ECOWAS/GBEP 5th Bioenergy Week

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Study Tour for Capacity Building

“Addressing food and energy security through sustainable biomass value chains”

Ghana, Accra, 22-24 June 2017

Session 3: RESOURCES ASSESSMENT, OPTIONS AND STRATEGIES
WATER RESOURCES
Prof Suani Coelho
Coordination: Prof. Dr. Suani T. Coelho

Special Contribution: Prof. Dr. José Goldemberg

Research team (2017):

- Five Pos doc fellows:
  - Alessandro Sanches Pereira
  - Fábio R. Soares
  - Javier Farago Escobar
  - Marilin Mariano dos Santos
  - Vanessa Pecora GarciaLasso

- Eight PhD students:
  - Adriano Violante
  - Fernando Oliveira
  - Luís Gustavo Tudeschini
  - Manuel Moreno Ruiz Poveda
  - Monica Anater
  - Roberto Sartori
  - Claudia Treumann
  - Naraisa Coluna (PhD candidate)

- Two MSc students:
  - Caio Jopper
  - Danilo Perecin

SINCE 1996
www.iee.usp.br/gbio
Summary

• Presentation of RCGI- Research Center on Gas Innovation – FAPESP/SHELL

• Water Quantity
  – Water consumption on ethanol from sugarcane
    • Progress on efficiency
    • Use of vinasse for fertirrigation – reduction on cane irrigation in some countries

• Water Quality
  – Bioenergy from vinasse and from urban and rural residues (large x small scale)
  – Synergies – increasing energy access x environmental sustainability

• Challenges – lack of funds, lack of policies, ....

• Brazilian experience – how utilities are obliged to invest on renewable energy R&D projects
Cleaner energy for a sustainable future

A centre for advanced studies of the sustainable use of natural gas, biogas, hydrogen and abatement of CO₂ emissions
RCGI – PROJECT 27 – Biogas Perspectives for São Paulo State

• **Roadmaps**
  – Biogas production technologies
  – Biogas purification – Biomethane

• Proposals to improve current legislation in Brazil and São Paulo

• Geo-referenced biogas mapping for São Paulo State
Potential for Biomethane injection into NG pipelines
Ethanol mills x gas pipelines (Sao Paulo)
Biomethane & Independence on diesel imports
Possible replacement of 59.7% of diesel consumption in SP

2015/16 season

N-Northeast:
49 MM t cane
1.9 billion L ethanol

Center-South:
617 MM t cane
No irrigation
Ferti-irrigation w/ vinasse
28.2 billion L ethanol
“Rescue” irrigation (*):
To plant sugarcane 80-120 mm
To ratoon cane 40-60 mm

Productivity average gains (*):
Sugar cane plant 12 to 20%
Ratoon cane 8 to 12%

Reuse: reduces the need for new uptake for irrigation.

(*) Source: Rosenfeld, U. Irrigação e Eferriragião nas Sub Regiões de SP e GO. Palestra: Simpósio de Tecnologia de Produção de Cana-de-Açúcar, GAPE/FEALQ, Piracicaba, 04/07/2003

Workshop on “Examples of Positive Bioenergy and Water Relationships”
Royal Swedish Academy of Agriculture and Science (KSLA)
Stockholm, 25-26 August 2015
Water use in sugarcane ethanol production

- **Agricultural phase:** most of the sugarcane produced in Brazil does not need irrigation.

- **Industrial phase – Progress in efficiency**
  - Reduction on water use (catchment):
    - 1997: 5 m³/t sugarcane
    - 2015 – maximum of 0.85 m³/tc - mandatory in Sao Paulo State

  **Results from GBEP Indicators Project for Brazil**
  - Some mills less than 0.7 m³/tc
  - Sugarcane dry cleaning process (no water)
  - Mechanical harvesting of green cane – little need for cleaning

Source: Coelho, S.
The water catchment, which had been 15-20 m³ per ton of cane about four decades ago, has been minimized with the closing of the water systems to reuse.

