Benchmark Regulation and Efficiency of Electricity Distribution

Hugh Rudnick

Bundesnetzagentur Conference
Bonn, 25-26 April 2006
Objective

Share the experience of Latin American countries that, from 1982 onwards, reformed their electricity power sectors to establish conditions of economic efficiency and attract private investment, replacing central planning and control by market oriented approaches.

Competition was introduced in generation and “pseudo competition” in transmission and distribution.

Share the characteristics of benchmark yard stick regulation for distribution, with analytical cost models, model company and model network concepts, used in Chile, Argentina, Peru and others.
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity- costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
The building of the price for the final consumer

\[ P_{\text{generation}} + \text{cost } T_x + \text{cost } S_Tx + \text{cost } D_x \]
Electricity cost
Industrial consumer

Year
Chilean Pesos

Energy cost  Distribution cost
Market reforms: benefit final consumer

Market environment

Monopolistic activity
(stimulate efficiency through regulation)

$P_{\text{generation}} + \text{cost } Tx + \text{cost } STx + \text{cost } Dx$
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity- costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
Price regulation objectives for monopoly

**Strategic objectives**
- avoid loses of monopoly prices
- avoid individual tariff considerations
- provide
  - economic efficiency signals for operation and investment
  - flexibility and stability
  - adequate response to market changes
  - symmetry of risks and opportunities for the regulated agent

**Prices must be fixed considering**
- cost of service provision
  - reflect to the consumer the supply cost structure
- adequate return to investment capital
- incentives for cost reduction
Distribution monopoly regulation

Requirements
- concession required to run the business
- public service activity
- obligation to serve
- open access to wires
- quality of service regulated

Rights
- concession granted for the right to use public roads and private grounds with compensation
- realistic price regulation considering restrictions
- adequate return to investment capital, if efficient
- higher efficiency rewarded
Regulatory Models

All models to regulate industrial monopolies consider **fixing initial prices** and **adjusting them with time**.

\[ P_0 \cdot f(P'_t) + Z_t = P_t \]

- **Initial Price**
- **Annual adjustment factor**
- **Adjustment**
- **Price in year t**
Regulatory Models

Fixing initial prices

From “what are the costs?” to “what they should/could be?”

Based on real costs, standardised ones, efficient ones?

Adjustment with time

Regulatory models adjust prices on a yearly bases, given parameter changes or incentive needs

Based on inflation, efficiency increases?
Regulatory Models

**Cost Plus (Cost based) Regulation**
recognize real costs and determine required rent, no incentives to reduce costs

**Incentive Regulation - Price Cap**
bridge between traditional regulation and deregulation – costs fixed and reduced over time (productivity index RPI-X)

**Model Company or Yardstick Competition**
possibility to compare costs of different similar companies- introduction of concept of a model company
Comparison of different companies achieved through identifying different “distribution areas”

Models determined for each area, tariffs different for each area
Challenges
- definition of “efficient” investment and administration
- manage information deficiencies
- regulator independent from monopoly pressure (avoid capture)
- need to consider reliability and quality of supply

Risks
- conflictive interests between regulator and monopoly
- regulator manipulating model company with other objectives
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity - costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
Process of electricity distribution

**Investment planning**
- Identify new system needs.
- Develop plans to satisfy need.
- Facilitate plans and budgets.
- Assess large projects.

**Network construction**
- Build lines, substations, low voltage networks.

**System operations**
- Connections & disconnections
- Follow up and control of system operations
- Correct damages & incidents.

**System maintenance**
- Maintenance of lines, substations and low voltage networks.
- Maintenance of protection equipment.

**Business management**
- Measurement, meter reading
- Billing
- Contracts
- Solution management.
Cost components in added distribution value

Distribution Value Added

Fixed costs
- Meter reading
- Billing
- Distribution of bills
- Accounting related to client
- Bill follow up
- Client relation
- Other fixed costs related to client.

