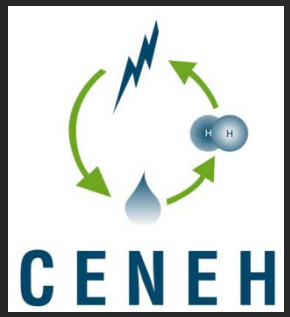





# *The Hydrogen Laboratory & The Brazilian Reference Center for Hydrogen Energy*




December 09th, 2009

Dr. Newton Pimenta
Cristiano Pinto
LH2 & CENEH

# The State University of Campinas UNICAMP

- ✓Founded in 1966
- ✓5 campuses (4 cities)
- ✓72 units
- ✓24 libraries
- ✓4 hospitals
- ✓1,750 professors
- ✓16,500 undergraduate students
- ✓11,450 graduate students (5,250 PhD students)

# The State University of Campinas UNICAMP

- UNICAMP is the site for 3 energy centers:
  - The Hydrogen Laboratory (LH2) at the Physics Institute
  - The Interdisciplinary Center for Energy Resources Planning (NIPE)
  - The Brazilian Reference Center for Hydrogen Energy (CENEH)

# The Brazilian Reference Center for Hydrogen Energy

- ✓ Ministry of Science & Tech.
- ✓ State University of Campinas
- ✓ University of Sao Paulo
- ✓ SP Environment Secretary
- ✓ CEMIG - Power Co.
- ✓ Vitae Civilis - N G O

CENEH

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CT BRASIL

UNICAMP

USP

SMA/SP

CEMIG

Vitae Civilis

# The Brazilian Reference Center for Hydrogen Energy

- ✓ Promote energy uses of hydrogen → Fuel Cells
- ✓ Collect and disseminate information about hydrogen technologies
- ✓ Conduct research, developments and studies
- ✓ Promote events and congresses
- ✓ Assist the government with energy policies

CENEH

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# The Brazilian Reference Center for Hydrogen Energy

- ✓ Cooperation with the LH2 at UNICAMP for R&D projects on $H_2$ production and applications
- ✓ The first course about best practices on hydrogen safety
- ✓ WICaC (International $H_2$ & FC Seminar) – one of the most important events about FC and hydrogen in Latin America (2002, 2004, 2006, 2008)
- ✓ Oct / 2010: WICaC 2010

CENEH

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# The Hydrogen Laboratory at UNICAMP

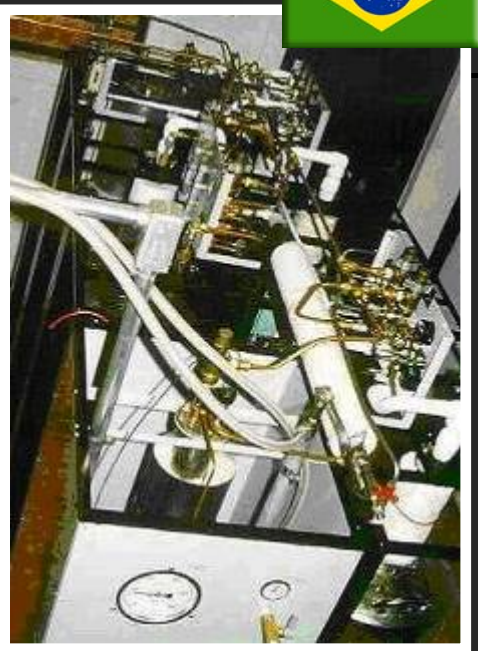
- LH2 has been working on $H_2$ technology since 1975.
- Some research topics:
  - Hydrogen Economy;
  - Hydrogen from renewables;
  - Automotive hydrogen technologies;
  - Alkaline water electrolysis for $H_2$ generation;
  - Ethanol and NG reforming;
  - Trace gas analysis and gas standards.

CENEH

IFGW
Instituto de Física Gleb Wataghin

# The Hydrogen Laboratory at UNICAMP

- Alkaline water electrolysis plant for $H_2$ production;
- Operation: 1982 to 2000;
- 2 electrolysers: 3 $m^3/h$
- Up to 1,000 $m^3$ per month, high purity hydrogen (5.5);
- $H_2$ used in semiconductor manufacture research.



# The Hydrogen Laboratory at UNICAMP

- Although the small scale, the operation is quite similar to larger plants.
- This work gave a good experience in purification and handling compressed and high purity $H_2$ and other gases.
- Development of trace gas analysis and standards in Brazil.

# National actions

- ✓ 2001: A study was conducted to identify the Brazilian R&D capabilities in $H_2$ and fuel cells
- ✓ 2002: The study led the MCT to release the Brazilian Program on Fuel Cells (ProH2)
- ✓ The program coordinates efforts and public investments in FC and $H_2$ technologies through a network of universities and R&D centers
- ✓ 4 networks are operational

# National actions

- Networks:
  - PEMFC
  - SOFC
  - Fuels and Hydrogen
  - Systems

- Today there are at least 50 groups that can contribute to $H_2$ technology research in areas such as: electrochemistry, ceramic, materials, polymers, catalysis, engineering, system integration, etc.
- More than 12 demonstration projects supported by private companies and government agencies
- 3 fuel cell companies; 1 fuel processor company

# National actions

- ✓ Adherence of Brazil to the International Partnership for the Hydrogen Economy (IPHE)
- ✓ Ministry of Mines & Energy is about to complete the revision of the Brazilian roadmap for the $H_2$ economy.
- ✓ $H_2$ Roadmap indicates strategic policies, principles and objectives to foster and implement the Hydrogen Economy in Brazil.

