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Querétaro, México
October 8-9, 2013

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

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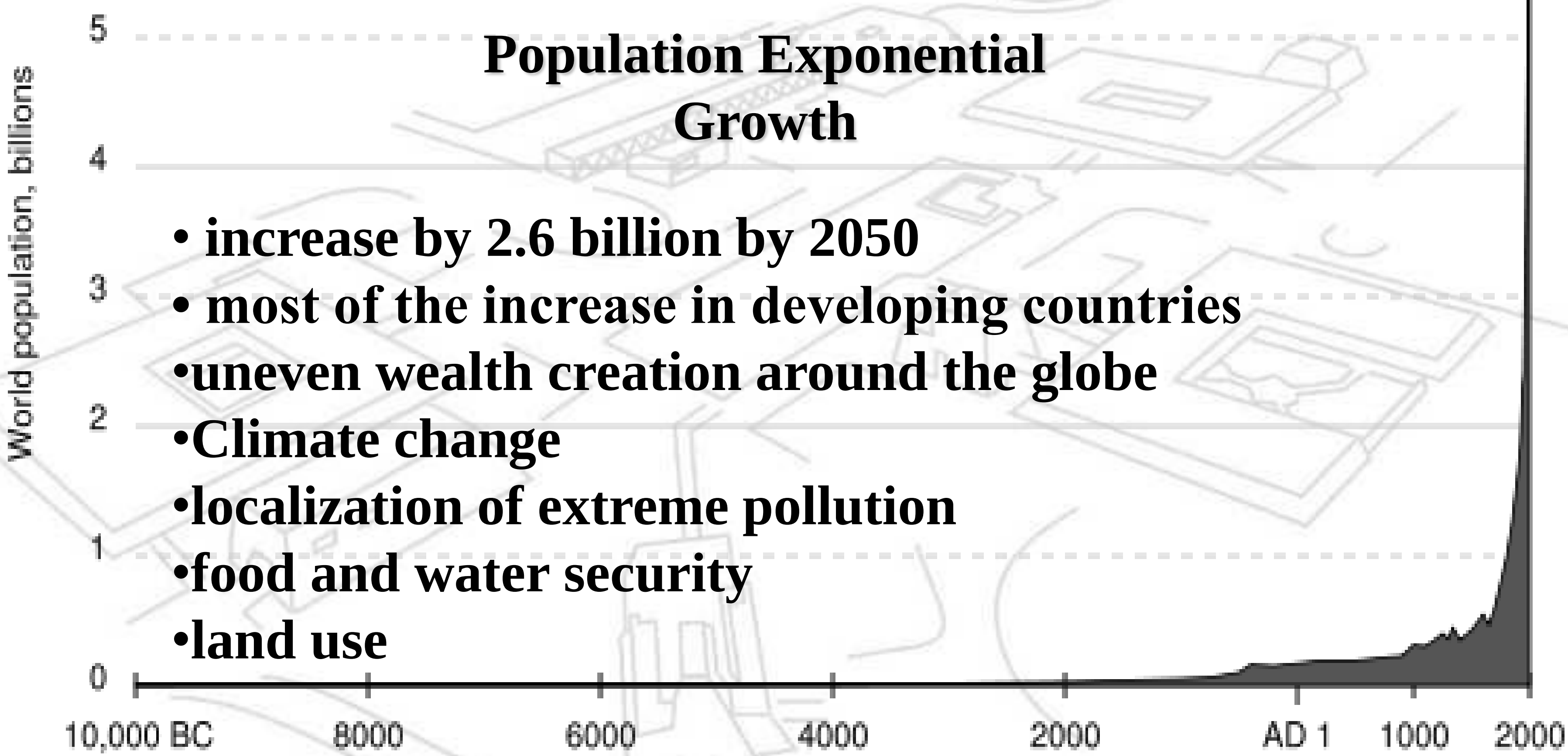
Diretor de Metrologia Científica e Industrial
Inmetro

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



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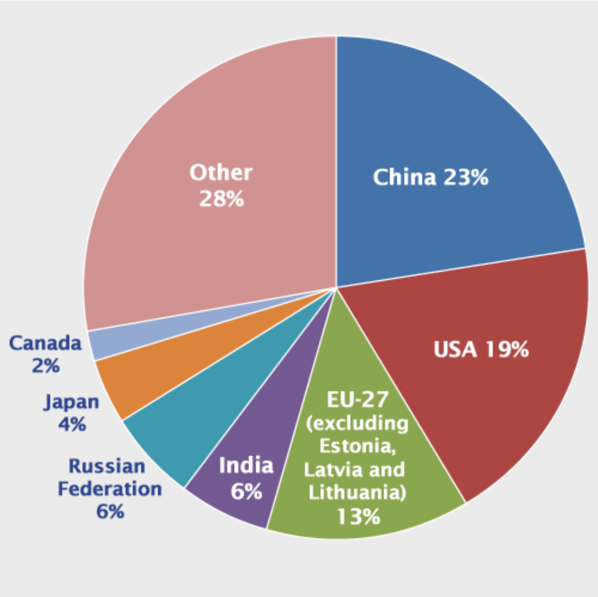
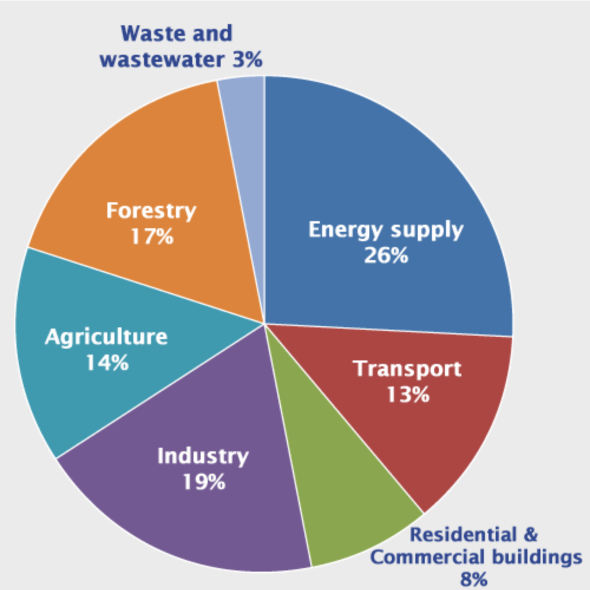
Why to be concerned?

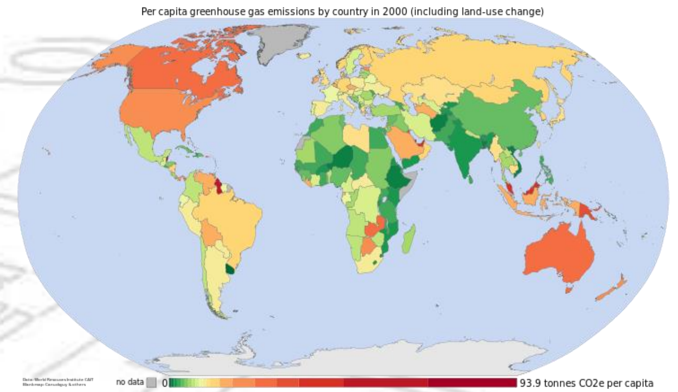


2008 Global CO2 Emissions from Fossil Fuel Combustion and some Industrial Processes (million metric tons of CO2)Source: [National CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2008.]



