Energy, Environment and Sustainability Issues in Brazil: Projections, Challenges, Needs

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Energy situation and trends in Latin America: Brazil, Mexico and Argentina
### Economic and Energy Forecast: Brazil and Mexico

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brazil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (million)</td>
<td>198</td>
<td>220</td>
<td>239</td>
</tr>
<tr>
<td>Domestic Energy Supply (million toe)</td>
<td>279</td>
<td>398</td>
<td>557</td>
</tr>
<tr>
<td>Energy Consumption (million toe)</td>
<td>246</td>
<td>353</td>
<td>483</td>
</tr>
<tr>
<td>CO₂ emissions (Mt CO₂)</td>
<td>414</td>
<td>562</td>
<td>770</td>
</tr>
<tr>
<td><strong>Mexico</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (million)</td>
<td>104</td>
<td>116</td>
<td>121</td>
</tr>
<tr>
<td>Domestic Energy Supply (million toe)</td>
<td>198</td>
<td>263</td>
<td>354</td>
</tr>
<tr>
<td>Energy Consumption (million toe)</td>
<td>125</td>
<td>168</td>
<td>226</td>
</tr>
<tr>
<td>CO₂ emissions (Mt CO₂)</td>
<td>342</td>
<td>442</td>
<td>563</td>
</tr>
</tbody>
</table>

Source: For Brazil: EPE-MME (2010); For Mexico: Prof Fabio Manzini
## Comparison of Energy and CO₂ Emissions of Brazil, Mexico, LA, China and World

<table>
<thead>
<tr>
<th></th>
<th>IEA Countries</th>
<th>World</th>
<th>Latin America</th>
<th>China</th>
<th>Brazil</th>
<th>Mexico</th>
</tr>
</thead>
<tbody>
<tr>
<td>DES/Population (toe per capita)</td>
<td>5.15</td>
<td>1.77</td>
<td>1.1</td>
<td>1.25</td>
<td>1.11</td>
<td>1.8</td>
</tr>
<tr>
<td>DES/GDP (toe/thousand – 2000 US$)</td>
<td>0.19</td>
<td>0.32</td>
<td>0.32</td>
<td>0.85</td>
<td>0.31</td>
<td>0.30</td>
</tr>
<tr>
<td>Electricity Consumption/Population (kWh per capita)</td>
<td>9,049</td>
<td>2,516</td>
<td>1,645</td>
<td>1,607</td>
<td>1,955</td>
<td>1,836</td>
</tr>
<tr>
<td>CO₂/DES (t CO₂/toe)</td>
<td>2.33</td>
<td>2.37</td>
<td>1.87</td>
<td>2.93</td>
<td>1.58</td>
<td>1.7</td>
</tr>
<tr>
<td>CO₂/Population (t CO₂ per capita)</td>
<td>12.01</td>
<td>4.18</td>
<td>2.05</td>
<td>3.66</td>
<td>1.76</td>
<td>3.0</td>
</tr>
<tr>
<td>CO₂/GDP (kg CO₂/2000 US$)</td>
<td>0.45</td>
<td>0.76</td>
<td>0.59</td>
<td>2.5</td>
<td>0.49</td>
<td>0.51</td>
</tr>
<tr>
<td>CO₂/GDP (PPP) (kg CO₂/2000 US$)</td>
<td>0.44</td>
<td>0.51</td>
<td>0.29</td>
<td>0.66</td>
<td>0.23</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Source: EPE-MME (2010) from IEA; For Mexico: Prof Fabio Manzini
Brazil, Mexico, Argentina Electricity Supply

Brazil - 2008

Source: MME – BEN, Brazil (2009)

Mexico - 2008

Argentina - 1992

Composition of Argentina Electricity Generation
13,185 MW - 1992

Source: from Prof Fabio Manzzini

Total Thermal: 49%
The Brazilian Energy Long Policy:
- Achieving Petroleum Self-Sufficiency
- Maintaining Green Energy Matrix
Brazil External Dependence on Energy

Source: MME –BEN, Brazil (2009)
Expected Evolution of Vehicle Fleet Profile until 2030 in Brazil

Source: EPE-MME, Brazil (2010)
Renewable Energies in Brazilian Energy Matrix

Source: EPE-MME, Brazil (2010)
Expected Evolution of Energy Supply in Brazil

Source: EPE-MME, Brazil (2010)
Evolution of Brazilian GHG Emissions 1990-2005 (GtCO$_2$eq/year)

Source: EPE-MME, Brazil (2010)
Expected Evolution of GHG in Brazil, 2005-2030

Source: EPE-MME, Brazil (2010)
Main Needs and Challenges in the Energy Sector in Brazil
Main Needs and Challenges in the Energy Sector in Brazil