Investment costs, Operation & Maintenance
- Capital costs
- Operational costs
  - High Voltage
    - Feeders
    - Control equipment
    - Protection equipment
  - Low Voltage
    - Distribution substations
    - Low voltage networks
    - Protection equipment
  - Technical losses
    - Storage
    - Workshops
    - Labs and tools
    - Operational engineering
    - Transport
    - Security
    - Rent, insurance
    - Network maintenance and operation
    - Patents and property taxes
  - Other losses

Distribution losses
- Other losses
Characteristics of distribution costs

Cost of distribution dictated by capacity requirements (demand defines network dimensioning, thus defines investment and operation)

Energy only important given network losses

Important economies of scope (the higher the load density, the lower the unit costs)

Marginal cost of distribution equal to average costs (except for high density)
Distribution characteristics

Total monthly costs **semi urban area**, Chile, 1988
Average value 10,2  US$/kW/month
Distribution characteristics

Total monthly cost **rural area**, Chile, 1988
Average values 13,8 US$/kW/month
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity- costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
Cost structure for distribution

\[ \text{Cost} = \frac{\text{Investment annuity} + \text{Operation} + \text{Losses}}{kW_{HV} + kW_{LV}} \]

Replacement cost concept for investment.

Investment annuity considering useful life of installations and given return rate.

Econometric models are built to represent the industry costs, with a log-log regression between the average cost per km*kW and the km*kW, for high voltage and low voltage.

Following examples represent Chilean distribution industry.
Distribution characteristics

Relation between unit costs HV and the product \( \text{kmHV} \cdot (\text{kWHV} + \text{kWLV}) \)

\[
\text{Cost}_{HV} = \text{km}_{HV} \cdot (\text{kW}_{HV} + \text{kW}_{LV}) \cdot e^{(A \cdot \ln(\text{km}_{HV} \cdot (\text{kW}_{HV} + \text{kW}_{LV})) + B)}
\]
Distribution characteristics

Relation between unit cost LV and the product $km_{LV} \cdot kW_{LV}$

\[
\ln(\text{Cost}_{LV} \text{ per kW*km}) = A \cdot \ln(km_{LV} \cdot kW_{LV}) + B
\]

\[
\ln(km_{LV} \cdot kW_{LV})
\]
Investment (VNR) and operation cost (Cexp) for 12 of the 39 companies considered