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*

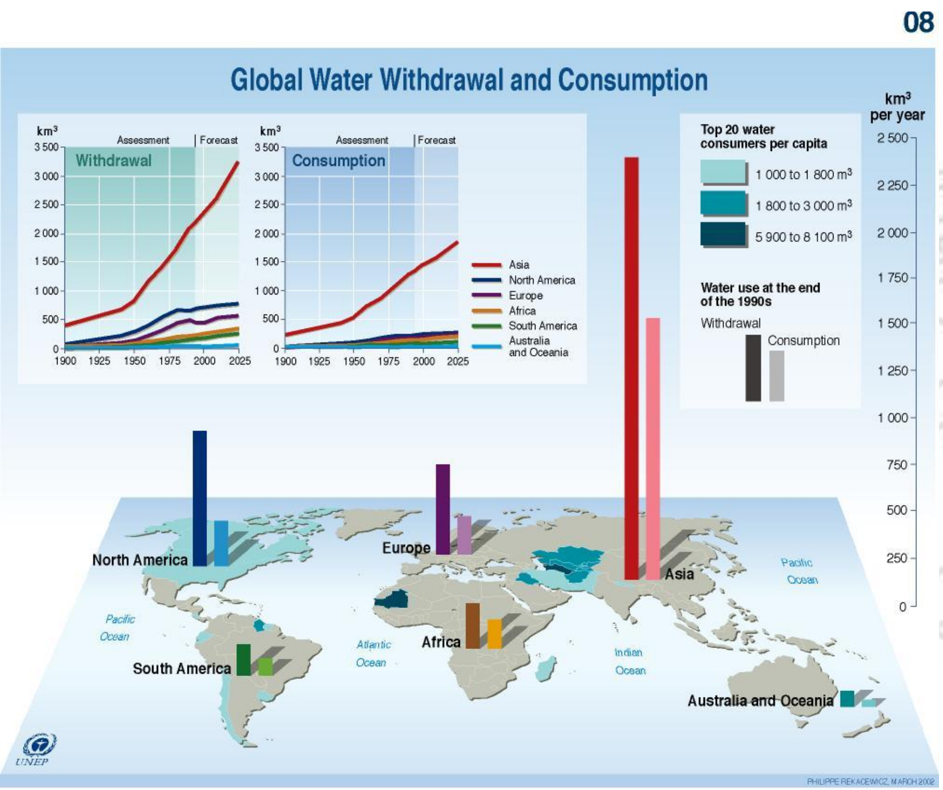


Per capita anthropogenic greenhouse gas emissions by country for the year 2000 including land-use change.

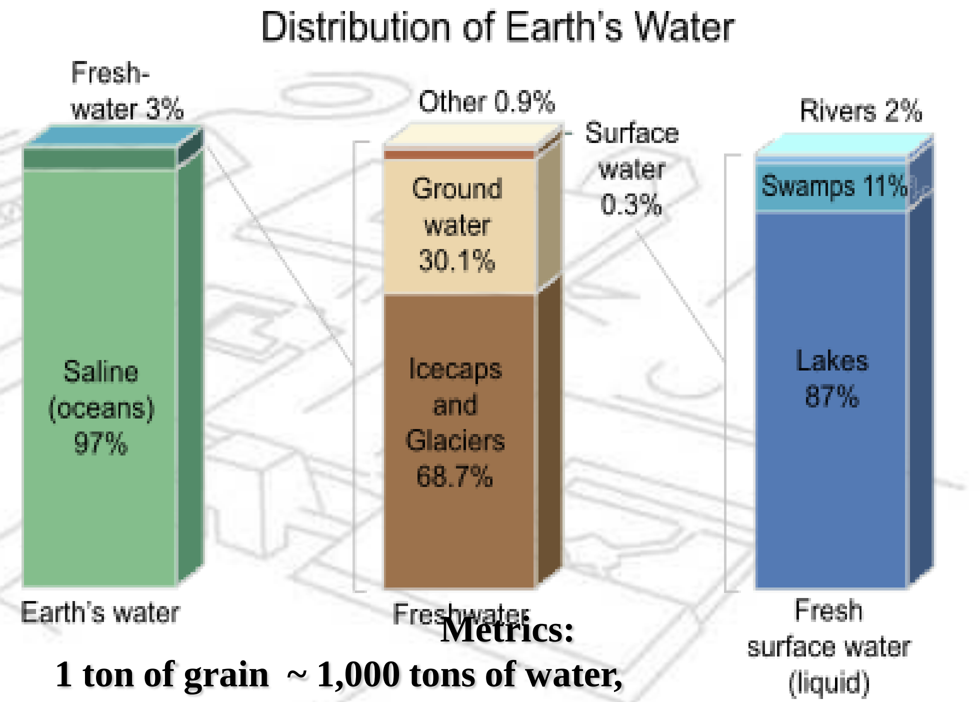
Effects of CO_2 Increase

Year (#)	CO_2 (ppm)	Temp. (ºC)	Sea level (cm)	Traffic Light
1 900	290	0	0	
2 000	380	0.8	10	
2 100	1 200	6.0	100 ?	

Why to be concerned?



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

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.

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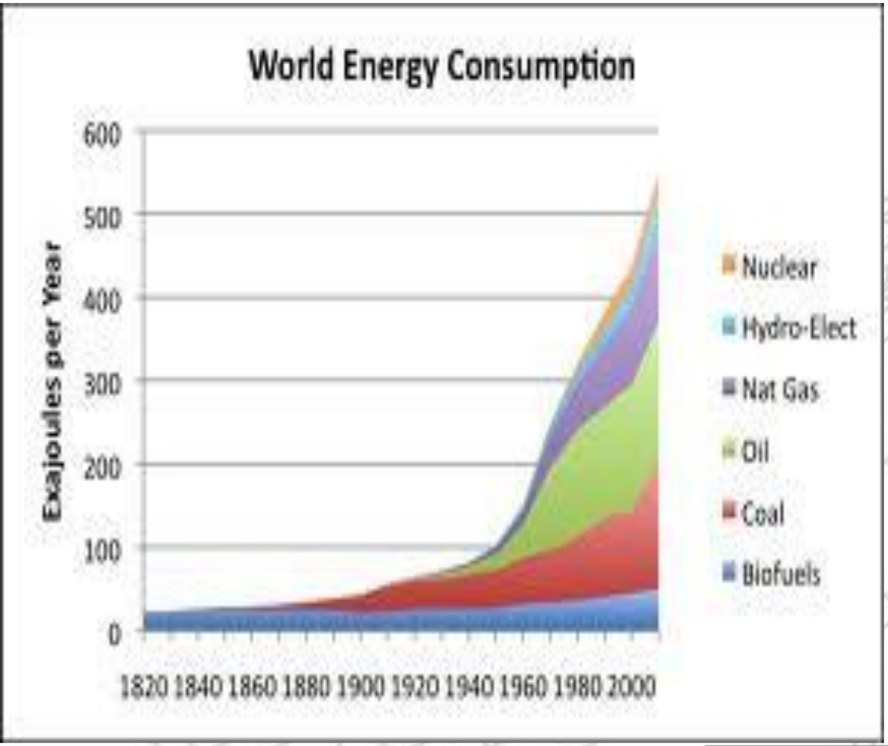

