If there is one thing that is characteristic of electricity markets worldwide, it is a rising awareness of risk.

While electricity markets worldwide are becoming increasingly competitive, risks associated with rising fuel prices, fuel availability, economic and political changes, among others, are confronting those markets. Utilities and their customers are recognizing the need to develop risk management skills to compete in the marketplace.

The Latin America energy marketplace led the world with its deregulation reforms, but is confronting new risks that are challenging its market structures and imposing new competitive arrangements, with transactions being based more and more on prices set by market forces rather than regulation.
Contents

• Energy markets in Latin America- gas and electricity

• Deregulation processes – advances and recessions

• Risks involved in energy markets

• Assessment and management of risks

The Latin America markets

• Central America
  ✓ Several countries, with low energy consumption, being integrated to achieve adequate scale.

• Andean Community
  ✓ Countries with abundant energy resources that could be better used.

• Mercosur
  ✓ Countries with higher energy consumption than rest of region. Abundant energy resources (hydro and natural gas)
The gas and electricity markets

-one of the most dynamic regions of interaction between electricity and natural gas
-important natural gas reserves and hydro potential capacity, coupled to high demand growth
-need to diversify energy resources
-economic reforms opened space for private investment in energy
-development of an infrastructure of gas and electricity interconnections
-macro economic and political difficulties in some countries giving origin to regional energy crisis

Latin America – global vision

Total Installed Capacity (2001)
221 GW (57%H, 43%T)
The economic growth

LATIN AMERICA & THE CARIBBEAN

Source: Cepal, 2005

High electricity demand growth

Chile - projection of demand growth over 6%
Demand growth correlated to GDP

Mexico

Potential hydro resources

Source: Olade
Natural gas reserves

- **Venezuela**: 4.1 TCM (147 TCF) (60%)
- **Peru**: 0.2 TCM (8.7 TCF) (4%)
- **Bolivia**: 0.7 TCM (23.9 TCF) (11%)
- **Chile**: 0.05 TCM (1.6 TCF) (1%)
- **Colombia**: 0.2 TCM (7.2 TCF) (3%)
- **Brazil (w/o Santos)**: 0.2 TCM (7.8 TCF) (4%)
- **Brazil (With Santos Basin)**: 22.8 TCF
- **Argentina**: 0.7 TCM (25.8 TCF) (3%)

TCM: Trillions Cubic Meters
TCF: Trillions Cubic Feet

Energy resource distribution

- **Important load**
- **Natural gas reserve**
- **Hydro reserve**
Increasing gas exchanges

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Advances and Recessions

• The 80’s and 90’s–the great leap forward
  – The start of reforms in the 80’s
    • Chile
    • Argentina
  – The natural continuation in the 90’s
    • Peru, Colombia, Bolivia, Central America
  – The incomplete experiments
    • Brazil

Trajectories Electrical Reform Processes

Private property
- Vertical integration allowed

Mixed property or partial private participation
- Vertical segmentation with restrictions on functions

Exclusive state property
- Central control
- Integrated & regulated
- Single buyer
- Open market

Future probable trajectories

Source: Cepal, 2003
Trajectories Gas Reform Processes

<table>
<thead>
<tr>
<th>Property Type</th>
<th>Control Type</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private property</td>
<td>Central control</td>
<td>Brazil, Argentina</td>
</tr>
<tr>
<td>Mixed property or partial private participation</td>
<td>Integrated regulated</td>
<td>Colombia, Chile, Colombia</td>
</tr>
<tr>
<td>Exclusive state property</td>
<td>Open market</td>
<td>Mexico, Bolivia, Brazil</td>
</tr>
</tbody>
</table>

1990/2002, millions US$

**Welcome private investment**

<table>
<thead>
<tr>
<th>Country</th>
<th>Electricity</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>43.000</td>
<td>4.900</td>
</tr>
<tr>
<td>Argentina</td>
<td>16.000</td>
<td>9.200</td>
</tr>
<tr>
<td>Chile</td>
<td>8.000</td>
<td>2.300</td>
</tr>
<tr>
<td>Colombia</td>
<td>6.000</td>
<td>2.000</td>
</tr>
<tr>
<td>Peru (*)</td>
<td>4.500</td>
<td>1.000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>77.500</strong></td>
<td><strong>19.400</strong></td>
</tr>
</tbody>
</table>

