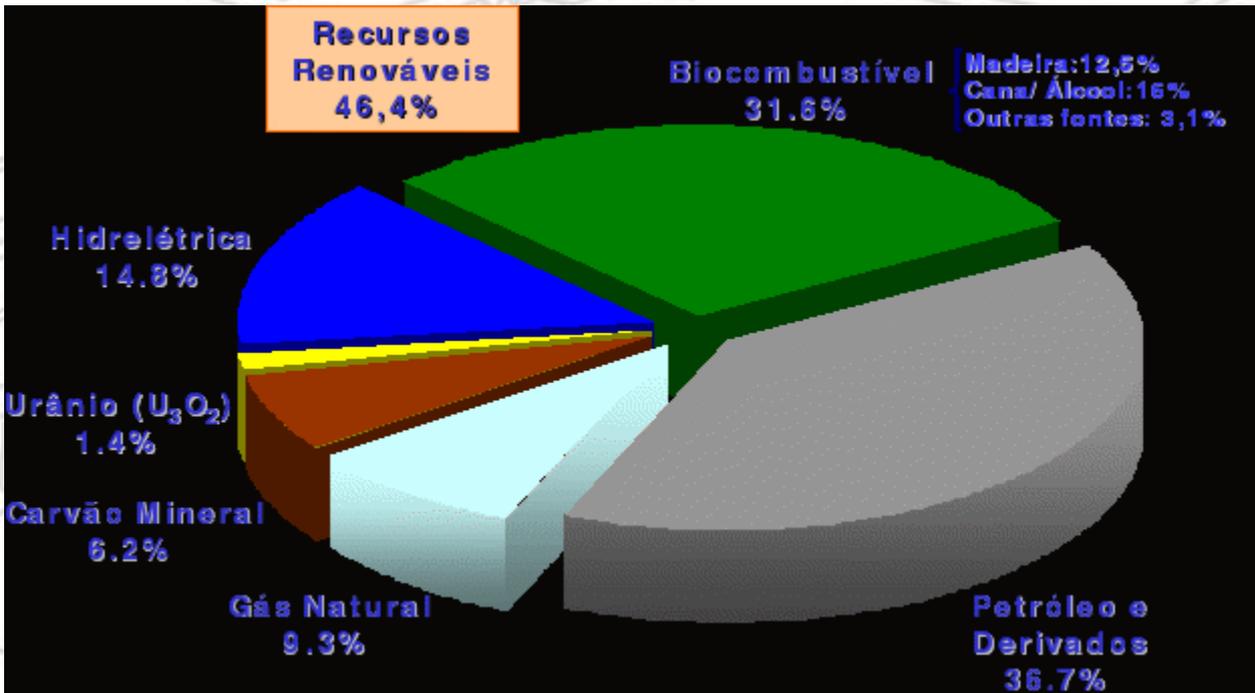
- a) NOAA (National Oceanic Atmospheric Administration)/ERSL (Earth Research System Laboratory)/GMD (Global Monitoring Division)**
- b) University of Colorado (Boulder – US)**
- c) University of Leeds (UK)**
- d) University of Harvard (US)**
- e) MaxPlank Institute (Jena – Germany)**
- f) University of Leicester (UK)**

Source: Luciana Gatti-IPEN

Renewable- Energy Activities in Brazil



Brazilian Energy Matrix



Smart Grids

Brazilian Program



Traceability of PMU

Dynamic Monitoring of Electric Grids

Security Protocols

Colaboration- NIST, PTB

The Brazilian System for More Efficient Products

Endorsement seals (Procel / Conpet)



Labeling
(Inmetro)



Accredited laboratories
Accredited certification bodies

Minimum Energy Performance
Standards (Energy Efficiency Level and
Indicators Management Committee)