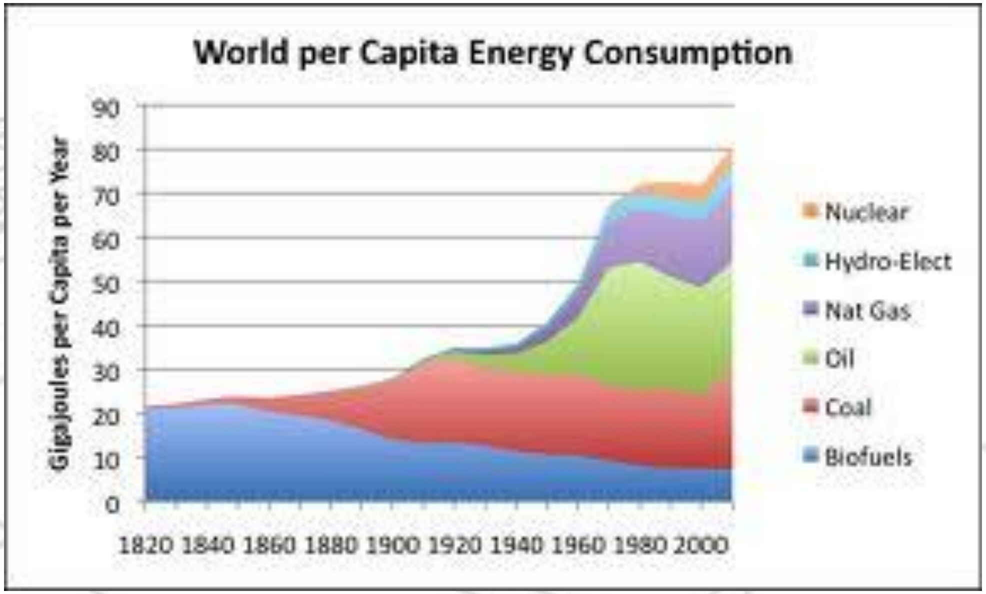

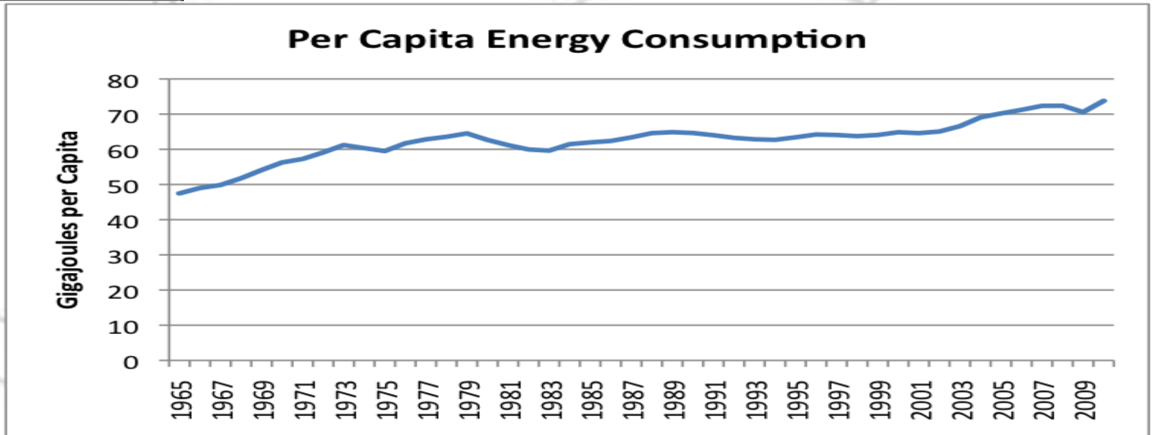

Why to be concerned?

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	1lgasoline 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

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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

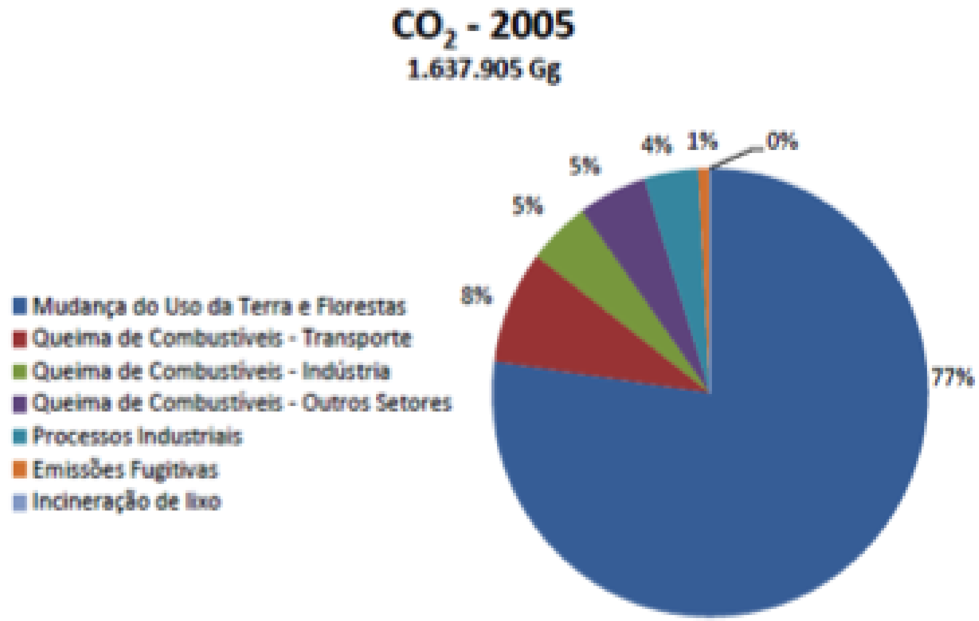
It must be treated in global basis and requires strong international cooperation

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


50% Global Tropical Forest
~ 120Pg above ground biomass
Amazon river discharge represent around 20% of Global fresh water input to ocean
~20% Global biodiversity
Panamá
Trinidad e Tobago
Venezuela
Colômbia
Brasil
Fortaleza
Salvador
Bolívia
São Paulo
Rio de Janeiro



Fonte: MCT, 2010

Building the Brazilian Observation System of Climate Change-GHG Measurements

- **Vertical Profiles**
- **CO_2, CH_4, N_2O, CO and SF_6**

Courtesy Luciana Gatti

Sampling with Aircraft Vertical Profiles in Amazon Basin

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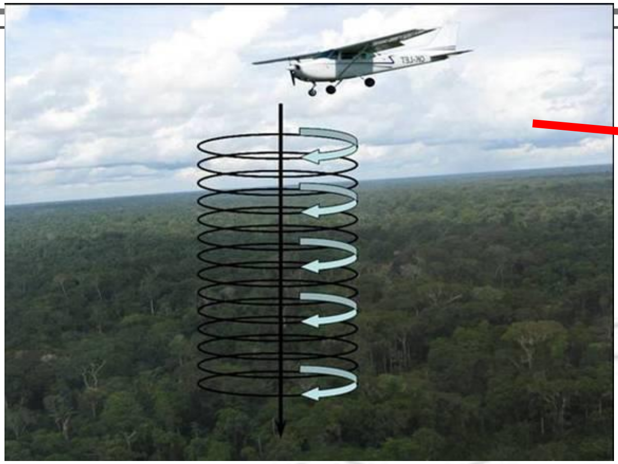