- **Renewable Energies:**
  - Maintain high proportion renewable energy in the energy matrix while growing energy consumption
  - Extend the “Brazilian Renewable Energy Model” to other countries, in particular to Latin America and Africa
  - Sustainably increase production of biomass (ethanol and others) and hydropower
  - Extend use of solar and wind energies
  - Each country/region has its own potential

- **Fossil Fuel:**
  - Decrease dependence on petroleum derivates such as diesel
  - Explore deep waters oil and gas reserves
UNICAMP activities in Energy and Environment (research and graduate studies)
Activities of UNICAMP in Energy and Environment

Basic Sciences: IF, IQ, IB

Engineering: FEM, FEA, FEEC, FEQ, FEAGRI, and FEC

Related Graduate Programs:
- Energy Planning (PSE/FEM)
- Petroleum Engineering (IG/FEM)
- Environmental Studies (IFCH)
- Engineering (Electrical, Mechanical, Chemical, Civil, Agricultural, Food)
- Basic Sciences (Physics, Biology, Chemistry)
Interdisciplinary Center of Energy Planning (NIPE)

Research Topics:

- Energy Technology forecast
- Energy demand in residential sector (Energy efficiency programs and prospective studies)
- Renewable Sources of Energy in Latin America: market, programs and promoting mechanisms

Main Partners: utility companies, energy regulating agencies

NIPE/UNICAMP study concluded that Brazil could replace 10% of the World gasoline by sugarcane bioethanol! Giving birth to the Brazilian Bioethanol Research Center-CTBE
Petroleum Engineering Center (CEPETRO)

- Created in 1987
- LabPetro: agreement Unicamp-Petrobras
- Strategic Partnership with Petrobras
- M.Sc. and Ph.D. in Petroleum Engineering (FEM)
- M.Sc. and Ph.D. in Petroleum Science and Engineering (FEM/IG)
  - Number of Graduated Students: 123 M.Sc. and 17 Ph.D. (2000-2010)
- Main Areas: reservoirs and management, exploitation

CEPETRO/UNICAMP is actively conducting research with Petrobras to explore new off-shore oil reserves (pre-salt)
Energy Systems Planning (PSE/FEM)

-M.Sc. and Ph.D. in Energy Planning (FEM)
-Main areas: energy planning, regulation, R&D

PSE/FEM/UNICAMP is the most important Energy Planning graduate program in Brazil, helping to graduate specialists for enterprises (R&D), government agencies (regulation)
Other energy and environment related research centers

-Nucleus of Environmental Studies and Researches (NEPAM)
- Scientific research and Environmental education.
- Cooperation with non-governmental organizations (NGOs).
- Consultancy to governmental entities.
- Regular publications and extension activities.

-Center of Meteorological and Climatic Researches Applied to Agriculture (CEPAGRI)
- To render services of public interest, such as weather forecast and direct support to agriculturists and general public.
- To develop researches of image processing from meteorological satellites and natural resources, agricultural planning, ecological and climatic zoning, mapping of extreme phenomena (tornados, frosts, droughts, etc.) and graphic models to potential fires in forests.

-Multidisciplinary Center of Chemical, Biological and Agricultural Researches (CPQBA)
- To support research projects and technical and industrial development.
- To render specialized services in the chemical, biological and agricultural areas to the industry and governmental agencies.
Cooperation UNICAMP/Bioethanol Research Laboratory-CTBE
Bioenergy Laboratory (LABIOEN/PRP/UNICAMP)

- Partnership with São Paulo State Government and São Paulo State Research Foundation – FAPESP
- Create 3 bioenergy research centers in São Paulo State
- 5 research areas:
  - biomass production
  - biomass conversion,
  - biorefinery,
  - engines/fuels, and
  - sustainability aspects
- Bioenergy is strategic in São Paulo State: 60% of sugarcane is produced in SP; 50% of all light vehicle in Brazil runs with sugarcane ethanol
Possibilities of Collaboration/Financing

FIPSE/CAPES – US-Brazil Higher Education Consortia Program: exchange of undergraduate students, with US universities
http://www2.ed.gov/programs/fipsebrazil/index.html

CAPES/Fulbright Commission
To encourage Brazilian professors in renowned US universities

CAPES/ Julio Redecker Fellowship
For Brazilian PhD students to US universities

CAPES/Fulbright Fellowship
For Brazilian PhD students to conduct research training in US universities
http://www.capes.gov.br/cooperacao-internacional/estados-unidos/capesfulbright-estagio-de-doutorando

FAPESP – São Paulo State Research Foundation: exchange of researchers
http://www.fapesp.br/en/

CNPq – Brazilian National Research Foundation: exchange of researchers
http://www.cnpq.br/english/cnpq/index.htm