Ministry of Mines
and Energy

BRAZILIAN HYDROGEN ECONOMY DEVELOPMENT

Joint IPHE ILC/SC Meeting

João José de Nora Souto
Deputy Secretary for Oil, Natural Gas and Renewable Fuels
Ministry of Mines and Energy

December 2009
Washington, DC

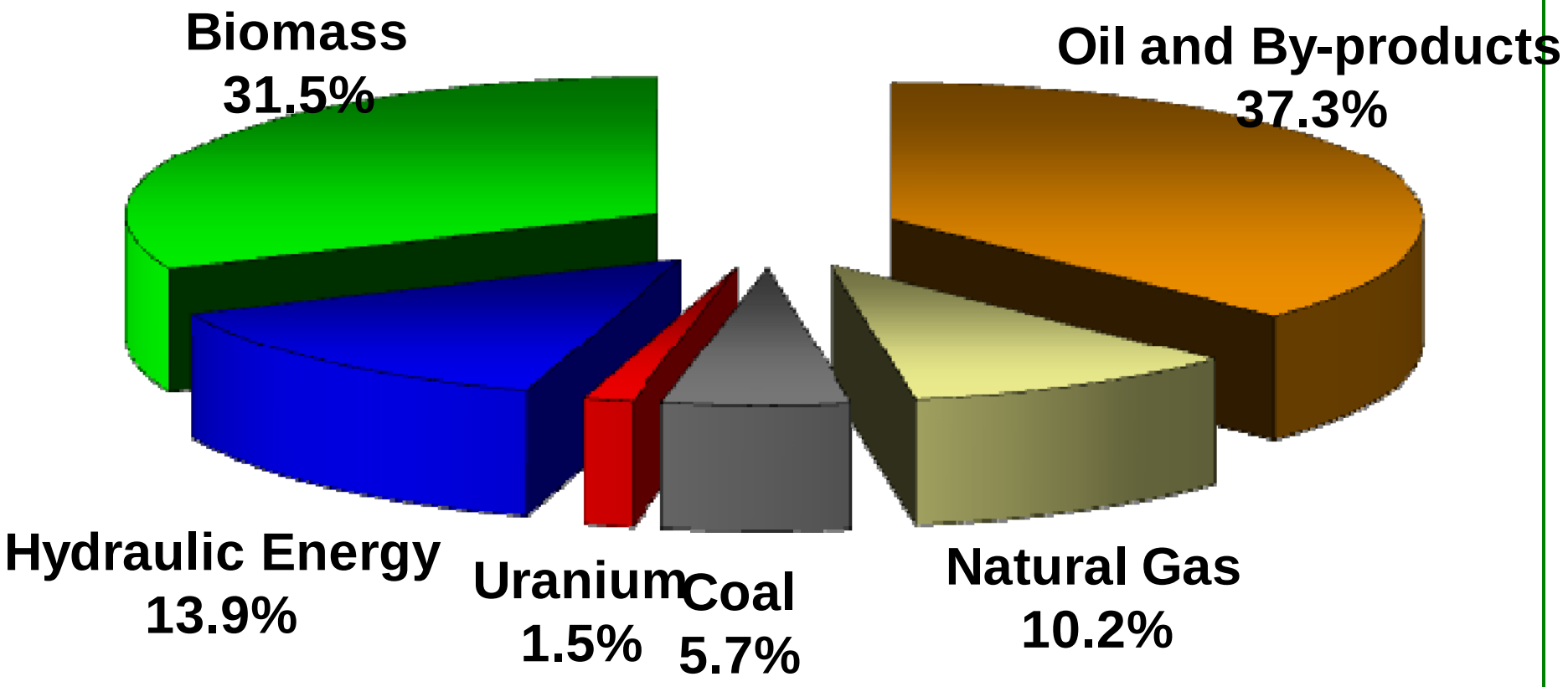
Ministry of Mines
and Energy

PRESENTATION OUTLINE

- Brazilian Energy Mix Update
- Brazilian Experience in Renewable Fuels
- R&D Program for Hydrogen and Fuel Cells
- Renewable Hydrogen Production
- Stationary Applications
- Demonstration Projects: Transportation