MAGICC System

PFP and PCP

Courtesy Luciana Gatti

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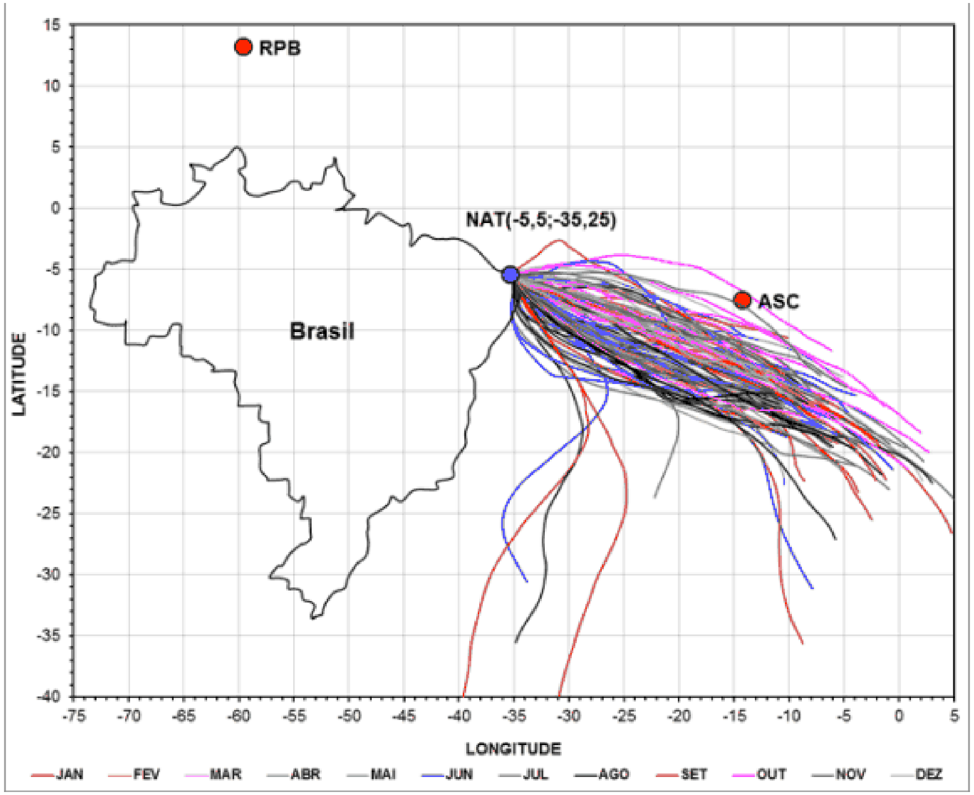
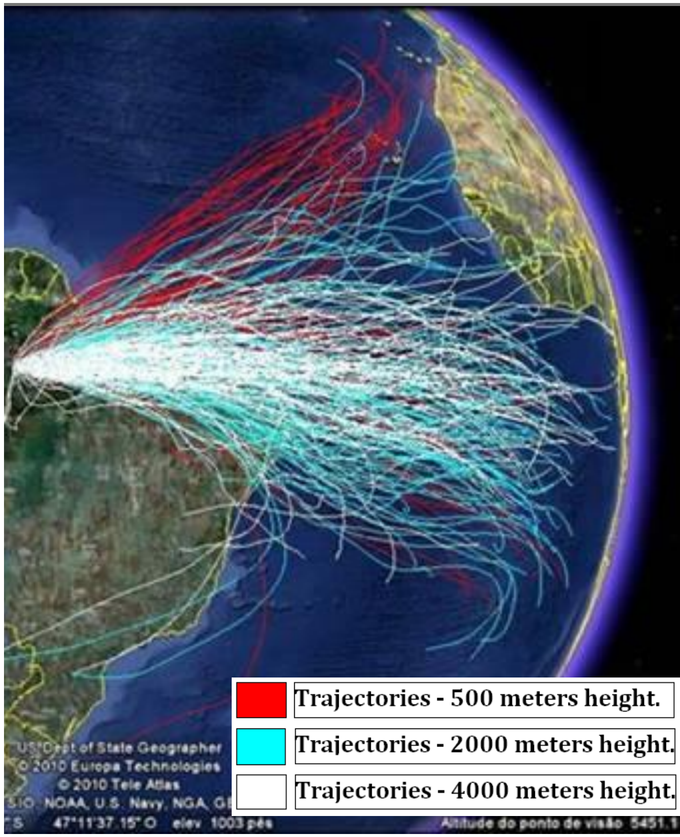
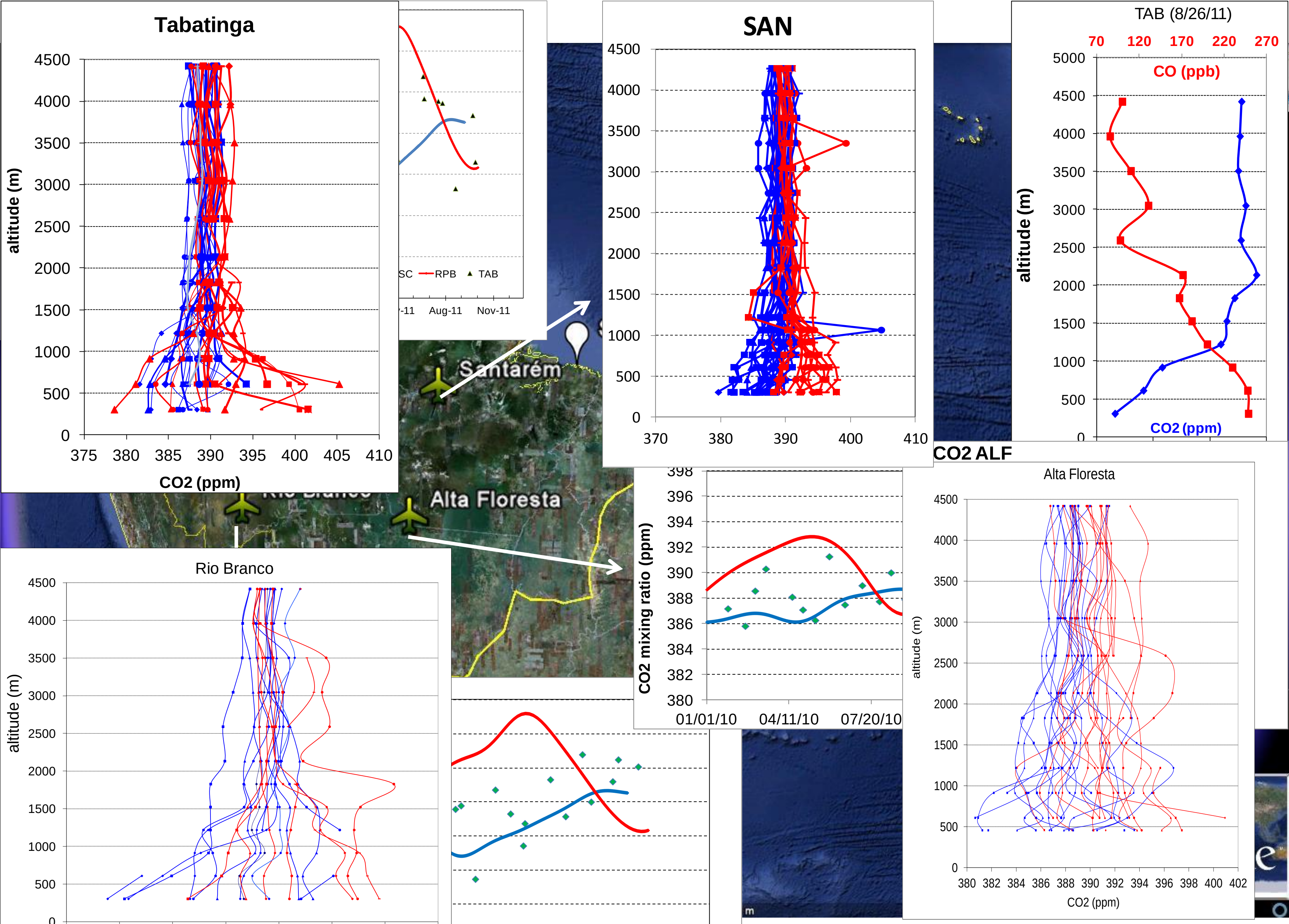




12 mass trajectories/month

Courtesy Luciana Gatti



Courtesy Luciana Gatti

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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

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. 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, NOx, aerosol particules from burning and urban and industrial emissions, ozone and its precursors.