<table>
<thead>
<tr>
<th>Código empresa</th>
<th>Nombre empresa</th>
<th>VNR AT (m$)</th>
<th>VNR BT (m$)</th>
<th>CExp AT (m$)</th>
<th>CExp BT (m$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Emelari</td>
<td>5,153,988</td>
<td>7,801,464</td>
<td>1,190,883</td>
<td>1,419,617</td>
</tr>
<tr>
<td>2</td>
<td>Eliqsa</td>
<td>7,135,682</td>
<td>8,992,105</td>
<td>1,466,897</td>
<td>1,567,474</td>
</tr>
<tr>
<td>3</td>
<td>Elecda</td>
<td>14,863,113</td>
<td>19,105,397</td>
<td>2,271,316</td>
<td>2,875,336</td>
</tr>
<tr>
<td>4</td>
<td>Emelat</td>
<td>9,785,113</td>
<td>9,703,282</td>
<td>1,989,908</td>
<td>1,439,124</td>
</tr>
<tr>
<td>5</td>
<td>Emeq</td>
<td>28,575,191</td>
<td>27,794,254</td>
<td>2,937,812</td>
<td>2,697,148</td>
</tr>
<tr>
<td>6</td>
<td>Chilquinta</td>
<td>38,583,871</td>
<td>56,391,652</td>
<td>5,672,466</td>
<td>10,634,949</td>
</tr>
<tr>
<td>7</td>
<td>Conafe</td>
<td>23,093,035</td>
<td>22,692,748</td>
<td>1,626,828</td>
<td>2,728,035</td>
</tr>
<tr>
<td>8</td>
<td>Emelca</td>
<td>534,186</td>
<td>423,750</td>
<td>107,957</td>
<td>49,527</td>
</tr>
<tr>
<td>9</td>
<td>Litoral</td>
<td>2,847,422</td>
<td>4,901,432</td>
<td>299,363</td>
<td>875,181</td>
</tr>
<tr>
<td>10</td>
<td>Chilecra</td>
<td>128,030,463</td>
<td>217,238,697</td>
<td>14,196,894</td>
<td>33,451,971</td>
</tr>
<tr>
<td>11</td>
<td>Río Maipo</td>
<td>19,502,398</td>
<td>23,618,141</td>
<td>3,526,467</td>
<td>4,333,649</td>
</tr>
<tr>
<td>12</td>
<td>Colina</td>
<td>537,190</td>
<td>1,031,961</td>
<td>100,731</td>
<td>243,856</td>
</tr>
<tr>
<td>Código empresa</td>
<td>Nombre empresa</td>
<td>LRATET o km AT eq trif (km)</td>
<td>LRBET o km BT eq trif (km)</td>
<td>kW AT+BT (kW)</td>
<td>kW BT (kW)</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>-----------------------------</td>
<td>----------------------------</td>
<td>----------------</td>
<td>------------</td>
</tr>
<tr>
<td>1</td>
<td>Emelari</td>
<td>291.6</td>
<td>457.2</td>
<td>47,789.8</td>
<td>23,360.2</td>
</tr>
<tr>
<td>2</td>
<td>Eliqua</td>
<td>496.7</td>
<td>432.0</td>
<td>85,611.9</td>
<td>41,570.2</td>
</tr>
<tr>
<td>3</td>
<td>Elecda</td>
<td>545.6</td>
<td>859.3</td>
<td>148,275.5</td>
<td>90,435.1</td>
</tr>
<tr>
<td>4</td>
<td>Emelat</td>
<td>935.0</td>
<td>564.4</td>
<td>126,105.1</td>
<td>44,562.3</td>
</tr>
<tr>
<td>5</td>
<td>Emec</td>
<td>3,170.7</td>
<td>2,350.3</td>
<td>192,306.1</td>
<td>85,893.1</td>
</tr>
<tr>
<td>6</td>
<td>Chiquinta</td>
<td>2,450.5</td>
<td>3,486.3</td>
<td>362,610.8</td>
<td>183,866.0</td>
</tr>
<tr>
<td>7</td>
<td>Conafe</td>
<td>1,223.3</td>
<td>1,358.7</td>
<td>181,134.0</td>
<td>98,980.6</td>
</tr>
<tr>
<td>8</td>
<td>Emeica</td>
<td>65.5</td>
<td>47.2</td>
<td>2,459.5</td>
<td>1,894.8</td>
</tr>
<tr>
<td>9</td>
<td>Litoral</td>
<td>259.3</td>
<td>461.4</td>
<td>18,163.5</td>
<td>15,859.7</td>
</tr>
<tr>
<td>10</td>
<td>Chilecra</td>
<td>4,323.3</td>
<td>7,898.7</td>
<td>2,358,651.3</td>
<td>1,466,327.4</td>
</tr>
<tr>
<td>11</td>
<td>Rio Maipo</td>
<td>1,496.0</td>
<td>1,644.7</td>
<td>324,569.5</td>
<td>166,370.5</td>
</tr>
<tr>
<td>12</td>
<td>Colina</td>
<td>54.0</td>
<td>109.4</td>
<td>9,786.2</td>
<td>6,610.9</td>
</tr>
<tr>
<td>13</td>
<td>Total</td>
<td>7,289.4</td>
<td>16,997.7</td>
<td>1,466,327.4</td>
<td>1,466,327.4</td>
</tr>
</tbody>
</table>

Physical parameters: length of HV and LV networks, kW demand HV and LV
Structure of yardstick competition

Industry segmentation
- companies are grouped according to similar distribution costs, considering a maximum deviation
  - segments are identified

Reference company is chosen for each segment
- cost close to the group average
  - representation coverage
  - existence of previous studies

Efficiency distribution costs determined for each segment
- global industry check up

Tariffs set every four years
- indexation
2004 Chilean study

Segments and model company

Area 1:  **Chilectra**

Area 2:  Río Maipo, Emelat, **CGE**, Luzandes, Puente Alto, Eliqsa, Elecda, Conafe, Coop. Curicó.

Area 3:  Chilquinta, Emelari, Edelmag, **Emec**, Emelectric, Energía de Casablanca, Saesa.

Area 4:  Elecoop, **Colina**, Edelaysen.

Area 5:  Til Til, **Luzlinares**, Emetal, Litoral, Frontel, Luzosorno

Area 6:  Emelca, Luzparral, Socoepea, Codiner, Coopelan, **Copelec**, Coelcha, Cooprel.
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity- costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
Building the efficient company

Efficient network
- Low voltage network design
- Distribution transformer sizing
- High voltage network design

Efficient infrastructure (buildings and facilities)

Efficient management

Energy and capacity balances

Loss calculations

Use of geographical information - GIS based
LOW VOLTAGE NETWORK DESIGN

Based on identification of families of cells, electric project for sample ones, extrapolation to universe

500*500 meter cells
Conductor and transformer selection

Objective function
- minimize present value of investment, losses and depreciation.