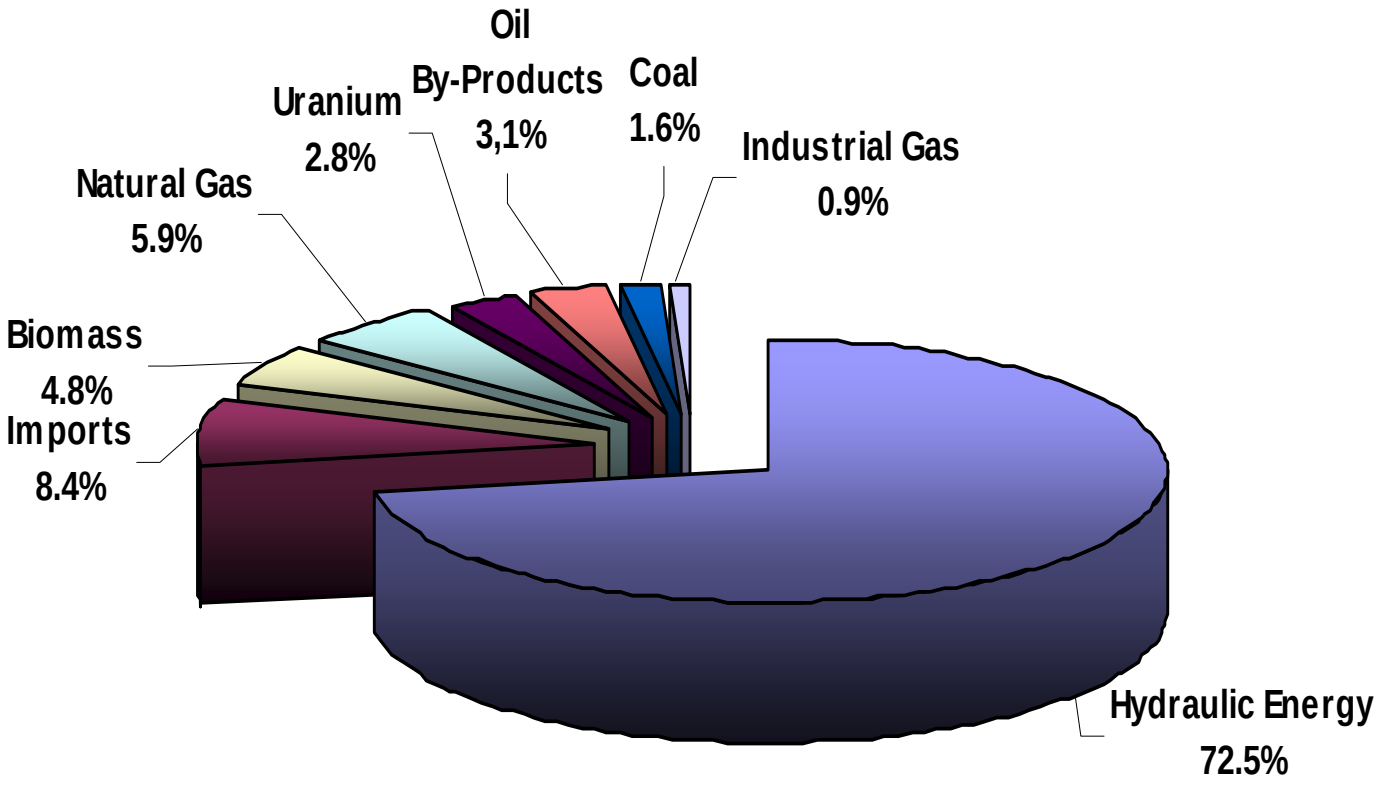
BRAZILIAN ENERGY MIX

BRAZILIAN ENERGY MIX



Source: Ministry of Mines and Energy (MME) – (Year 2008)