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

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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 measuremnts of IPEN

Coordination of the PBACV- Brazilian Program of LCA

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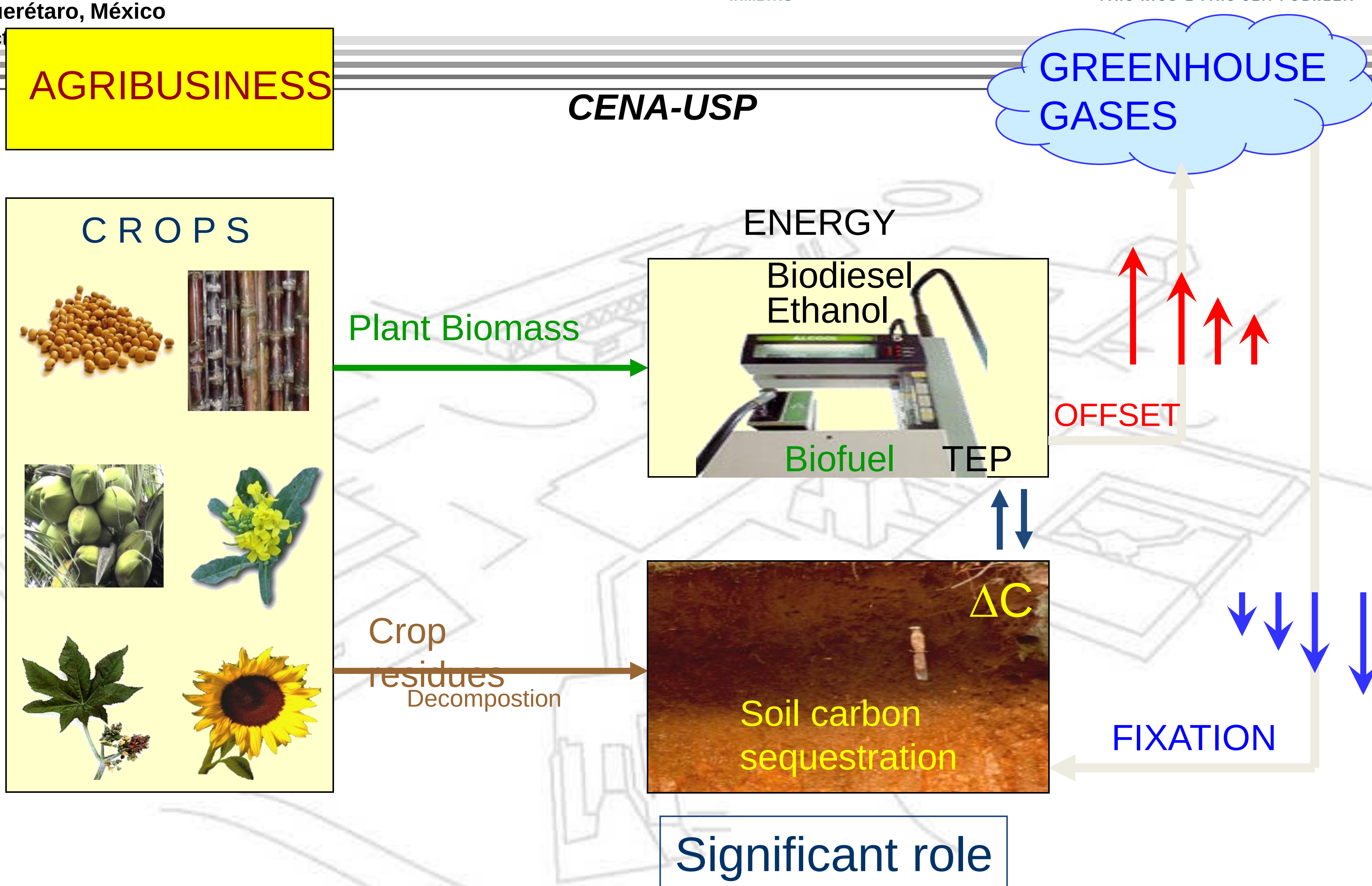

Courtesy C. Cerri - Cena

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Soil Carbon Stocks

Data needed for each soil layer:

- Carbon content
- Soil bulk density (BD)

$$C_{stock\ layer} = \text{C content} \times \text{BD} \times$$

% C

$d = \frac{m}{V}$

VALIDATION

Courtesy C. Cerri - Cena

Sampling greenhouse gas emissions

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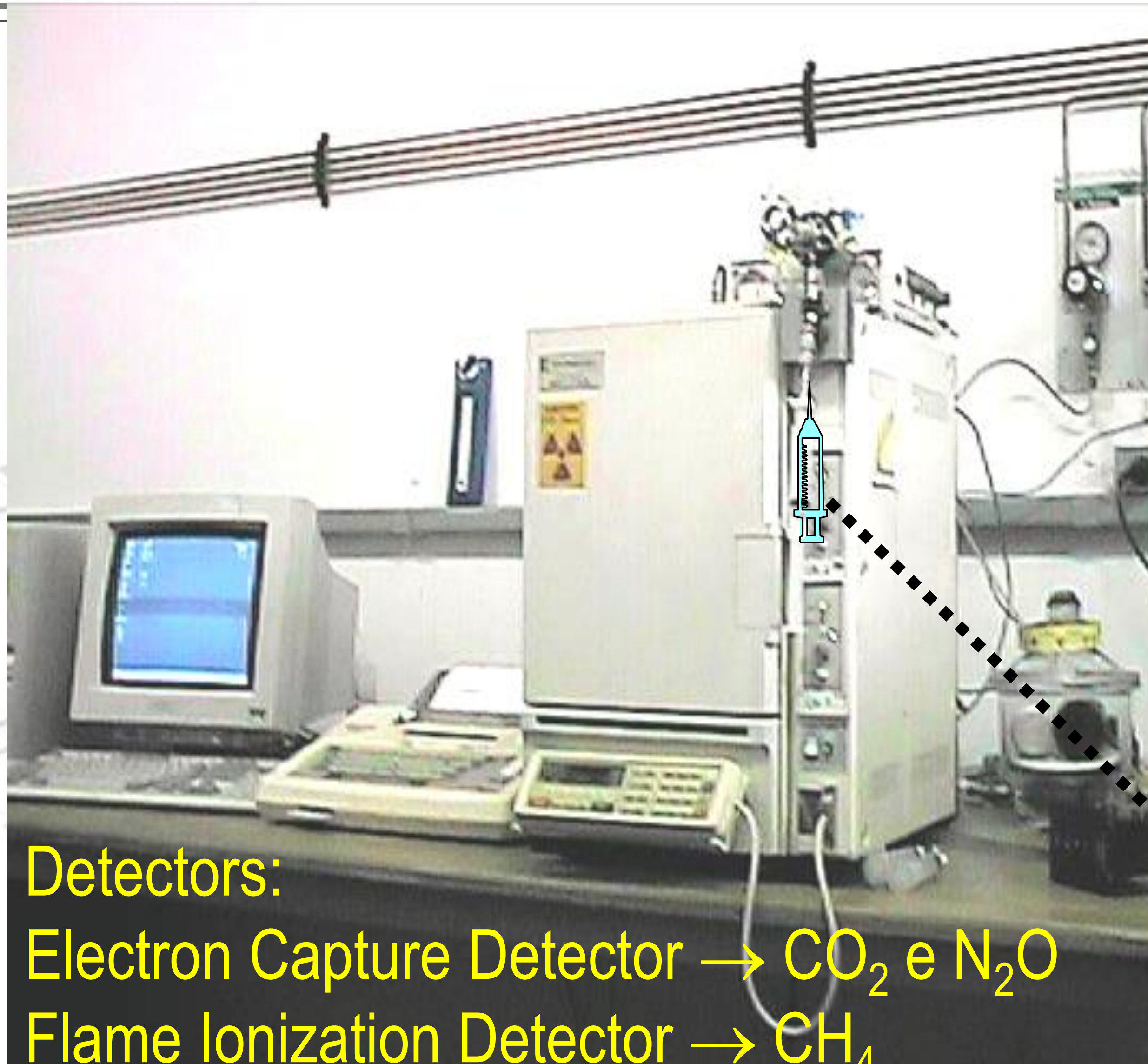
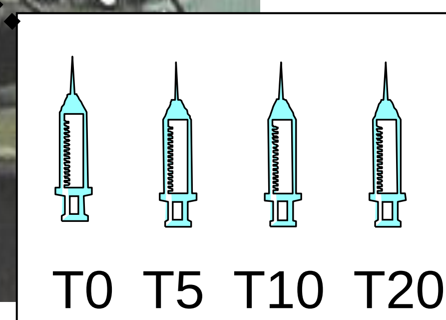
Chromatographic analysis of GHG