Parameters (2004)

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study horizon</td>
<td>Years</td>
<td>15</td>
<td>N</td>
</tr>
<tr>
<td>Return rate</td>
<td>%</td>
<td>10</td>
<td>Td</td>
</tr>
<tr>
<td>Demand growth rate</td>
<td>%</td>
<td>0 to 3</td>
<td>Tc</td>
</tr>
<tr>
<td>Energy price</td>
<td>$/kWh</td>
<td>18.55</td>
<td>$E</td>
</tr>
<tr>
<td>Capacity price</td>
<td>$/kW</td>
<td>5.523,36</td>
<td>$P</td>
</tr>
</tbody>
</table>
Transformer selection

\[
\text{VAN}^i = \sum_{k=0}^{N} \frac{\text{INV}^i_k + \text{CPT}^i_{k+1} \cdot (1 - \tau) - \text{DEP}^i_{k+1} \cdot \tau}{(1 + Td)^k}
\]
Conductor selection

\[
VAN^i = \sum_{k=0}^{N} \frac{INV_k^i + CPT_{k+1}^i \cdot (1 - \tau) - DEP_{k+1}^i \cdot \tau}{(1 + Td)^k}
\]
HIGH VOLTAGE
NETWORK DESIGN

Based on computer model (Peco)
Santiago high voltage network (12 and 23 kV)
<table>
<thead>
<tr>
<th>Items</th>
<th>Unit</th>
<th>Quantity</th>
<th>Value M$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.- AERIAL NETWORK</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Km network</td>
<td>km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Poles</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Structures</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4 Electric equipment</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 Ground connections</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6 Others</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Aerial</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.- UNDERGROUND NETWORK</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Km network</td>
<td>km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Vaults</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3 Canals</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 Electric equipment</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 Ground connections</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6 Others</td>
<td>c/u</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Underground</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Company</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Quality of service requirements

<table>
<thead>
<tr>
<th>Interruption indexes</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interruption average frequency per transformer (FMIT)</td>
<td>5,0 times a year</td>
<td>7,0 times a year</td>
</tr>
<tr>
<td>Interruption average frequency per kVA, (FMTK)</td>
<td>3,5 times a year</td>
<td>5,0 times a year</td>
</tr>
<tr>
<td>Total interruption time per transformer, (TTIT)</td>
<td>22 hours a year</td>
<td>28 hours a year</td>
</tr>
<tr>
<td>Total interruption time per kVA, (TTIK)</td>
<td>13 hours a year</td>
<td>18 hours a year</td>
</tr>
</tbody>
</table>

Penalties
Compensations to consumers based on value of non served energy
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity- costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
Cost reductions (Chile)

Evolution Low Voltage Cost Area 1
Pesos of July 2004

Year

$/kW/month
Loss reductions – technical and non technical

Chilectra (Santiago, Chile)

Edesur (Buenos Aires, Argentina)
Loss reductions (Peru)

E. Zolezzi, CTE, Oct. 99
Supply coverage (Peru)

Clients increase 77% from 1992 to 2001

Ref: PA Consulting Group
Costs as determined by parties involved

Chile results 2000  - HV cost ($/KW/year)
Returns of distribution companies (Chile)
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity- costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
New methods to determine efficiency

1968 Econometric methodology (introduction of deterministic frontier models)

1977 Stochastic frontier models and stochastic frontier analysis (SFA).

1978 Data envelopment analysis (DEA) with linear programming technique.

   -establish which companies of a sample determine the envelopment area or efficient production frontier. The radial distance of a company to the frontier provides the efficiency measurement. Therefore, companies that are on the frontier (the ones that determine it) are considered efficient, while the ones that are far from the frontier are considered inefficient.