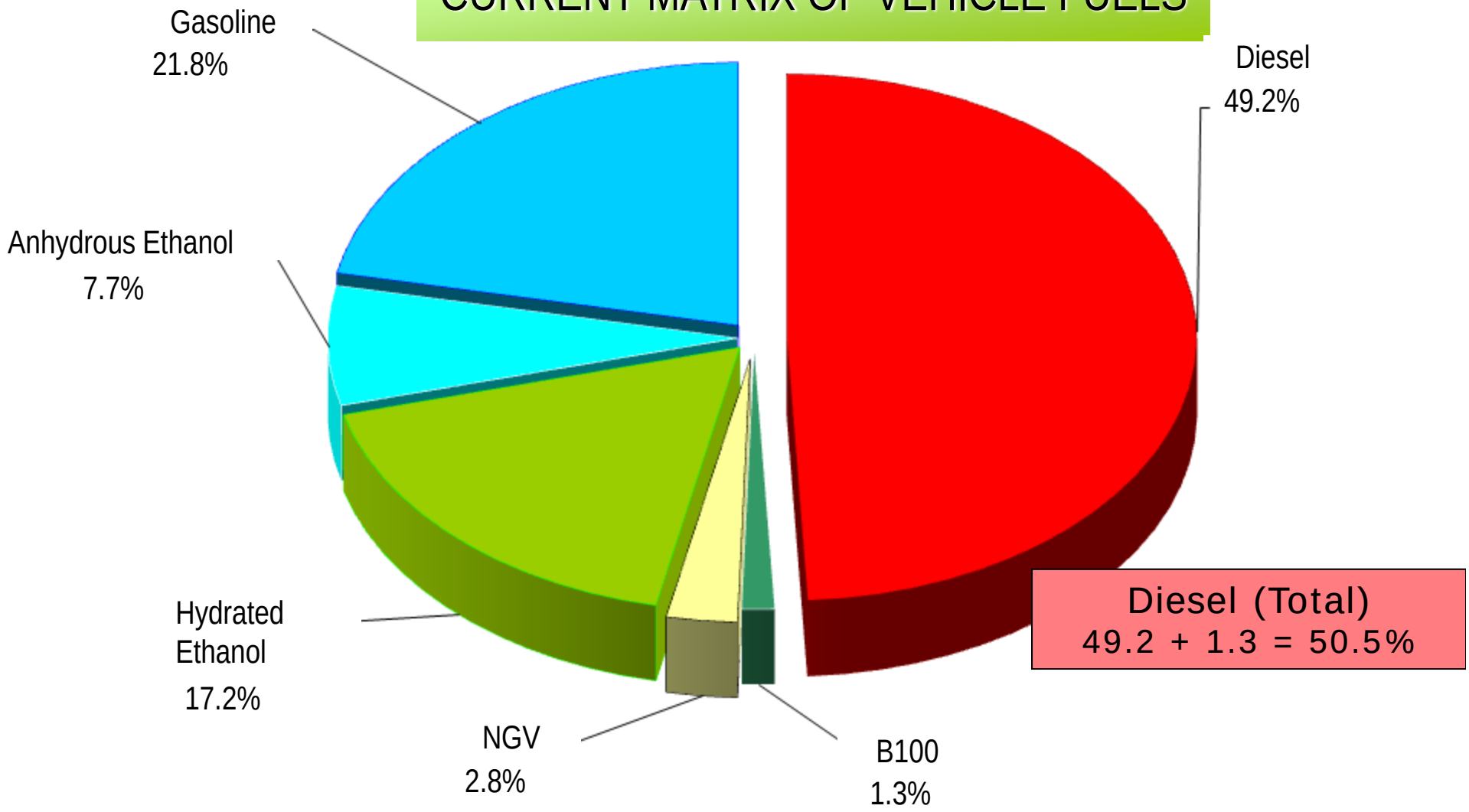
MATRIX OF ELECTRIC ENERGY



Source: MME, 2009 (Year 2008)
Note: Includes self-production

Ministry of Mines and Energy

CURRENT MATRIX OF VEHICLE FUELS



Diesel (Total)
49.2 + 1.3 = 50.5%

Gasoline C:
Gasoline + Anhydrous Ethanol
21.8 + 7.7 = 29.5%

Source : MME, 2009 (Year: 2008)