# National actions

- The roadmap also emphasizes some points that are of special interest for Brazil: $H_2$ from water electrolysis (PV, Wind, Hydro); $H_2$ from ethanol and biomass.

- Ethanol advantages:
  - renewable fuel ($CO_2$ balance approaches zero);
  - low toxicity; less dangerous by-products after use;
  - Brazil is a world leader in ethanol production;
  - consumer price is very competitive compared to gasoline;
  - distribution infrastructure is ready.

# CENEH Interests

- ✓ Implement demonstration projects to improve technical training and public awareness;
- ✓ Provide training and educational opportunities for technical and university (under-graduate and graduate levels);
- ✓ Support national and international scientific meetings, workshops and short courses;
- ✓ Keep bibliography: books, manuals, handbooks, codes and standards for Brazilian institutions.

# LH2 Current Projects

CENEH

LH2
LABORATÓRIO DE HIDROGÊNIO
IFGW - UNICAMP

# Distributed Generation (CPFL / UNICAMP)

- Project sponsored by a power distribution Co., Companhia Paulista de Força e Luz – CPFL;
- Implementation and operation of a distributed generation (DG) system at UNICAMP;
- The DG system consists of:
  - 5 kW PEMFC operating with hydrogen from natural gas;
  - 30 kW natural gas micro-turbine (electricity and heat);
  - 10 kW photovoltaic panels.
- Project spam: 2002 - 2008

# Distributed Generation (CPFL / UNICAMP)


Natural Gas Reformer, autothermal, 5 kW

# Distributed Generation (Eletronorte / UNICAMP)

- ✓ PV + Water Electrolyser + PEMFC:
  - ✓ Project sponsored by Eletronorte Power Company
  - ✓ PV power: 2.1kW + Electrolyser: 0.4m$^3$/h + PEMFC: 1kW

# VEGA (UNICAMP)
# Fuel Cell Hybrid Electric Vehicle

- Learning & test platform for hydrogen FCVs:
  - VEGA I: Stationary H2 ICE + batteries + PV (1996)
  - VEGA II: Hydrogen PEMFC + batteries (2005)

VEGA I in Brasília


VEGA II at the LH2

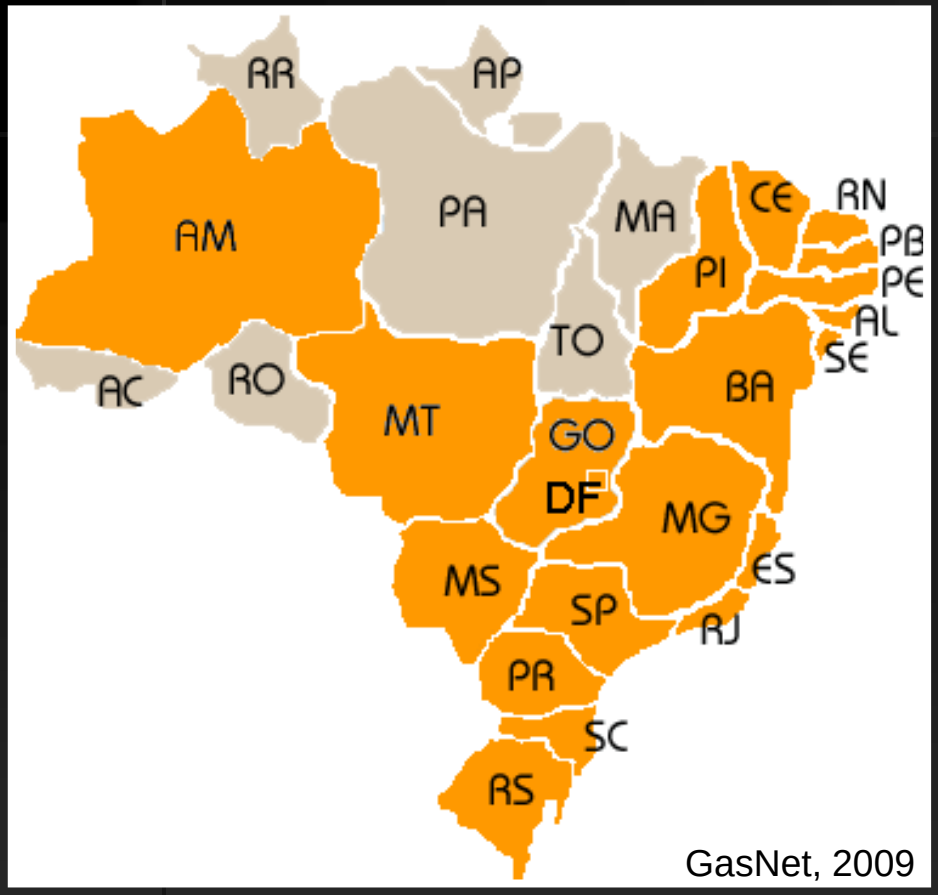
# VEGA (UNICAMP)
# Fuel Cell Hybrid Electric Vehicle