On average, the water catchment for industry, is about 2 m³ / ton of cane (data from 2005)

The self imposed target is 1 m³ per ton of cane
Water quality (1/2) – ethanol mills

1. Water quality in ethanol sector

   a) No water discharge

   b) Vinasse (by-product from ethanol distillation, 8-12 L/L of ethanol)
      – Current use: fertirrigation
      – Current trends: vinasse biodigestion - energy production
Vinasse anaerobic digestion for energy conversion
GEO ENERGETICA MILL – PARANA STATE

Filter cake, tops and leaves, vinasse
2012 – Start-up - 4 MW
Expansion – 16 MW
Water quality (2/2) – Synergies of energy production x environmental sustainability

2. Urban residues – MSW – case study
   – Furnas Electric Co. (Minas Gerais State)
   – 35 municipalities around the lake (touristic region)
   – Inadequate disposal of MSW
   – Possible water contamination with slurry from the waste
Water quality (2/2) – Synergies of energy production x environmental sustainability

2. Urban residues (cont.)

- Furnas Electric Co. (Minas Gerais State)

- Waste to energy plant – Municipality of Boa Esperança – 40,401 inhabitants
  - 1 MWe – MSW gasification plant (syngas to power)
  - Brazilian technology – CARBOGAS fluidized bed gasifier

BRAZILIAN TECHNOLOGY
MSW or biomass
Small Scale Fluidized Bed Gasification Plant

- MSW: 55 ton/day
- Net power generated: 1.06 MW
- Power surplus to export: 0.805 MW
- Area: 7,800 m²

- MSW LHV: 2,217 kcal/kg
- RDF LHV: 3,770 kcal/kg (refuse derived fuel)
- Syngas LHV: 1,294 kcal/Nm³
### Energy potential from MSW in the municipalities

<table>
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<th>n</th>
<th>City</th>
<th>State</th>
<th>People (Kg/day)</th>
<th>MSW Potential (Kg/day)</th>
<th>Power (KW)</th>
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Source: Estimates from J. Escobar, GBIO/USP, 2017)
Water quality (2/2) – Synergies of energy production x environmental sustainability

3. Rural residues (Parana State)
   - Small farmers – need for adequate disposal of animal waste
   - To avoid contamination of rivers and lakes
   - Itaipu Electric Co – Ajuricaba Basin
     • 21 farmers (5-swin and 16-cow producers)
     • Biodigestion plants (large and small)
     • Biogas cleaning (H2S)
     • Logistic: Biogas pipeline for the thermoelectric power plant

Source: Ajuricaba Project – Visit Suani Coelho (2017)
• Biogas-cookstoves (Brazilian manufacturer - MULLER)

• Biogas for small scale electricity production – 80kW engine

• 2017 - Tests with biomethane in light and heavy vehicles

Source: Ajuricaba Project – Visit Suani Coelho (2017)
Last issue: a recent example from Kenya

Cogen for Africa Project – 2011
UNEP/GEF
AfDB

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Solar PV (Horticulture - Tambuzi, Kenya)

Biogas (PJ Dave Flowers, Kenya)
Kakira Sugar Ltd, Uganda

Ethanol plant with own vinasse/biogas-based cogeneration unit (0.4MW)
General challenges for syngas, biogas and biomethane projects

• Lack of policies for demonstration plants
• Lack of capacity building of agro-industries and farmers
• Lack of understanding the synergies between syngas/biogas plants and reduction on environmental impacts
• LACK OF FUNDS...
Brazilian experience with R&D projects for renewable energies

- **Brazilian banks (e.g. BNDES) make investments (large plants)**

- **New legislation (2000) for electric utilities: mandatory to apply 0.5 % of revenues on Research and Development Projects + 0.5% in energy efficiency projects (Federal Law 9,991/2000)**
  
  - Brazilian Regulatory Agency – ANEEL – in charge of the enforcement (www.aneel.gov.br)
  - Several projects already developed with such funds
  - Example – ITAIPU Project in Ajuricaba basin – USD 500,000 investment (21 farms)

- **RCGI-Project 27 – Policies proposals for Biogas and Biomethane improvements (injection into NG grid)**
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