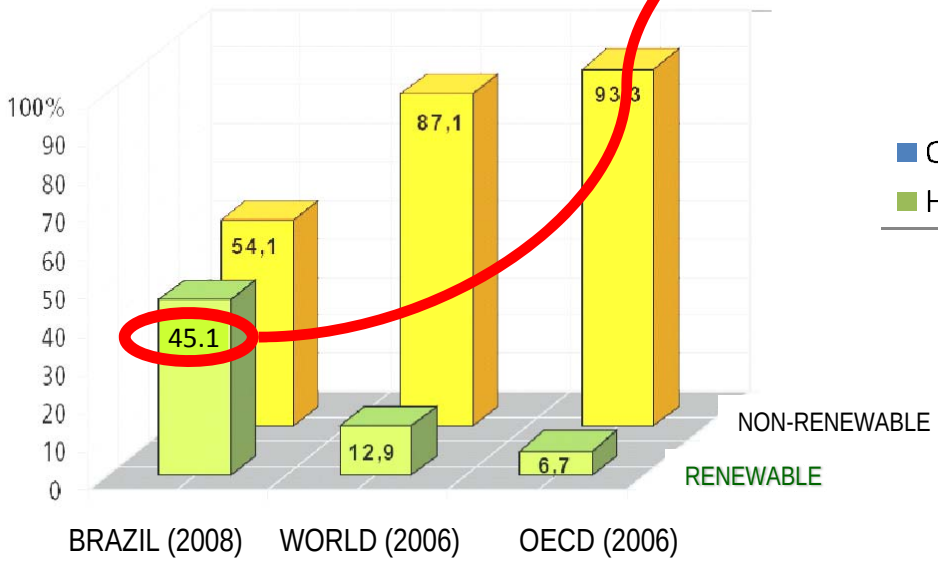
Ethanol (Total)
7.7 + 17.2 = 24.9%

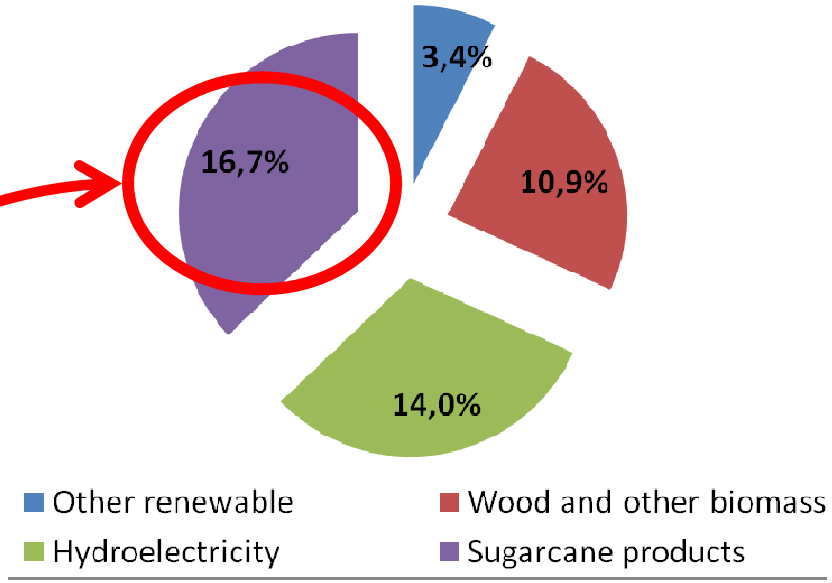
Ministry of Mines
and Energy

BRAZILIAN EXPERIENCE IN RENEWABLE FUELS

Renewable Energy in Brazil

- Brazilian Energy Policy privileges diversification of sources;
- Since April/2008 ethanol is responsible for the largest share of light vehicle fuels;
- Gasoline is the alternative fuel.





Source: MME - Resenha Energética Brasileira (May/2009)