29 schemes

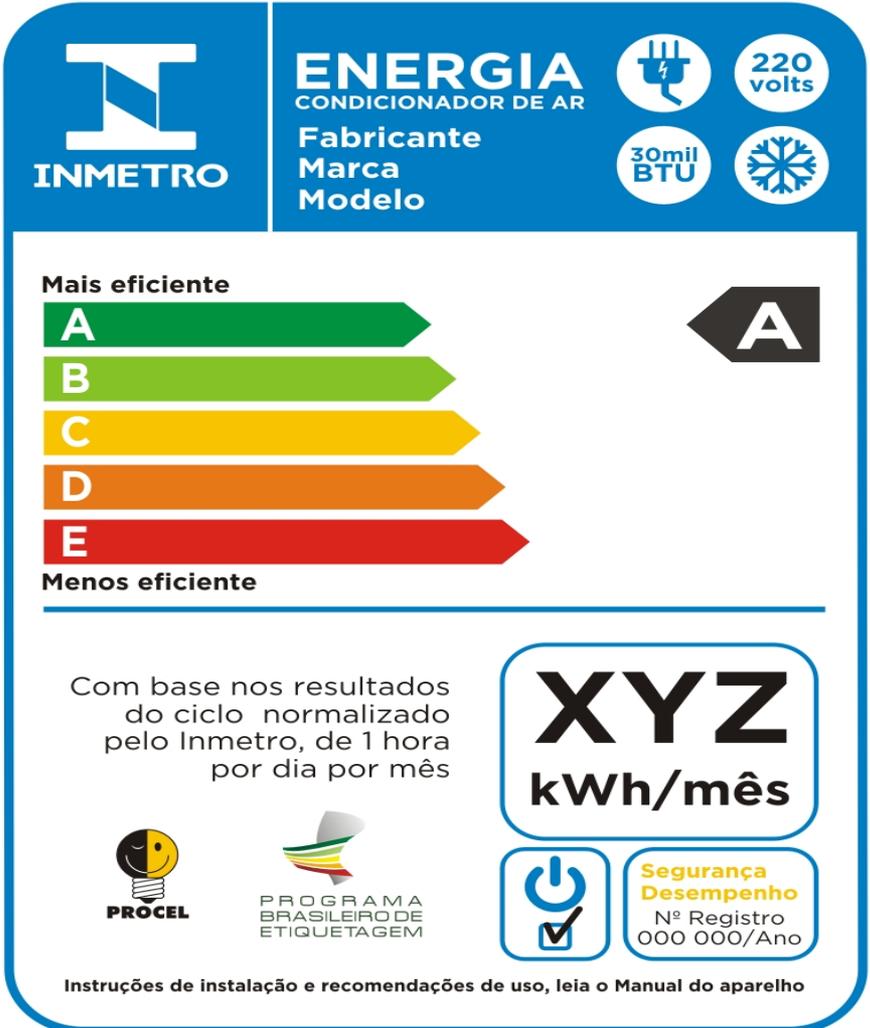
21 mandatory

12 more in the next 2
years

**Demands are
increasing in number
and complexity**



**In Brazil, 78% of
the consumers
take the
labeling into
consideration
when buying
products**



INMETRO

ENERGIA
CONDICIONADOR DE AR

Fabricante
Marca
Modelo

220 volts
30mil BTU

Mais eficiente

A B C D E

Menos eficiente

Com base nos resultados do ciclo normalizado pelo Inmetro, de 1 hora por dia por mês

XYZ
kWh/mês

PROCEL

PROGRAMA BRASILEIRO DE ETIQUETAGEM

Segurança Desempenho
Nº Registro 000 000/Ano

Instruções de instalação e recomendações de uso, leia o Manual do aparelho

In the last 10 years, the
average refrigerator

In the same
period, it saved

70%
more efficient.

US\$ 2,3 billions
on energy bills.

And more efficient lighting saved

US\$ 11,5 billions.