Detectors:

Electron Capture Detector → CO_2 e N_2O

Flame Ionization Detector → CH_4

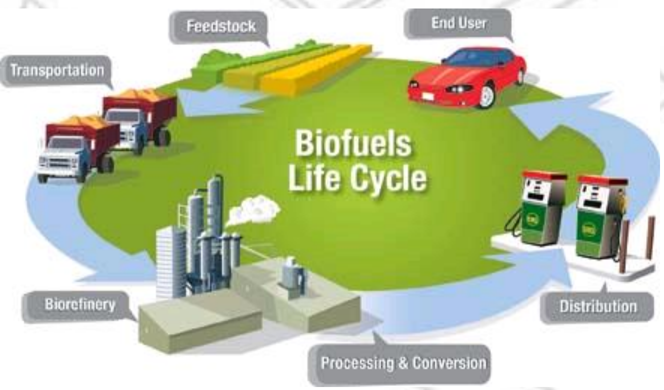


Courtesy C. Cerri - Cena

LCA for Biofuels

The Inmetro LCA Collaboration

traces and evaluates the [environmental and energy impacts] over the "life cycle" of a given "product



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).

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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

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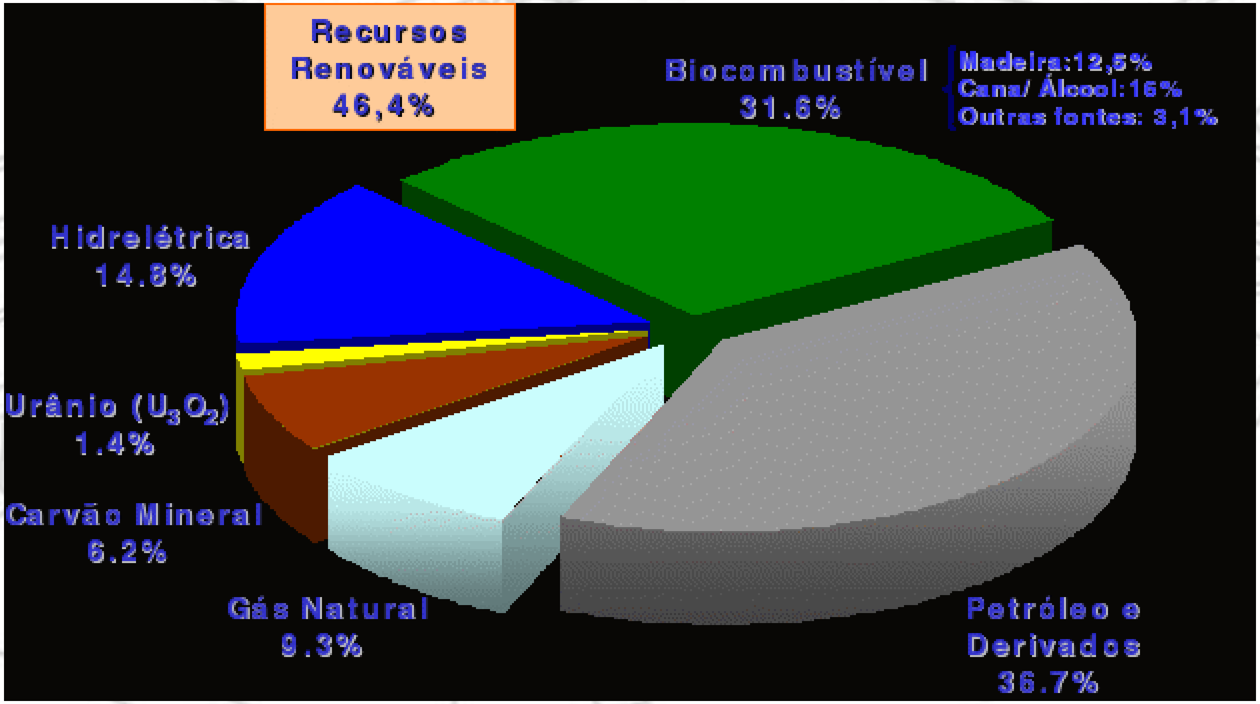
Brazilian Energy Matrix



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)

pbe

Accredited laboratories
Accredited certification bodies

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

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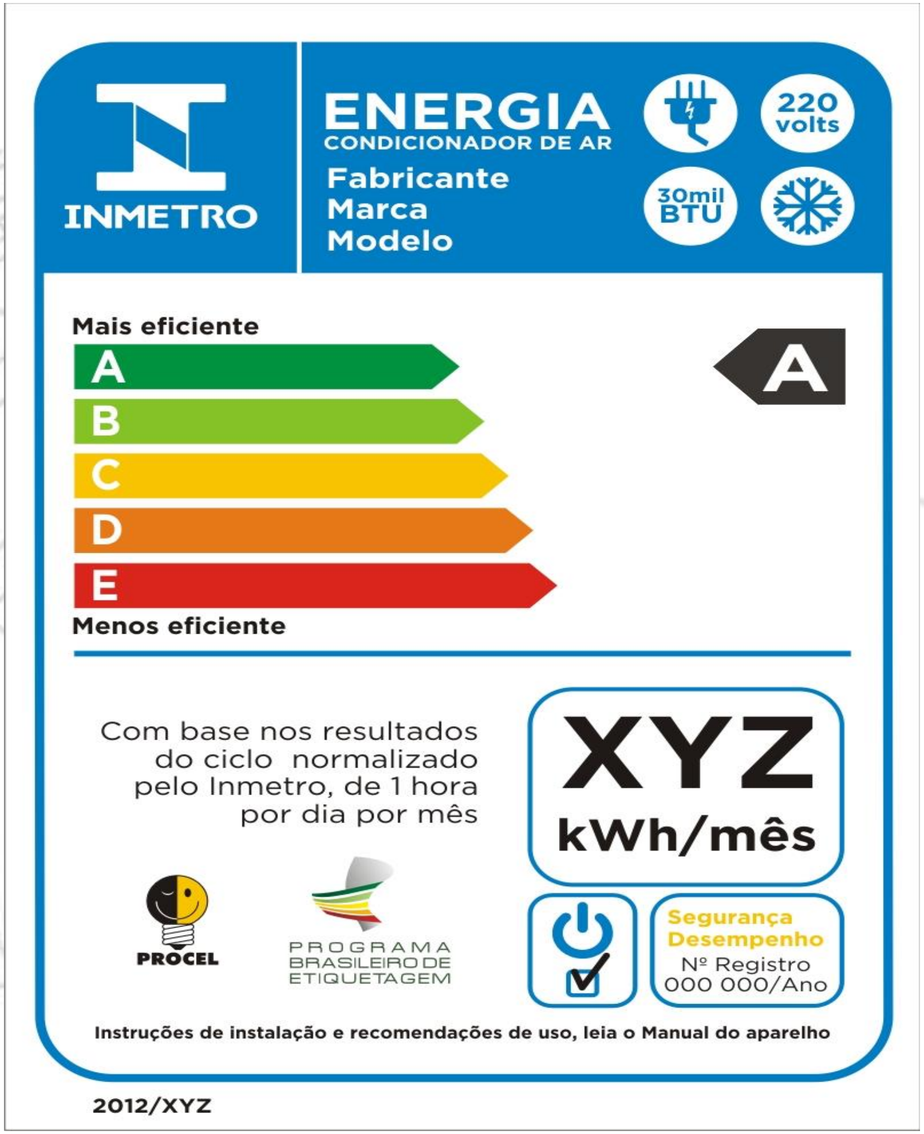
29 schemes