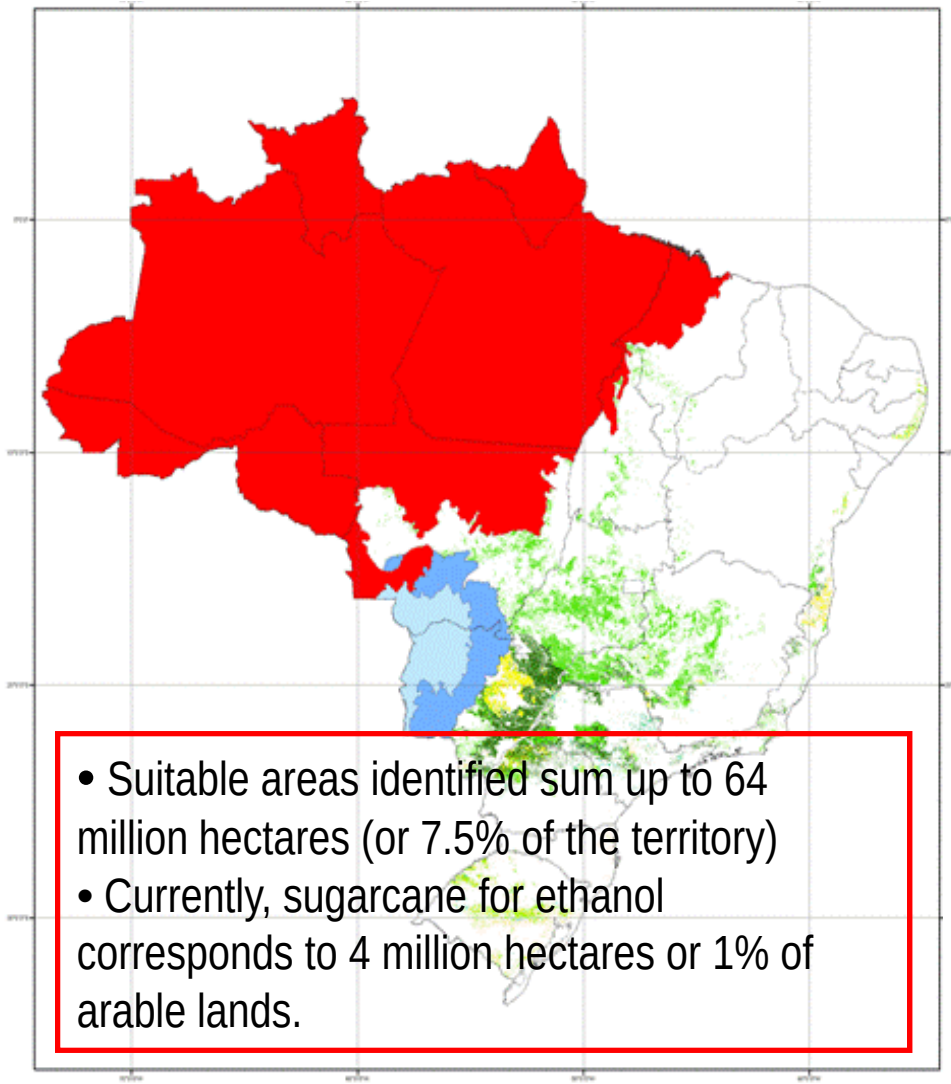
The Contribution of Biofuels in Brazil

- The ethanol usage in Brazil since the 70's was responsible for avoiding the emission of **851 million tons of CO_{2eq}**;
- It is recognized that sugarcane ethanol usage reduces 90% of GHG emissions in comparison with regular gasoline. It's energy balance is 9.3;
- The National Agro-Ecological Zoning for Sugarcane (ZAE Cana), is the largest crop survey in Brazil's history and the first ever to incorporate economic and social considerations into its proposed model for the sustainable development of the industry;
  - Our goal is to turn the areas of three Brazilian Biomas (**Amazon, Pantanal and Alto Paraguai**) off-limits for sugarcane farming and processing. Areas with **native coverage** are also off-limits in ZAE;
  - We also pursue the zero sugarcane burning target for next decade;
- **National Commitment of Brasília:** The Protocol is the result of a national dialogue between the sugarcane industry, unions and Federal government, designed to improve working practices beyond what is mandatory by the Brazilian legislation;

Ministry of Mines and Energy

Sugarcane Expansion Agro-Zoning

BRAZIL – Qualified Areas (P, R, M) in Livestock (Ap) and Agriculture (Ag)



Due to environmental reasons, the bill would effectively make 92.5% of Brazil's national territory off-limits for sugarcane farming and processing.

Legenda

- Limite Estadual
- Bioma Amazônia
- Bioma Pantanal
- Bacia do Alto Paraguai
- Áreas com aptidão agrícola preferencial em pastagens
- Áreas com aptidão agrícola preferencial em agropecuária
- Áreas com aptidão agrícola regula em pastagens
- Áreas com aptidão agrícola regular em agropecuária
- Áreas com aptidão agrícola marginal em pastagens
- Áreas com aptidão agrícola marginal em agropecuária

Excluded biomes

- Suitable areas identified sum up to 64 million hectares (or 7.5% of the territory)
- Currently, sugarcane for ethanol corresponds to 4 million hectares or 1% of arable lands.

P – Areas qualified as "Preferential"
R – Areas qualified as "Regular"
M – Areas qualified as "Marginal"

Ag means agriculture, i.e., areas covered with cultures or cultivated pasture, cases in which it was not possible to discriminate in LandSat images; Ap means cultivated pasture areas; Ac means agriculture areas.

