The Perspectives of Biomethane to Contribute to Increase the NG Supply


GBio - IEE-USP
Outline

• Summary of GBio, RCGI and RCGI’s Project 27
• Contextualization
• Methodology
• Biogas/biomethane potentials
• Results
• Conclusions
• **Base:** Institute of Energy and Environment of the University of São Paulo
• **Coordination:** Prof. Suani T. Coelho, PhD
• **Special Contribution:** Dr. José Goldemberg, PhD
• **Research team:**
  – 5 Postdoc and PhD fellows
  – 6 PhD candidates
  – 2 MSc students
• Researching bioenergy since 1996
• www.iee.usp.br/gbio
RCGI - Research Center for Gas Innovation

World center for advanced studies regarding the sustainable use of natural gas, biogas, hydrogen, and management, transportation and storage of CO2 emissions.

Based at the Polytechnic School of the University of São Paulo

Result of FAPESP partnerships with Shell

Research, innovation and diffusion of knowledge.

Engineering, Physical Chemistry and Energy Policy and Economics projects.

Currently: 29 projects

www.rcgi.poli.usp.br
RCGI Project 27

• Project objectives
  – Analysis of the perspectives for biogas and biomethane (from urban and rural sources) in the State of São Paulo; geo-referenced mapping
  – Analysis of environmental benefits of increasing the biogas/biomethane share in the energy matrix of São Paulo State
  – Analysis of standards for biomethane injection into NG grid, as well as the other biomethane final uses, such as in automotive vehicles and biogas for decentralized electricity generation.

• CDM Project
  – Development of a CDM project based on biomethane injection into NG grid
  – The CDM project will be based on the simulation of the potential GHG emissions reductions due to NG replacement by biomethane.
  – CDM project to be submitted to UNFCCC as a project deliverable
Mapping of potential biogas sectors/producers in São Paulo

Technology review for biogas production

Technical potential for biogas production in each sector

Review of different end uses of biogas/biomethane

Technology review for biomethane production through biogas cleaning (CO₂ extraction)

Technical/economic potential of different end uses of biogas

Technical/economic potential of different end uses of biomethane

Environmental aspects of different end uses of biogas/biomethane

CDM project for NG replacement by biomethane

Mapping of biogas/biomethane production in the St of SP
Contextualization

- Uses for biogas and biomethane
  - Power generation (gas turbine, CHP)
  - Thermal use (heat)
  - Diesel and gasoline substitution (vehicular use)
  - NG substitution (injection on the grid)
- Paris Agreement: C emissions reduction
  - By 2025: reduction of 37% compared to 2005.
  - By 2030: reduction of 43% compared to 2005.
- São Paulo State Climate Policy (2009)
  - Reduction of 20% on GHG by 2020 when compared to 2005;
- Legislations to promote the injection of biomethane into the gas grid
  - São Paulo, Rio de Janeiro, Espírito Santo and Rio Grande do Sul
Contextualization

• Regulatory environment
  – Brazil:
    • ANP Technical Note N. 157.2014 SBQ RJ, Sep 17, 2014;
    • ANP Resolution N. 08/2015, Jan 30, 2015;
    • ANP Resolution N. 03/2017 (public consultancy)
  – Europe
    • Regulations being discussed since 2012;
    • Uses for electric energy, heat, vehicular use and injection on the grid;
    • Alternative use of NG;
    • Injection: Climate change solution/barriers
Methodology

• Literature review
  – Biogas, biomethane, biogas sources, biogas and biomethane production;
  – Energy conversion options for biogas and biomethane;
  – Existing legislations in Brazil and experiences on other countries (mainly policies in European Union);

• Biogas potential assessment from different sources
  – Residues production estimatives (MSW, Sewage, animal residues and vinasse)
  – Residue to biogas indexes;
  – Estimation of biomethane produced from biogas