| | Power System | | Electric Motor | Battery System | Hydrogen Source | Max.Speed | Range |
|---|---|---|---|---|---|---|---|
| VEGA I | Stationary ICE generator | 2.5 kW | 15 kW | 10 x 100 A.h | 2 cylinders 12 $m^3$ 200 bar | 50 km/h | 50 km |
| VEGA II | PEMFC | 7.5 kW | 25 kW | 20 x 50 A.h | 2 cylinders 12 $m^3$ 200 bar | 60 km/h | 80 km |

# Itaipu

- The LH2 and CENEH have a cooperation agreement with Itaipu (a Brazilian and Paraguayan hydroelectric power generation company, 14 GW)
- The cooperation includes:
  - Support to Itaipu initiatives on hydrogen production and FC applications
  - Provide consulting for each project developed by Itaipu and its partners
  - Plan and build the hydrogen infrastructure at Itaipu
  - Assemble Itaipu's Hydrogen FC Bus

# Compressed NG for Vehicles



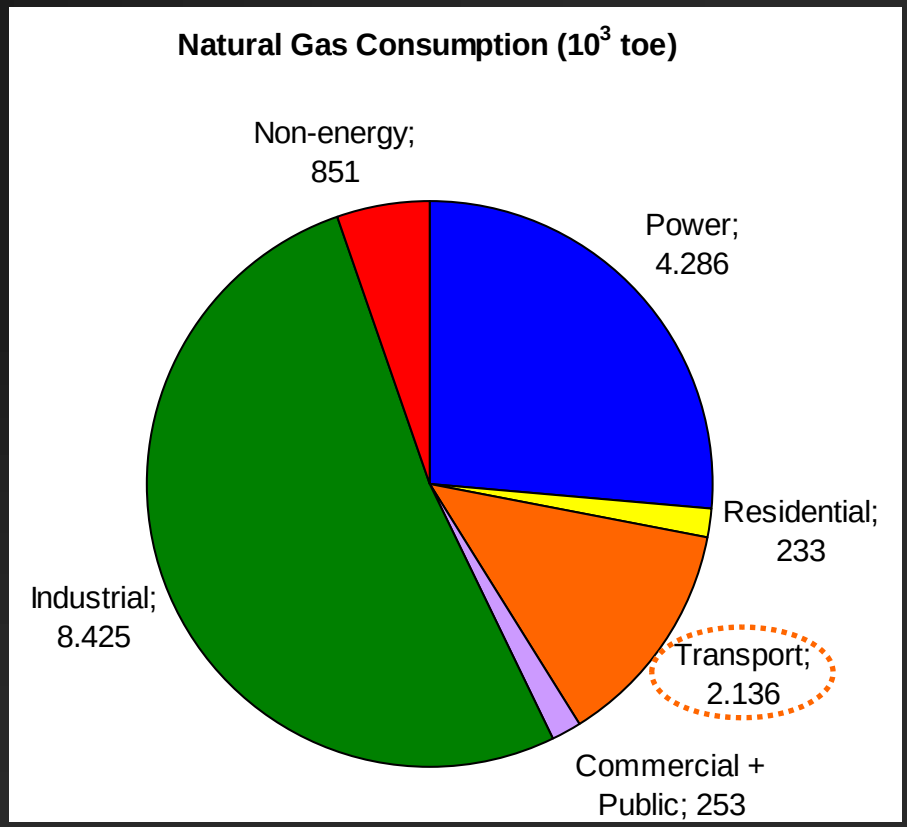

- States with CNG stations
- States without CNG stations

Stations in Brazil: 1.750

Vehicles on CNG: ~1,5 million

Natural Gas Supply: $25.9 \times 10^3$ toe

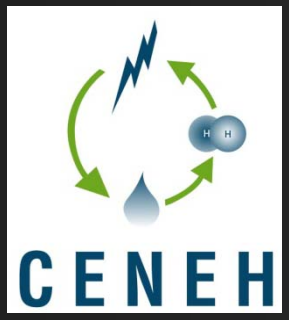
Natural Gas Consumption: $15.3 \times 10^3$ toe




BEN, 2009

# LH2 & CENEH: CNG + $H_2$

- LH2 and CENEH plan to start a project to use CNG infrastructure and vehicles to foster hydrogen stations in Brazil
- Project under evaluation by 2 energy companies
- Time frame: 24 months
- Targets include an evaluation of:
  - Current CNG stations and vehicles adaptations for using CNG & $H_2$;
  - Environmental impacts, possible hydrogen sources, energy needs and mix



***Thank you***

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