0 250 500 1.000 1.500 2.000 Km
1:13.500.000
GCS - South American 1969

The Contribution of 2nd Generation Biofuels

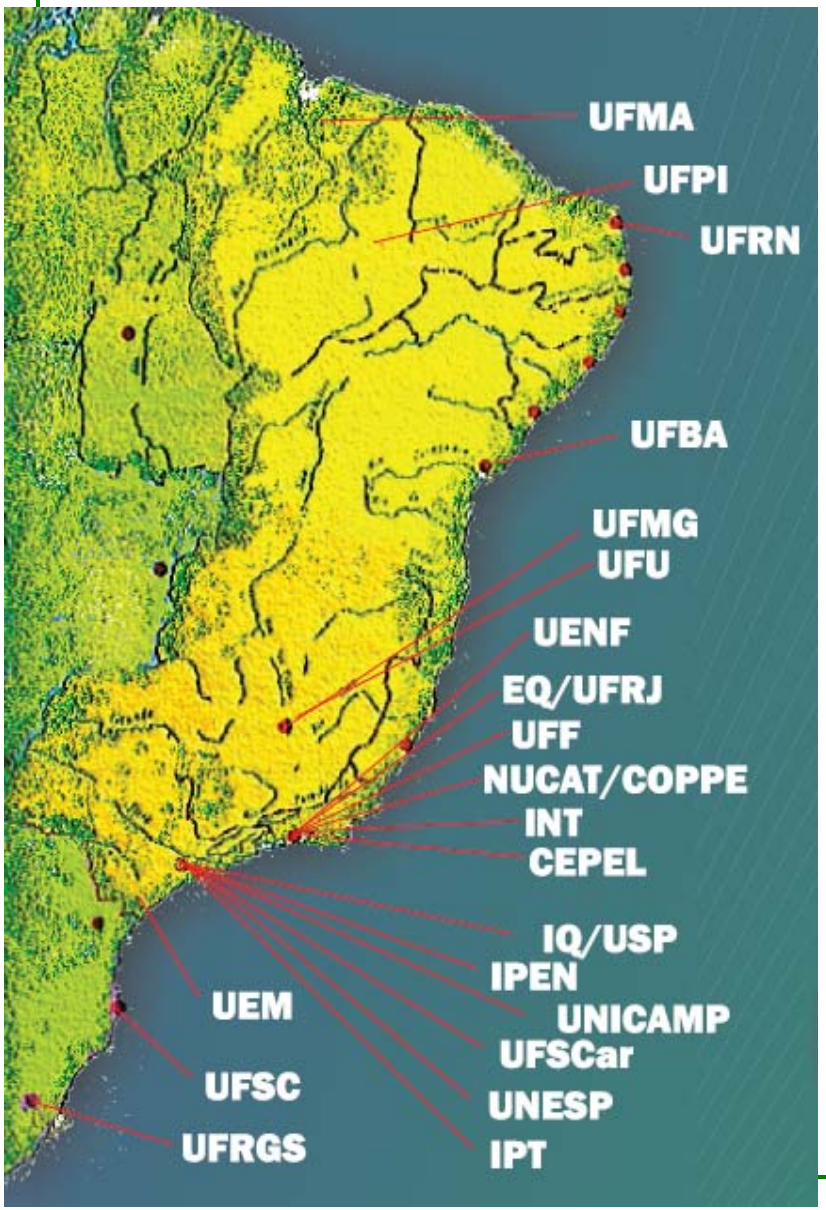
- According to IEA biofuels will provide 23% of total road transport fuel in 2050 with 2nd generation biofuels accounting for roughly 90% of all biofuel produced;
- Sugarcane bagasse is a privileged raw material: it is ready for processing and it is available at the industrial facility;
- Other initiatives include improvements on sugarcane varieties pursuing better biomass and sugar ratio per unit of mass;
- Lot of expertise at the industry and agriculture private research centers;
- Petrobras will launch its first demonstration plant in 2011;
- Cooperation is necessary and likely to happen.

Ministry of Mines
and Energy

R&D PROGRAM FOR HYDROGEN AND FUEL CELLS

Ministry of Mines
and Energy

PROH2 R&D
PROGRAM FOR THE HYDROGEN AND FUEL CELLS



- The program is based on network projects in five areas:
  - i. Hydrogen production
  - ii. PEM fuel cells
  - iii. SOFC fuel cells
  - iv. Systems, integration and engineering
  - v. Utilization, Applications and use
- Over 40 Research groups from Universities and Research centers