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



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In the last 10 years, the average refrigerator

70%

more efficient.

In the same period, it saved

U$ 2,3 billions

on energy bills.

And more efficient lighting saved

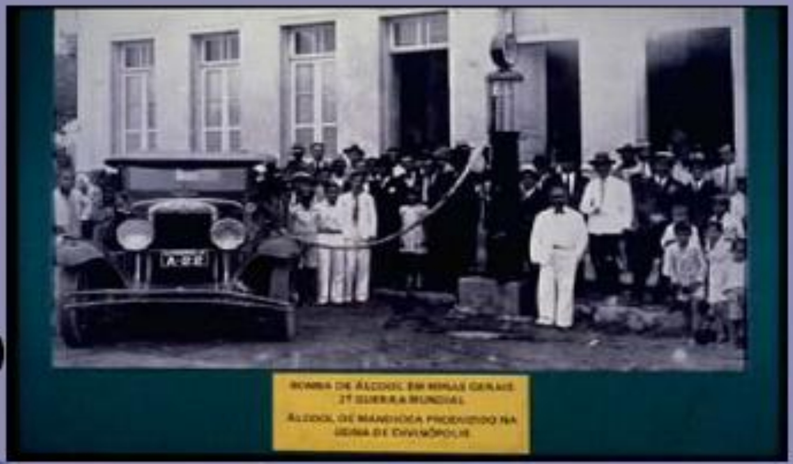
u$ 11,5 billions.