Ethanol – BRAZIL

1928



1931



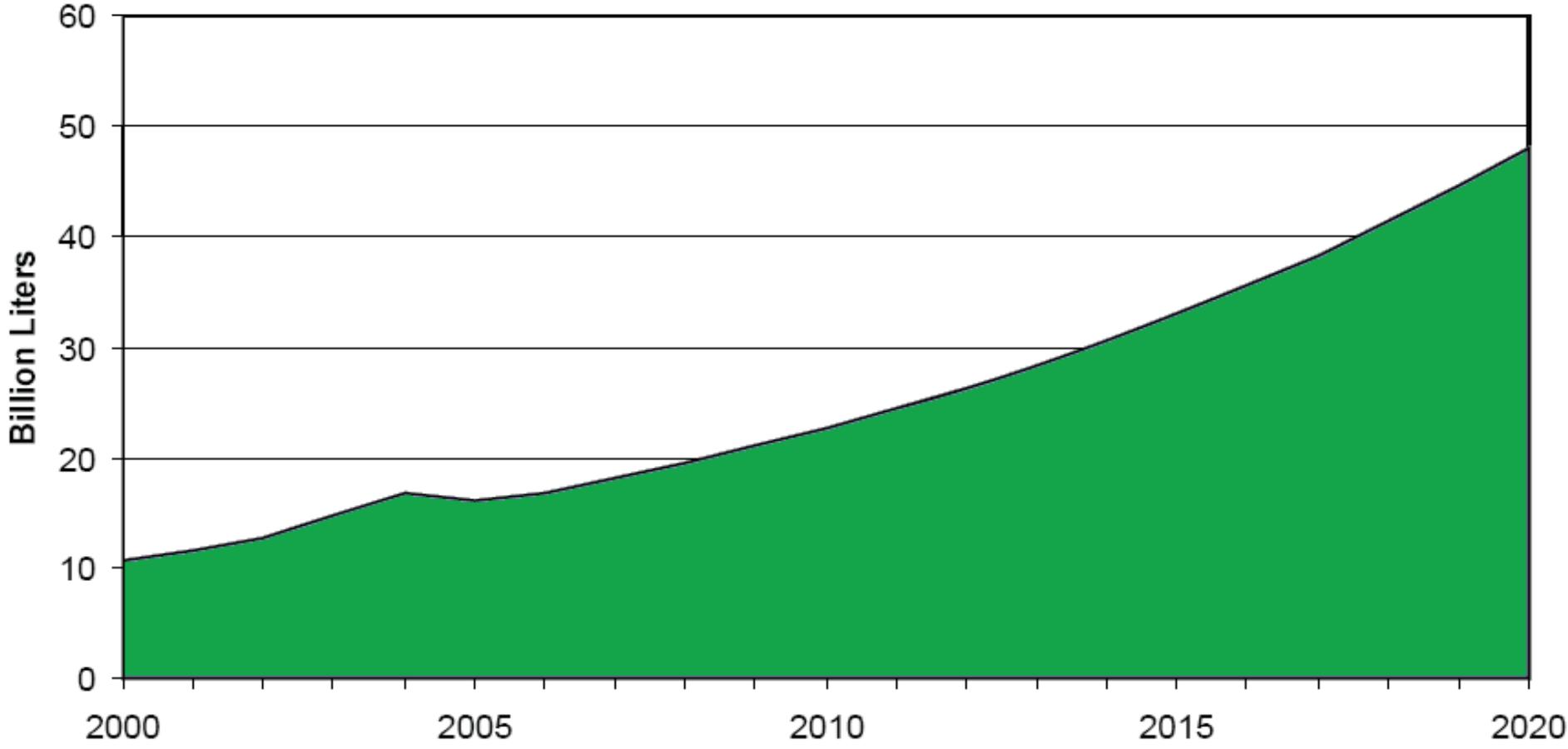
1940



1974

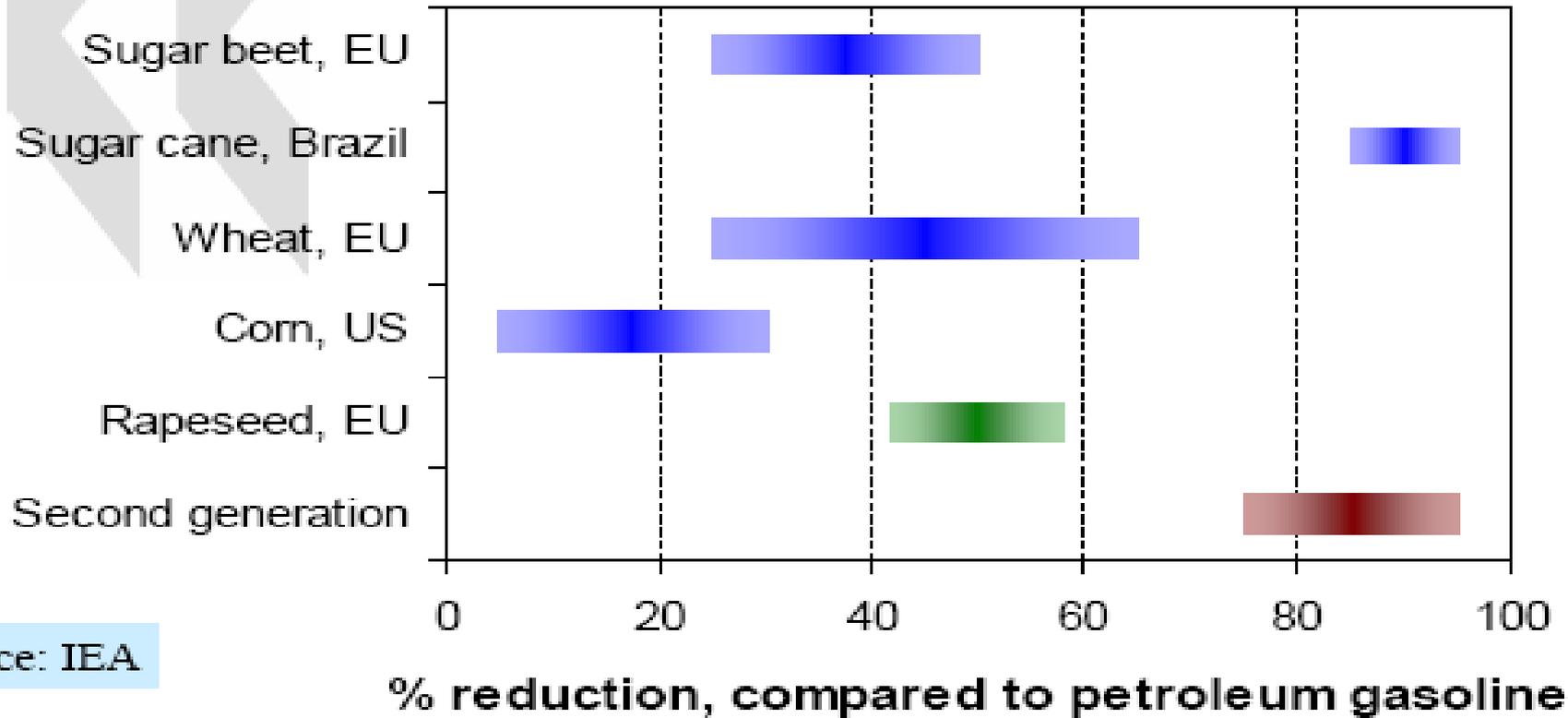


Historic and Planned Brazilian Ethanol Production



Climate Change mitigation potential