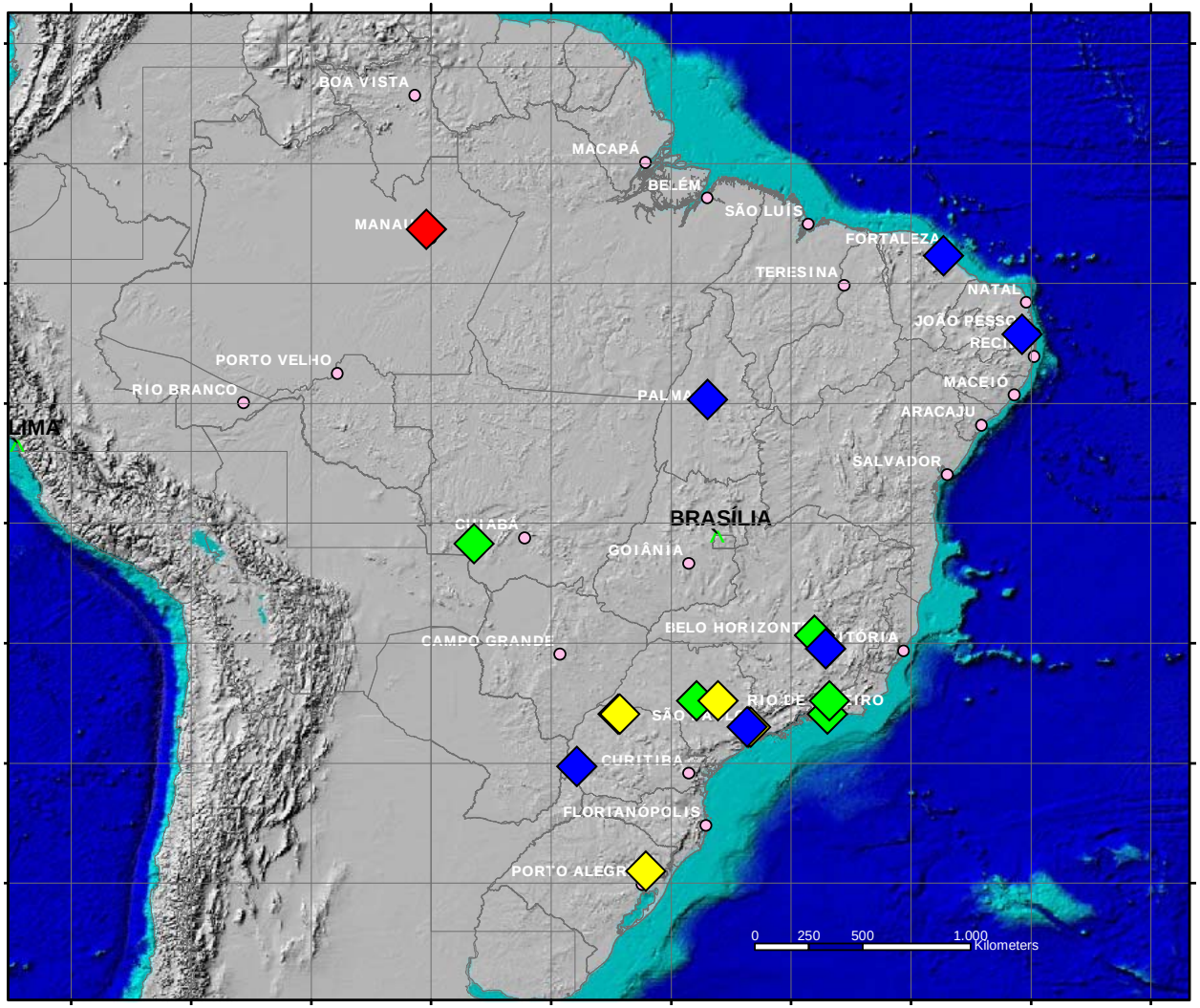
PUBLIC INVESTMENT

AREA	INVESTIMENT USD (MM)
Production, Purification and Storage	6.7
Fuel Cell	15.6
Systems, Integration and Engineering	6.4
TOTAL	28.7

Renewable Hydrogen Production

Ministry of Mines
and Energy

RENEWABLE HYDROGEN PRODUCTION



Projects

- Solar PV
- Ethanol reforming
- Biomass gasification
- Water electrolysis (hydro, solar and wind)

RESEARCH AND DEVELOPMENT

Network of Hydrogen Production for Fuel Cells

Objectives: Integrated development and evaluation of several technologies for hydrogen production from different feedstock (ethanol and biomass) and natural gas;

Status: First fase will be concluded in 2010.

Fund.: U$ 2.700.000,00 from FINEP (Research and Project Financing Agency) of Ministry of Science and Technology

Partnership: Research groups from Universities and Research Centers

PROH2 R&D
RESEARCH AND DEVELOPMENT

Ethanol reformer cooperative project

Objectives: Development of a 5 kW PEM fuel cell system integrated with an ethanol reformer for hydrogen production, with the use of Brazilian technology in critical components.

Status: The following activities are under way: development of catalysts for auto thermal reforming, shift and preferential oxidation of CO reaction; determination of kinetics parameters; reactor design, construction, operation, and evaluation of a fuel processor for hydrogen production in a 5 kW PEM fuel cell made with Brazilian Membrane Electrode Assembly (MEAs).

Fund.: PROH2 R&D of Ministry of Science and Technology

Partners
INT - National Technology Institute
IPEN - Institute of Nuclear & Energy Research
CEPEL - Electrical Energy Research Center
COPPE - Federal University of Rio de Janeiro

RESEARCH AND DEVELOPMENT

Ethanol Reforming for Hydrogen Production

Objectives: Development of a fuel processor to H2 production from ethanol for a PEMFC.

Status:

- Catalysts for the reform and shift reaction already selected.
- Membrane reactor for the hydrogen purification is under development.
- The ongoing research involves scale up and reactor project.