(*) Until 2004 in gas

Source: Gas Atacama
Advances and Recessions

• The 00’s – the break
  – Continuing reforms (the Pacific)
    • Colombia
    • Chile
    • Peru
  – The recession (the Atlantic)
    • Argentina - the economic crisis - abandoning the path
    • Brazil – rationing and the new regulatory search
    • Bolivia – the political crisis

Advances and Recessions

• The great recession
  • The macroeconomic and political crisis
  • The State intervenes – the political action
  • Despising regulations and contracts
  • Negotiations and power balance as the development tool
  • The privilege of the short term

• Political action versus regulation
  • An unwarranted path for the long term
Required private investment

<table>
<thead>
<tr>
<th></th>
<th>Electricity</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>10.500</td>
<td>2.000</td>
</tr>
<tr>
<td>Argentina</td>
<td>3.900</td>
<td>2.500</td>
</tr>
<tr>
<td>Chile</td>
<td>2.000</td>
<td>200</td>
</tr>
<tr>
<td>Colombia</td>
<td>1.600</td>
<td>1.000</td>
</tr>
<tr>
<td>Per</td>
<td>1.100</td>
<td>1.500</td>
</tr>
<tr>
<td>Total</td>
<td><strong>19.100</strong></td>
<td><strong>7.200</strong></td>
</tr>
</tbody>
</table>

Required 2004/2008, millions US$

Source: Gas Atacama

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• Assessment and management of risks
Deregulation, segmentation and privatisation of the electricity industry in Latin America brought about uncertainty and the need to face risk by all involved, changing the way decisions are made by the different agents.

Risk may be defined as the potential harm that may arise from some present process or decision or from some future event, the hazard to which we are exposed because of uncertainty. Harm can take different forms in the electricity industry, whether one is an investor in generation, a sale organization, or an end-user.

Markets brought uncertainty and risks

- Electricity price (volatility)
- Fuel price
- Fuel availability (uncertain availability)
- Economic conditions (economic upheaval, inflation, floating exchange rates, interest rates)
- Volume (uncertain ability to balance supply and demand of electricity)
- Financial risk (credit, settlement, liquidity and operational risks)
Markets brought uncertainty and risks

- Weather load dependence
- Hydrological conditions
- Environmental constraints
- Transmission restrictions
- Technology changes
- Regulatory conditions (consistency and stability of regulations, transparency)
- Political decisions (political tariff setting)

Demand growth uncertainty

Brazil: GDP correlation, but affected by crisis
Demand growth uncertainty

- Brazil: the expectations of load growth in early 2001 for the next years were ~4.5%.
- Because of the 2001 power crisis and rationing, projections revised downwards, with an increase in uncertainty.
- Challenge is to assure supply adequacy under uncertainty.

Fuel price volatility – WTI crude oil

Source: EIA, Febr. 2005
Fuel price volatility – gas prices

Source: www.wtrg.com

Fuel price uncertainty – gas prices

Source: National Petroleum Council (2005)
Uncertainty in hydrology

Store hydraulic energy in central Chile

- Condition common to Latin American markets
- Predominance of volatile hydroelectricity generation

The Chilean case
- In an average year, about 80% can be supplied with hydro generation in the main system
- In a rainy year, such as 1972-1973 or 1992-1993, nearly 100% of energy requirements can be supplied with hydro generation.
- During an extreme drought such as those of 1968-69 or 1998-99, hydro generation cannot supply more than 40%
Brazilian Southeast Region spot prices

Price volatility

![Spot Prices (US$/MWh)](chart)

Brazilian Northeast Region spot prices

Price volatility

![Energy Rationing](chart)

![Gas supply difficulties](chart)

Exchange rate: 1 USD = 2.6 R$
Price volatility

Chilean main system spot prices coupled to hydrology

Fuel availability – the gas dependence

Argentinean natural gas exports to Chile
Fuel availability – the gas dependence

Restrictions of Argentinean natural gas exports to Chile

Crisis led to market des integration
The country risk

[Graph showing country risk over time with specific base points for Latin, Brasil, Chile, México, and Perú.