Ethanol – BRAZIL

1928

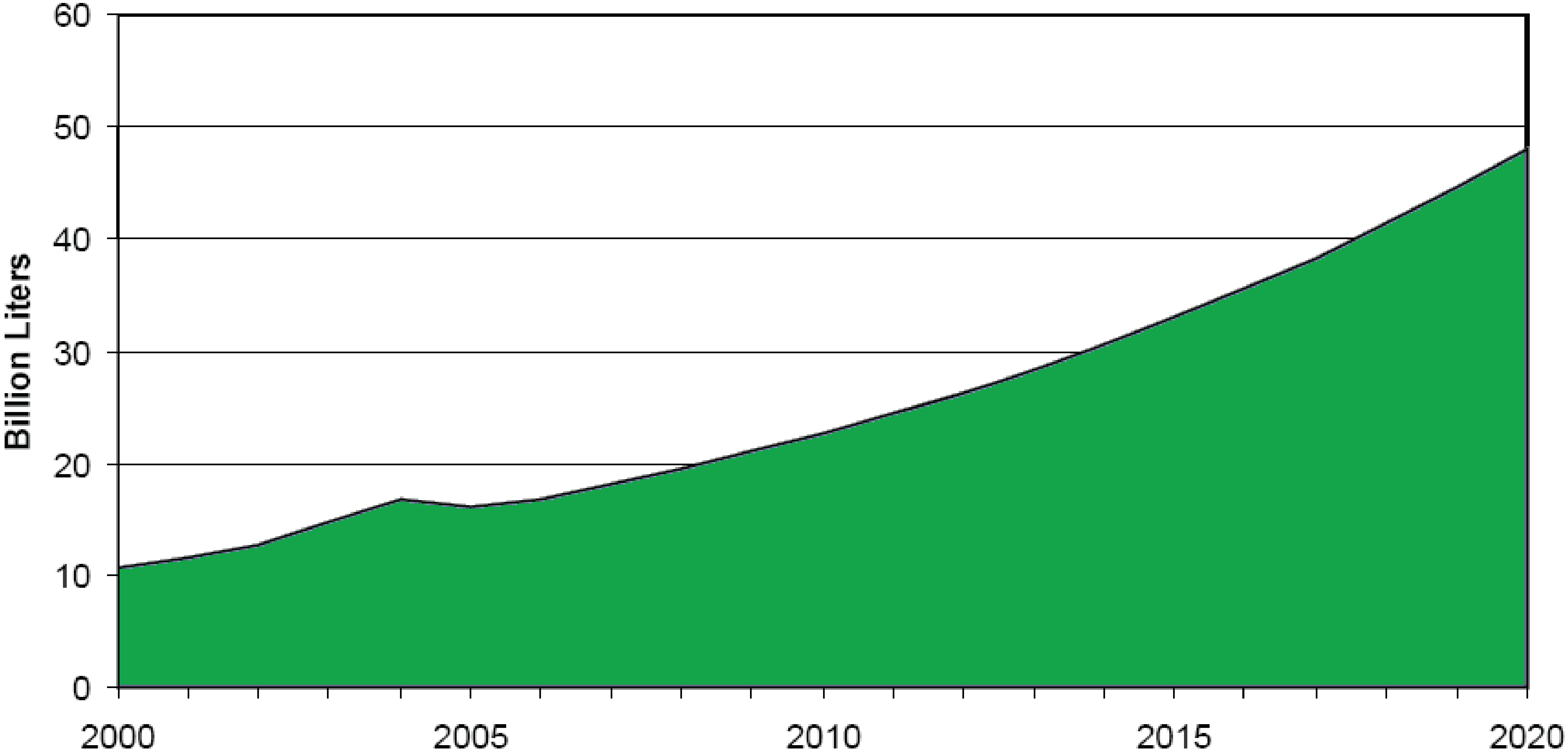
1931

1940



1974

Historic and Planned Brazilian Ethanol Production



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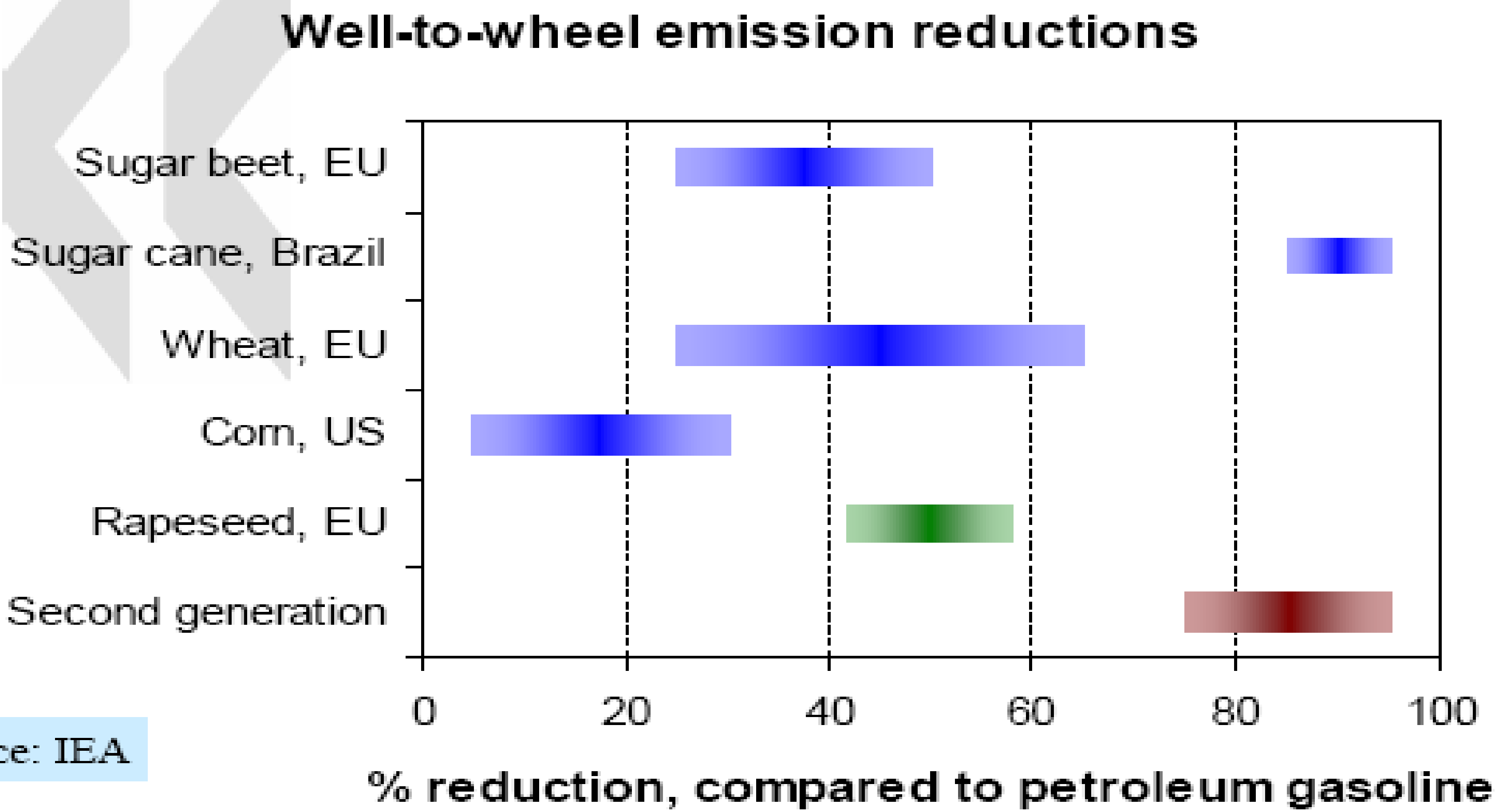
Climate Change mitigation potential



ource: IEA

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Center for Automotive Technology - INMETRO

Laboratories of Metrology Inmetro

Laboratory of emissions and and energy efficiency

Laboratory of active and passive vehicle safety

Laboratory to support the auto parts sector

Research Laboraties, Private Laboratories

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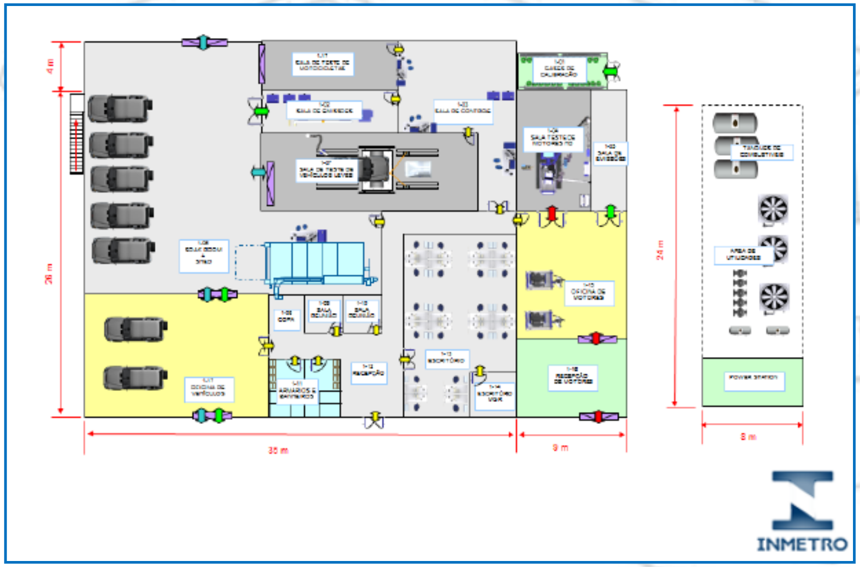
Laboratory of emissions and energy efficiency

Homologation tests according to Euro V and VI, Energy efficiency certification, Research and Development, for light vehicles running with petrol, bioethanol and diesel.



- **Chassis Dynamometer with climatic chamber and emissions equipment**
- **Dynamometer for motocycles**
  Dynamometer for heavy diesel engines
- **SHED Chamber**
- **“Soak Room”**
- **Vehicles workshop**

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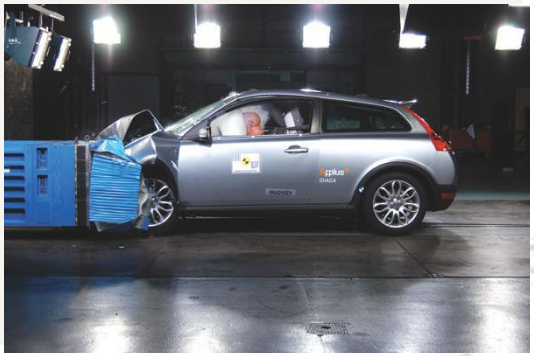


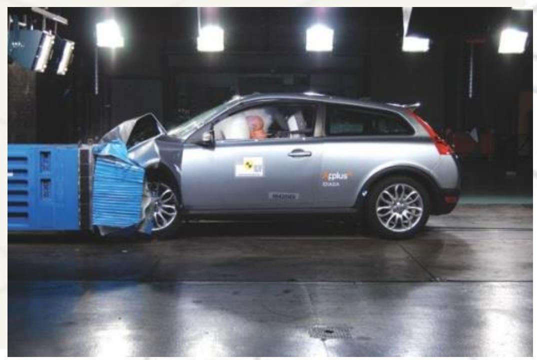

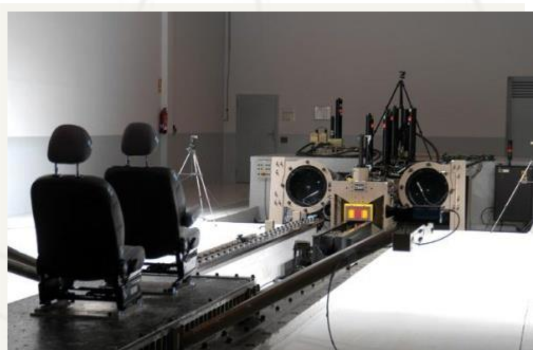

Laboratory of Vehicle Safety

Homologation and Basic Research

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