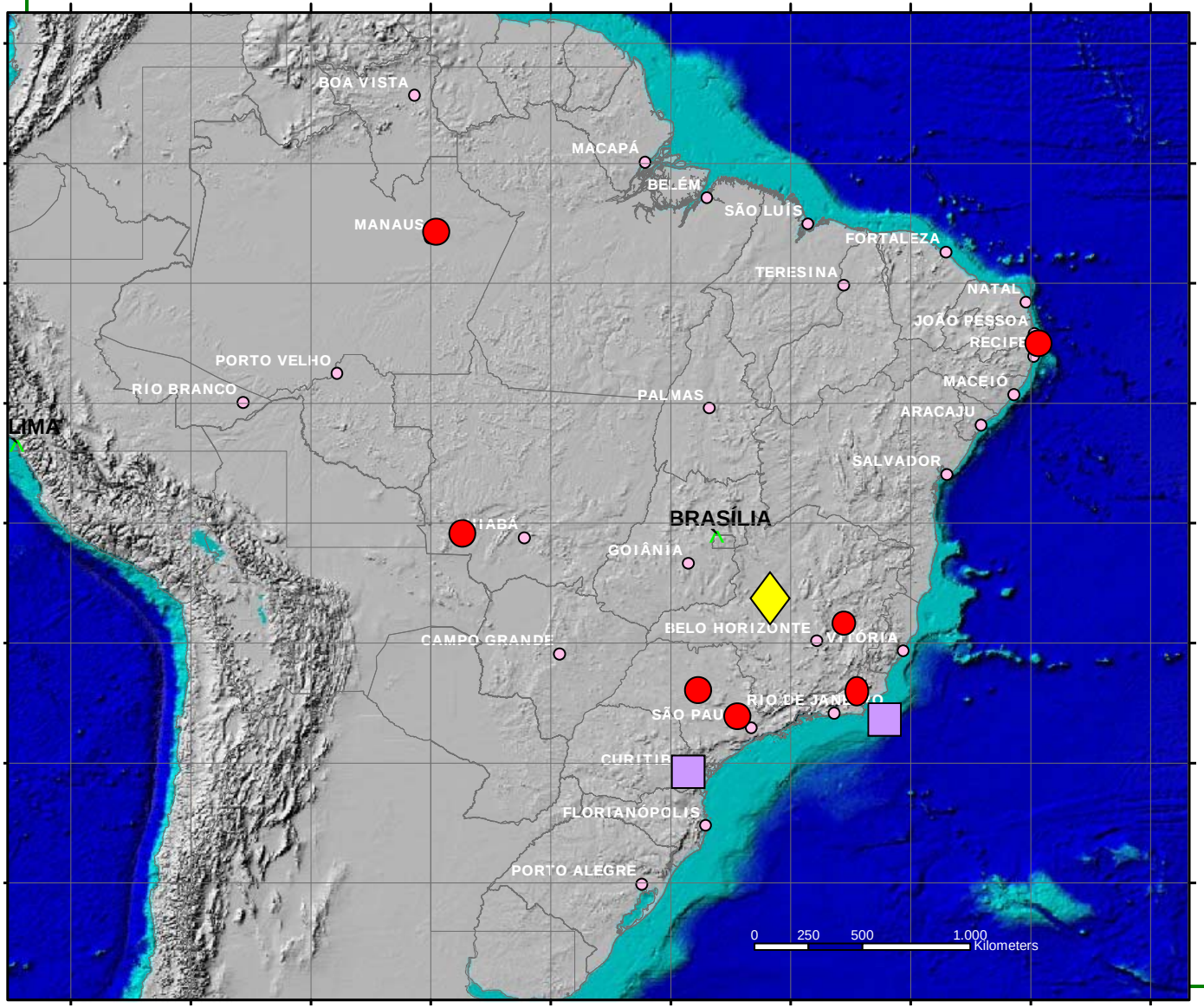
Fund: U$ 3.200.000 from FINEP of Ministry of Science and Technology

Partnership:
INT - National Technology Institute
IPEN - Institute of Nuclear & Energy Research
CEPEL - Electrical Energy Research Center

Stationary Applications

Ministry of Mines
and Energy

STATIONARY APPLICATIONS



DEMONSTRATION PROJECTS: TRANSPORTATION

Ministry of Mines
and Energy

Brazilian Fuel Cell Bus

Hybrid dual system (2 x 85Kw Fuel Cell)
Hydrogen from electrolyze fuel station - São Paulo State

Phase I Concluded: Prototype finishing the final road test.

Phase II Started: 3 more buses will be constructed based on the prototype by end of 2011

Hybrid Bus with Battery and Fuel Cell

12m Low Floor Bus Urban

(hydrogen from electrolyze fuel station) – **Rio de Janeiro State**

Initial test will start by july/2010

Sponsors: Ministério da Ciência e Tecnologia, BRASIL UM PAÍS DE TODOS, FINEP, BR PETROBRAS

Partnership: WEG, BUSSCAR

Ministry of Mines
and Energy

BRAZILIAN HYDROGEN ECONOMY DEVELOPMENT

Joint IPHE ILC/SC Meeting

Thanks for your attention!

João José de Nora Souto
Deputy Secretary for Oil, Natural Gas and Renewable Fuels
Ministry of Mines and Energy

December 2009
Washington, DC