Source: Cepal, 2004]

The political risk

Argentina
• Emergency law of 2002 – new political leaders fighting for survival
• distribution and transport concession contracts are dismissed
• gas tariffs are frozen, stimulating distorted growth of gas consumption.
• negative returns on investments
• investments frozen leading to export rationing
Short political cycles scare investors

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Source: Cambridge Energy Research Associates.
Risk management

Risk management is the process of assessing risk and then developing strategies to manage the risk.

Important in the development of the energy infrastructure.

Energy infrastructure characteristics

- Long construction periods
- Long term investment
- Minimum plant sizes, given economies of scale
- Large sunk costs within large investments
- Indivisibility of equipment and technical discontinuity require supply ahead of demand
- Demand fluctuation forces significant idle capacity

Need to adequately assess and manage risk
Decision making in generation investment

- Decisions taken by generator investors, whose objective is to maximize company value
- Market provides important signals to investments
- High levels of uncertainty and risk
- Companies take decisions based on strategic perspective
- Traditional planning/optimization is not sufficient
- Present trend is to assess investments based on risk assessment and risk management models, using different methodologies

Supply uncertainty and risks - approaches

- **Obligation to supply**
  - With pass through of contracts: Low risk for invest. High cost transferred to consumers
  - With reference price: Depends on reference price. Some problems

- **Market driven**
  - Pass through of benchmark merchant plants: Risk for investors and suppliers. Sensitive to country risk
  - Merchant plants: High risk for investors. Sensitive to country risk
Methodology scheme in decision making of generation capacity investment

Investment analysis methodologies

Development level and electricity markets applications

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Development level</th>
<th>EM applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive Strategy</td>
<td>High</td>
<td>Theoretical</td>
</tr>
<tr>
<td>Scenario Simulation</td>
<td>Medium</td>
<td>Real</td>
</tr>
<tr>
<td>Decision Analysis</td>
<td>High</td>
<td>Real</td>
</tr>
<tr>
<td>Business Dynamics</td>
<td>Medium</td>
<td>Theoretical</td>
</tr>
<tr>
<td>Real Options (RO)</td>
<td>High</td>
<td>Theoretical/Real</td>
</tr>
<tr>
<td>RO w/Game Theory</td>
<td>Low</td>
<td>In research stage</td>
</tr>
</tbody>
</table>
Investment analysis methodologies

**Qualitative Behavior analysis**

- Industry analysis
- Identify uncertainties and risks for the Genco
- Evaluated competitive advantages, positioning and sustentation of the Genco

- Create consistent and reasonable “histories" of the future
- A method to think about the long term where uncertainty is too great
- Scenarios are used to evaluate strategies, planning and policies of organizations

**Planning/Optimization analysis**

- Trade/Off risk analysis
- The concept is hedging to adverse scenarios
- Min-max regret approach
- Tried to avoid a solution that may have a bad performance in the future

- Long term behavioural simulation modeling
- The underlying concept is learning and the recognition of feedback and time lags
- Models the dynamic evolution of the market and the logic of relationships among their components
Investment analysis methodologies

Financing/Economic based analysis

- Measure value of the flexibility of decisions
- Models the uncertainty of contingent variables (costs of fuels, electrical prices, demand, etc.) through state variables that follow stochastic processes
- Define the optimal timing of investment, the choice of technology, valuation of capacity expansion

- Generation market is an oligopoly (generally)
- Strategy interaction affects decision making
- Basically trade-off between the value of waiting for the appropriate timing of investment and the strategic value to act before the competitors
- Game theory line include preemptive games and war of attrition games

Let the market manage risk

Brazil and Chilean approaches through auctions

- New auction schemes replace regulated price calculations
- Brazil regulated pool as a a kind of ‘single buyer’ intermediary to purchase power via auctions that blend cheaper hydro power with more expensive thermal generation and offers a single price for distributors.
- Chile to implement auction process where distributors offer 15 year contracts to generator investors in uncertain gas supply environment.
- Load’s willingness to contract drives system expansion
- The importance of auction design to face market power
Let the market manage risk - Brazil

Existing energy

New energy

Demand

Old contracts

Auctions

Energy blocks without contracts by 2015

Let the market manage risk - Chile
Hugh Rudnick

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Final version: www.ing.puc.cl/power/risk/