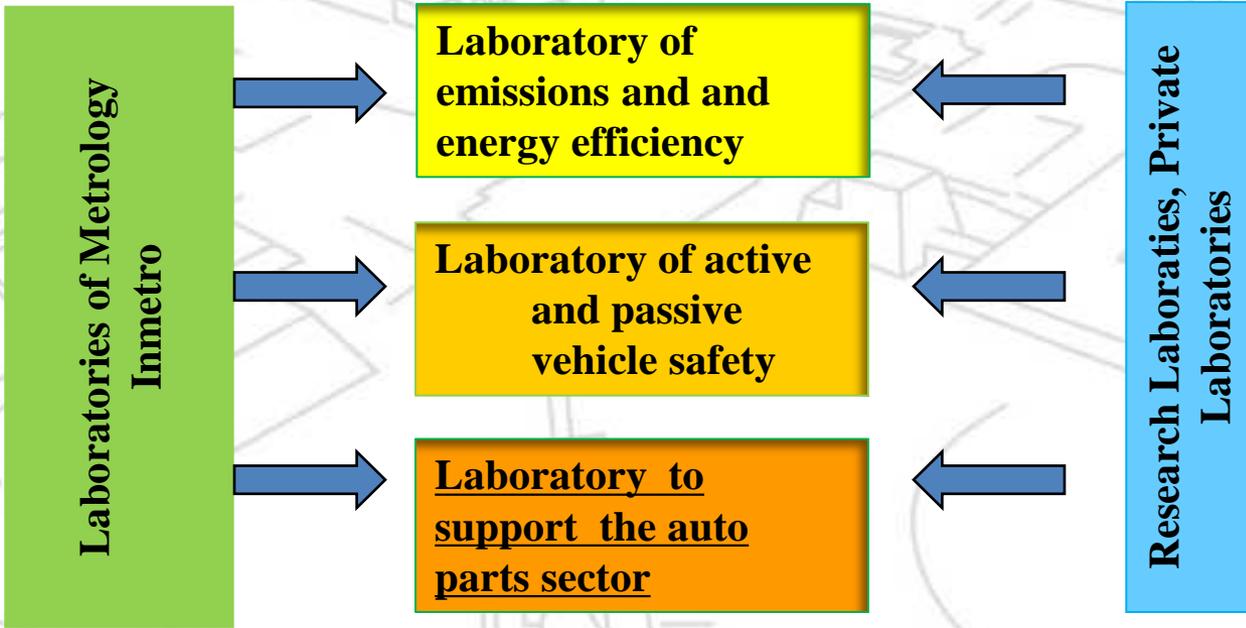
Well-to-wheel emission reductions

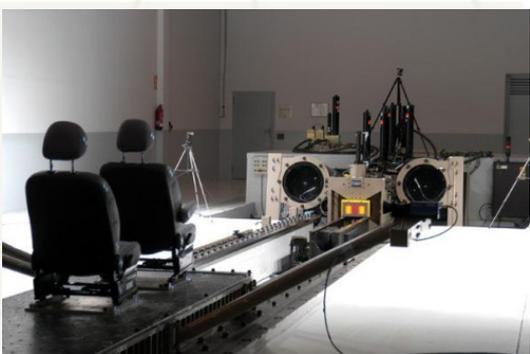
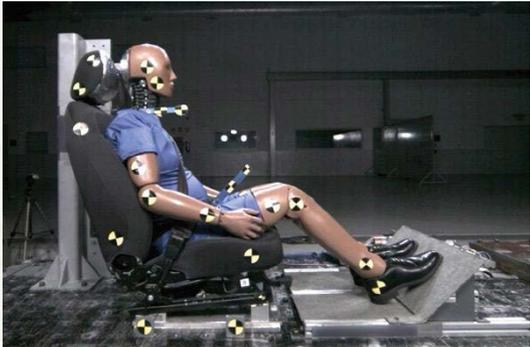


Source: IEA



Center for Automotive Technology - INMETRO





Laboratory of Vehicle Safety

Homologation and Basic Research



Workshop
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Desenvolvimento, Indústria
e Comércio Exterior



*Thank
you!*