POWER SECTOR DEVELOPMENTS IN BRAZIL

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Outline

• Brazilian system overview
• Investment needs
• Investment options
• Market rules for new investments
• The Bioelectricity initiative
• Conclusions
The Brazilian power system

Surface area: 8.5 million sq km
(≈ continental USA + 1/2 Alaska)
175 million inhabitants
Inst. capacity (2003): 85,000 MW
Production: 42,000 ave. MW
≈ 55% of South America
Peak Demand: 53,500 MW
- comparable to UK or Italy
Current energy mix

- Thermal + interconnections (15%): combined- and open-cycle natural gas, coal, oil and nuclear
- Hydro (85%): large plants in cascade, in several basins
- all hydro plants are dispatched as a "portfolio", with "wetter" basins exporting energy to "drier" ones

Itaipu: 14,000 MW
Brazil: transmission system

Transmission is an important factor for the integration of hydro power production

Country is interconnected by 80,000 km of HV lines

Long transmission lines (> 1,000 km)

+ 40,000 km of HV circuits until 2012

* Eletrobrás, Ten Year Expansion Plan 2003-2012
Power sector organization

- Regulatory agency (ANEEL)
- Nationwide ISO (ONS) and Wholesale Energy Market (CCEE), both private, under ANEEL supervision
- Generation
  - 11 gencos, 15% private (by energy produced)
  - total revenues (2003): US$ 9 billion
- Transmission
  - 26 transcos, 17 private
  - total revenues (2003): US$ 1.6 billion
- Distribution
  - 64 major discos, 80% private (by energy consumed)
  - total revenues (2003): US$ 16 billion
Power sector investments

- Capital intensive
- Long-term investments
- Uncertainty on demand growth
- Yearly investments: US$ 6 billion

![Pie chart showing distribution of investments: Generation 51%, Transmission 16%, Distribution 33%](Source: MME. 2004)
Generation investment needs

- Until 2008, there is over-capacity (consequence of energy rationing in 2001)
- Assuming a 4% GDP growth, about 3,500 MW of new capacity must enter the system every year, starting 2009
- Because of construction time, investment decisions must be made early in 2005
Resources for generation expansion

**North:** substantial hydro; limited natural gas

**Northeast:** hydro exhausted; offshore natural gas; LNG imports; power import from North and Southeast; biomass (sugarcane); windpower

**South:** electricity and gas imports from Argentina; local coal; binational hydro plants; wind

**Southeast:** hydro; Bolivian gas + large offshore gas fields; biomass (sugarcane)
Market rules

- All consumers must be 100% covered by energy supply contracts
  - Verified ex-post, on an yearly basis
- Although supply contracts are financial (forward contracts), they must be backed by physical production capacity ("ballast")

- The need to sign new contracts to cover additional load is the driver for the entrance of new capacity
Contracting existing capacity

• Discos (70%): regulated auctions
  – carried out every year, for entrance in operation next year (contract renewal)
  – Five- to eight-year PPAs are offered
  – criterion for contracting in auctions is the smallest tariff ($/MWh)
  – discos are responsible for deciding how much energy they want to contract
    • contract costs can be passed through to customers

• Free consumers (30%): direct negotiation
Example of regulated auction

• Carried out December 7, 2004
• Total load: 17 thousand average MWs
  – 9 thousand ave. MWs starting 2005
  – 7 thousand, 2006
  – 1 thousand, 2007
• Fifteen generation bidders, totaling 26 thousand average MWs
• Eight-year contracts
• About US$ 27 billion in contracts were auctioned
Contracting new capacity

• Discos: regulated auctions
  – carried out every year, for entrance in operation five years later
  – 20-year PPAs are offered
    • this allows auction winners enough time to build plants and to have project finance
  – criterion for contracting in auctions is the smallest tariff ($/MWh)
  – discos are responsible for deciding how much energy they want to contract
    • contract costs can be passed through to customers

• Free consumers: direct negotiation
New Capacity auction rules

• Discos inform required load
• Auctioneer prepares a “Menu” of generation options
  – Hydro projects (concessions prepared by government)
  – Thermal projects + international interconnections (offered by candidate investors)
• Each project has an associated “firm capacity”, which serves as “ballast”
• Each investor bids an annual remuneration ($) for each desired project
• Projects are ranked by $/firm capacity and selected by increasing price until total capacity = required load
## Costs of “mainstream” supply options

<table>
<thead>
<tr>
<th></th>
<th>Investment (US$/kW)</th>
<th>Contract (US$/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>700</td>
<td>37</td>
</tr>
<tr>
<td>Combined-cycle gas</td>
<td>600</td>
<td>41</td>
</tr>
<tr>
<td>Coal (local)</td>
<td>1000</td>
<td>47</td>
</tr>
<tr>
<td>Nuclear</td>
<td>1000</td>
<td>47</td>
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</tbody>
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The role of renewables

- PROINFA: incentives for the construction of 3,300 MW of renewables: small hydro, biomass and windpower (1,100 MW each)
- Compulsory contracting by all consumers
  - Operation will start 2007-2008
- Contract prices (US$/MWh):
  - Small hydro: 42
  - Wind: 73
  - Biomass: 34

Biomass has the potential for becoming a “mainstream” expansion option
Sugarcane production - million tons

Source: Unica, Brazilian Sugar and Ethanol Market 2004, presentation by E.P. Carvalho, NY, March 2004

2010 projection: 540 million tons (50% increase)
Brazil: sugar-cane crop area

Source: Unica, Brazilian Sugar and Ethanol Market 2004, presentation by E.P.Carvalho, NY, March 2004

Current area
5 million ha
Brazil: potential sugar-cane crop area

Potential area
90 million ha

Source: Unica, Brazilian Sugar and Ethanol Market 2004, presentation by E.P. Carvalho, NY, March 2004
Economic advantages of Bioelectricity

- Shorter construction period
  - 2 years x 5 years for hydro
  - important due to uncertainty in load growth
- Natural “hedge” with sugar and ethanol production
  - greater competitiveness
- Location close to main load centers
  - reduction in transmission costs
- Synergy with hydro production pattern
- Carbon credits
Hydro and Biomass Complementary

State of São Paulo monthly rainfall (mm) historic average

Sugarcane harvest: April-November

SOURCE: IAC
Locational advantage

Sugarcane crop areas

Main electricity load centers

Source: Unica, Brazilian Sugar and Ethanol Market 2004, presentation by E.P. Carvalho, NY, March 2004
Additional Advantages of Bioelectricity

- Production in national currency
- Wider range of investors
- Job creation
The Biolectricity Initiative

- Joint endeavor of sugarcane producers and energy producers/traders
- Coordination with natural-based cogeneration initiative (COGEN)
Bioelectricity objectives/actions

• Short-term objective: participate with at least 2500 MW in the new capacity action
  – Work with government (Ministry of Energy and regulator) to finalize/detail power sector regulations
  – Define with Ministry of Environment and Ministry of Energy a “baseline scenario” for carbon credits (Kioto rules)
  – Additional negotiations with World Bank

• Mid-term: explore additional opportunities
  – Hydrogen from ethanol
  – Biorefineries
Conclusions

• Bioelectricity from sugarcane has the potential to become a “mainstream” energy option in the near future in Brazil

• “Window of opportunity” because of strong growth of sugar/ethanol sector, new power sector regulations and start of Kioto initiative