2003 DEA and Distribution Value Added
<table>
<thead>
<tr>
<th>Variables</th>
<th>Sigla</th>
<th>Unidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valor Neto retornable total</td>
<td>VNRT</td>
<td>m$*</td>
</tr>
<tr>
<td>Valor Neto retornable alta tensión</td>
<td>VNRAT</td>
<td>m$*</td>
</tr>
<tr>
<td>Valor Neto retornable baja tensión</td>
<td>VNRBT</td>
<td>m$*</td>
</tr>
<tr>
<td>Costos de explotación**</td>
<td>CEXPLT</td>
<td>m$*</td>
</tr>
<tr>
<td>Costos de explotación alta tensión</td>
<td>CEXPLAT</td>
<td>m$*</td>
</tr>
<tr>
<td>Costos de explotación baja tensión</td>
<td>CEXPLBT</td>
<td>m$*</td>
</tr>
<tr>
<td>Energía comprada</td>
<td>ECOMP</td>
<td>kWh</td>
</tr>
<tr>
<td>Energía vendida total</td>
<td>EVENDT</td>
<td>kWh</td>
</tr>
<tr>
<td>Energía vendida en alta tensión</td>
<td>EVENDAT</td>
<td>kWh</td>
</tr>
<tr>
<td>Energía vendida en baja tensión</td>
<td>EVENDBT</td>
<td>kWh</td>
</tr>
<tr>
<td>Número de comunas</td>
<td>NCOMU</td>
<td></td>
</tr>
<tr>
<td>Número de clientes</td>
<td>NCLTS</td>
<td></td>
</tr>
<tr>
<td>Longitud total de líneas</td>
<td>KMT</td>
<td>Km</td>
</tr>
<tr>
<td>Longitud de líneas en alta tensión</td>
<td>KMAT</td>
<td>Km</td>
</tr>
<tr>
<td>Longitud de líneas en baja tensión</td>
<td>KMBT</td>
<td>Km</td>
</tr>
<tr>
<td>Potencia total coincidente</td>
<td>KWT</td>
<td>KW</td>
</tr>
<tr>
<td>Potencia total coincidente en horas de punta alta tensión</td>
<td>KWAT</td>
<td>KW</td>
</tr>
<tr>
<td>Potencia total coincidente en horas de punta baja tensión</td>
<td>KWBT</td>
<td>KW</td>
</tr>
<tr>
<td>Número de trabajadores</td>
<td>NTRAB</td>
<td></td>
</tr>
<tr>
<td>Remuneraciones anuales</td>
<td>REMUN</td>
<td>m$*</td>
</tr>
<tr>
<td>Bienes muebles e inmuebles</td>
<td>BMI</td>
<td>m$*</td>
</tr>
<tr>
<td>Costo por compra de energía y potencia</td>
<td>CCOMP</td>
<td>m$*</td>
</tr>
<tr>
<td>Costos por pérdidas de energía y potencia***</td>
<td>CPERD</td>
<td>m$*</td>
</tr>
</tbody>
</table>

* : Miles de pesos del 31 de Diciembre de 1999  
** : No considera los costos por compra de energía y potencia  
*** : De acuerdo a precio monómico definido por la CNE
# VARIABLES UTILIZED IN DEA MODEL

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>VADT (1), (2), (3)</td>
<td>EVEND (1), (2), (3)</td>
</tr>
<tr>
<td>KM T (1), (2), (3)</td>
<td>KWT (1)</td>
</tr>
<tr>
<td>ENFAC (3)</td>
<td>NCLTS (1), (2), (3)</td>
</tr>
<tr>
<td>NTRAB (2), (3)</td>
<td></td>
</tr>
<tr>
<td>SALARIO (2), (3)</td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{min } \theta_p \\
\text{subject to: } \theta_p x_{ip} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0 \quad i = 1, 2, \ldots, m \\
- y_{kp} + \sum_{j=1}^{n} \lambda_j y_{kj} \geq 0 \quad k = 1, 2, \ldots, s \\
\lambda_j \geq 0 \quad j = 1, 2, \ldots, n
\]

where \(\theta_p\) is the efficiency of the electrical distribution company under evaluation.
# VAD EFFICIENCY RESULTS