• Focus: São Paulo State
Biogas potentials

• Landfills
  – Brazil still has only 58% of MSW disposed adequately (more than 1,500 dumping disposals, most in Northeast region - lowest HDI)¹.
  – Federal law 12.305/10 - National Policy on Solid Residues (NPSR)
  – Biogas naturally produced at the landfill (under anaerobic conditions)

• Sewage
  – Brazil still has only 55.2% of sewage collecting and only 51.7% of those receives treatment ²
  – São Paulo: high collection of sewage, but little treatment (raw dumping)
  – Biogas is produced in bioreactors, but it is not energetically used (flaring)

¹ IPEA, 2013
² IBGE, 2008
Biogas potentials

• Animal residues
  – Brazil still has an extensive animal production system
  – treatment of waste from animal creations becomes a necessity due to the high content of organic matter
  – Poultry residues are better for biogas production when compared to pig and cattle residues¹
  – Biodigestion in UASB or covered lagoon reactors;

• Agroindustry
  – São Paulo is the biggest producer of sugarcane and ethanol (14,6 MML)²
  – Focus: sugarcane and ethanol plants residues (vinasse)
  – In Sao Paulo State, CETESB controls the amount of vinasse disposed in the soils (fertigation)
  – Biodigestion in UASB reactors (long residence times);

¹ MAHADEVASWAMY & VENKATARAMAN, 1986
² UNICA, 2017
Biogas Potentials

Source: Joppert et al, 2014
### Results

<table>
<thead>
<tr>
<th>Biogas source</th>
<th>Estimated biogas production ($10^6$ m$^3$/year)</th>
<th>Estimated biomethane production ($10^6$ m$^3$/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfills</td>
<td>2,419.43</td>
<td>1,209.72</td>
</tr>
<tr>
<td>Sewage treatment</td>
<td>430.99</td>
<td>215.49</td>
</tr>
<tr>
<td>Animal residues</td>
<td>132.75</td>
<td>66.38</td>
</tr>
<tr>
<td>Vinasse</td>
<td>2,610.41</td>
<td>1,501.03</td>
</tr>
<tr>
<td><strong>Total – São Paulo</strong></td>
<td><strong>5,593.58</strong></td>
<td><strong>2,992.62</strong></td>
</tr>
</tbody>
</table>

NG consumption in São Paulo State (2014)$^1$: 6,181.82x$10^6$ m$^3$/yr

48% of the demand for NG in the São Paulo State

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$^1$ Secretaria de Energia do Estado de São Paulo, 2014
## Results

<table>
<thead>
<tr>
<th>Biogas source</th>
<th>Potential power output (MW)</th>
<th>Estimated electric energy output (GWh/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfills</td>
<td>495.0</td>
<td>3,769.0</td>
</tr>
<tr>
<td>Sewage treatment</td>
<td>88.0</td>
<td>671.0</td>
</tr>
<tr>
<td>Animal residues</td>
<td>26.0</td>
<td>207.0</td>
</tr>
<tr>
<td>Vinasse</td>
<td>798.0</td>
<td>4,067.0</td>
</tr>
<tr>
<td><strong>Total – São Paulo</strong></td>
<td><strong>1,407.0</strong></td>
<td><strong>8,741</strong></td>
</tr>
</tbody>
</table>

NG consumption in São Paulo State (2014)\(^1\): 150,723 GWh/year

5.8% of the demand for EE in the São Paulo State

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\(^1\) Secretaria de Energia do Estado de São Paulo, 2014
Conclusions

• The preliminary results show the important contribution of biogas and biomethane to emissions reduction in São Paulo and to reach the goals of Paris Agreement;

• Biomethane produced from vinasse, alone, can contribute to, theoretically, reduce almost the amount to be reduced according the São Paulo State Climate Policy (diesel replacement);

• This is the main reason for the contribution of Project 27 in RCGI: to contribute to reduce carbon emissions in Brazilian energy matrix, through the replacement of fossil fuels, besides the strategic benefits of increasing the natural gas offer.
Thank you!

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