<table>
<thead>
<tr>
<th>Empresa</th>
<th>Cod.</th>
<th>Modelo 1 (\theta)</th>
<th>Modelo 2 (\theta)</th>
<th>Modelo 3 (\theta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMELARI</td>
<td>1</td>
<td>67.09</td>
<td>70.56</td>
<td>83.13</td>
</tr>
<tr>
<td>ELIOSA</td>
<td>2</td>
<td>60.54</td>
<td>80.68</td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>ELECDA</td>
<td>3</td>
<td>79.71</td>
<td>98.85</td>
<td>99.96</td>
</tr>
<tr>
<td>EMELAT</td>
<td>4</td>
<td>46.97</td>
<td>43.83</td>
<td>87.51</td>
</tr>
<tr>
<td>EMEC</td>
<td>5</td>
<td>35.30</td>
<td>38.79</td>
<td>65.51</td>
</tr>
<tr>
<td>CHILQUINTA</td>
<td>6</td>
<td>60.86</td>
<td>45.65</td>
<td>51.42</td>
</tr>
<tr>
<td>CONAFE</td>
<td>7</td>
<td>54.66</td>
<td>62.88</td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>EMELCA</td>
<td>8</td>
<td>56.39</td>
<td>95.86</td>
<td>95.92</td>
</tr>
<tr>
<td>LITORAL</td>
<td>9</td>
<td>41.53</td>
<td>58.98</td>
<td>58.98</td>
</tr>
<tr>
<td>CHILECTRA</td>
<td>10</td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>RIO MAIPO</td>
<td>11</td>
<td>84.96</td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>COLINA</td>
<td>12</td>
<td>96.39</td>
<td>70.68</td>
<td>95.69</td>
</tr>
<tr>
<td>TIL TIL</td>
<td>13</td>
<td>53.60</td>
<td>53.61</td>
<td>55.24</td>
</tr>
<tr>
<td>PUENTE ALTO</td>
<td>14</td>
<td>85.89</td>
<td>85.89</td>
<td>85.89</td>
</tr>
<tr>
<td>LUZANDRES</td>
<td>15</td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>PIROQUE</td>
<td>16</td>
<td>56.89</td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>EMELECTRIC</td>
<td>17</td>
<td>26.63</td>
<td>44.32</td>
<td>45.83</td>
</tr>
<tr>
<td>CGE</td>
<td>18</td>
<td>49.59</td>
<td>68.04</td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>COOPELAN</td>
<td>21</td>
<td>22.32</td>
<td>49.44</td>
<td>49.81</td>
</tr>
<tr>
<td>FRONTEL</td>
<td>22</td>
<td>19.46</td>
<td>37.13</td>
<td>42.52</td>
</tr>
<tr>
<td>SAESA</td>
<td>23</td>
<td>29.08</td>
<td>59.69</td>
<td>70.16</td>
</tr>
<tr>
<td>EDELAYSEN</td>
<td>24</td>
<td>44.66</td>
<td>55.15</td>
<td>57.01</td>
</tr>
<tr>
<td>EDELMAG</td>
<td>25</td>
<td>58.07</td>
<td>61.39</td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>CODINER</td>
<td>26</td>
<td>23.92</td>
<td>71.49</td>
<td>71.77</td>
</tr>
<tr>
<td>ELECOOP</td>
<td>27</td>
<td>30.42</td>
<td>98.61</td>
<td>98.61</td>
</tr>
<tr>
<td>EDECSA</td>
<td>28</td>
<td>53.18</td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>COOP CURICO</td>
<td>29</td>
<td>28.91</td>
<td>81.29</td>
<td>81.96</td>
</tr>
<tr>
<td>EMETAL</td>
<td>30</td>
<td>16.21</td>
<td>96.27</td>
<td>96.27</td>
</tr>
<tr>
<td>LUZLINARES</td>
<td>31</td>
<td>21.11</td>
<td>50.76</td>
<td>55.14</td>
</tr>
<tr>
<td>LUZPARRAL</td>
<td>32</td>
<td>21.57</td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>COPELEC</td>
<td>33</td>
<td>17.77</td>
<td>30.92</td>
<td>33.92</td>
</tr>
<tr>
<td>COELCHA</td>
<td>34</td>
<td>21.72</td>
<td>47.50</td>
<td>47.50</td>
</tr>
<tr>
<td>SOCOEPA</td>
<td>35</td>
<td>38.39</td>
<td>79.17</td>
<td>79.17</td>
</tr>
<tr>
<td>COOPREL</td>
<td>36</td>
<td>50.01</td>
<td>60.96</td>
<td>60.96</td>
</tr>
<tr>
<td>CREO</td>
<td>39</td>
<td>61.06</td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
The importance of efficiency in distribution
Regulating the monopoly
The distribution activity- costs to consider
Analytical models
The building of an efficient company
Results of incentive regulation
Projections into the future (DEA, SFA, etc.)
Other elements of regulation
Other elements

**Transmission and sub transmission networks**
- efficient replacement value
- efficient model company
- centralized transmission expansion
- tariffs set every four years, indexation

**Competitive gas supply wit no price regulation**
- natural gas competing with bottled liquefied gas
- only security and quality regulated
- market power supervision