

The New Electricity Supply Industry in Argentina and Chile

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Background: The New Electricity Supply Industry

For a hundred of years electricity and its delivery were thought to be inseparable. Since the late-1980s and early-1990s things began to change. Due to diverse reasons [13] both developed and developing countries began to abandon the idea of an electricity industry vertically integrated to adopt a new model that allows competition and choice in electricity. The idea of commercial separation of electricity as a product and its delivery as a service was put in practice firstly in the U.K. The success of this change was took by other countries as an example and since that moment introduction of competition in the Electricity Supply Industry (ESI) has being taking place in many countries around the world.

The change in the ESI involves two different aspects that are very related to each other. One is *restructuring*; the other is *privatisation*.

Restructuring refers to changes in structure. It is about commercial arrangements for selling energy: separating or “unbundling” integrated industry structures and introducing competition and choice.

Privatisation is a change from government to private ownership, and is the end-point of a continuum of changes in ownership and management.

It can be considered that there are four basic ways to structure an electric industry and three different possibilities of ownership and management. [5]

In the case of structure the models are defined by the degree of competition:

- Model 1: No competition at all.
- Model 2: Requires a single buyer or purchasing agency to choose from a number of different producers, to encourage competition in generation.
- Model 3: Allows distribution companies to choose their supplier, which brings competition into generation and wholesale supply.
- Model 4: Allows all customers to choose their supplier, which implies full retail competition.

In the case of ownership and management, three different levels can be considered:

- First level: The ESI is a government department, with no separate accounts, and often with responsibilities that are only remotely connected to electricity production.
- Second level: The ESI is a distinct government-owned company, or nationalised industry.
- Third level: The ESI is a privately owned industry.

When considering the two aspects (i.e. structure and ownership) at the same time different possibilities arise. A matrix of structure and ownership/management results as shown in Fig. 1.

STRUCTURE

		<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>
O W N E R. / M A N A G.	<i>Government ownership</i>				
	<i>Public corporation</i>	Eng. & Wales Argentina Chile			
	<i>Private corporation</i>			Argentina Chile	Eng. & Wales

Fig. 1. Structure and ownership/management matrix.

The horizontal axis is competition and choice; the vertical axis is the degree of government control. Different levels of competition and choice, represented by the four models, are shown on the horizontal axis; on the left is full monopoly, on the right is full competition. On the vertical axis the dimension is the degree of government control. It starts at the top with a government department with full control, passing through a government-owned, but separate company, and ending with a privately owned company.

The countries of the world have electric industries all over this matrix. Many are moving from one place to another, but all the movement is from top to bottom, and from left to right: a reduction in government control, and an increase in competition and choice.

In Fig. 1 the cases of U.K., Argentina and Chile is represented.

In the whole process prices take a fundamental place as they must express real or true costs in order to make competitiveness work. If the market was perfect, the interaction of market forces would lead to setting the optimum assignment of resources. However, the characteristics of the ESI and the fact that transmission and distribution are natural monopolies makes the presence of a Regulator necessary. The Regulator has to establish the planning principles, the standards and the tariff structures that assure competition be able to work. In order to do that the true costs involved must be very well known and understood.

The New Electricity Supply Industry in Argentina

INDUSTRY STRUCTURE

Law N° 24065 of January 1992 (Energy Act) [8] divides the electricity industry into three sectors: generation, transmission and distribution.

The generation sector is organised on a competitive basis with independent generation companies selling their production in the Wholesale Electricity Market (WEM) or by private contracts with certain other market participants.

Transmission is organised on a regulated basis. Transmission companies are required to provide third parties access to the transmission systems they own and are authorised to collect a toll for transmission services. Transmission companies are prohibited from generating or distributing electricity.

Distribution involves the transfer of electricity from supply points of transmitters to consumers. Distribution companies operate as geographic monopolies, providing service to almost all consumers within their specific region.

Accordingly, distribution companies are regulated and are subject to service specifications. Distribution companies may buy the electricity needed to meet consumer demand in the WEM or from contracts with generation companies.

The Energy Act also recognises a class of large users, consisting of industrial customers and other users with particular electricity supply needs. Large users are divided [1, Annexe 17] in three different groups (GUMA, GUME and GUPA) in accordance to their power needs and the amount of energy contracted in the WEM.

DISPATCH AND PRICING

The Argentine electricity dispatch system is designed to ensure that the most efficiently produced electricity reaches customers.

Generation companies sell their electricity to distribution companies and other large users in the competitive WEM through supply contracts or in the spot market at prices set by CAMMESA (“Compañía Administradora del Mercado Mayorista Eléctrico Sociedad Anónima”, in english, Wholesale Electricity Market Operator Company).

CAMMESA shareholders are the generation, transmission and distribution companies, large users (through their respective associations) and the SE (“Secretaría de Energía”, in english, Secretariat Energy).

All generation companies in the SIN (“Sistema Interconectado Nacional”, in english, National Interconnected System) pool electricity in the WEM. Electricity is purchased from participants in the pool by distribution companies and other large users at the contractual, seasonal, or spot price.

The contractual price is paid by distribution companies and other large users that have entered into supply contracts with generation companies. Large users who contract directly with generation companies must also pay the distribution companies a toll for the use of the distribution network (Distribution use of system charges, DUS charges). The seasonal price is the price paid by distribution companies for electricity from the pool and is a fixed price reset every six months by CAMMESA and approved by the SE accordingly to supply, demand, available capacity and other factors. The seasonal price is maintained for at least 90 days. Thereafter, CAMMESA updates assumptions underlying the models employed to establish the seasonal price based on current data and results provided by companies that are members of the WEM. If the SE finds significant variance among current and prior data, it may modify the seasonal price through a resolution.

The spot price is an hourly price paid for energy and reflects the marginal cost of generation.

The actual operation of CAMMESA involves the dispatch of generating resources without regard to the contracts among generation companies and distribution companies or large users. Consequently, a generation company's capacity may be dispatched to provide more or less energy to the pool irrespective of its contractual commitments. Under these circumstances, the generation company will be obliged to buy or sell excess energy from or to the pool at spot prices.

In Fig. 2, the various possibilities of trading electricity in the WEM are shown [2]. The diagram also shows how the imbalances are traded in the market.

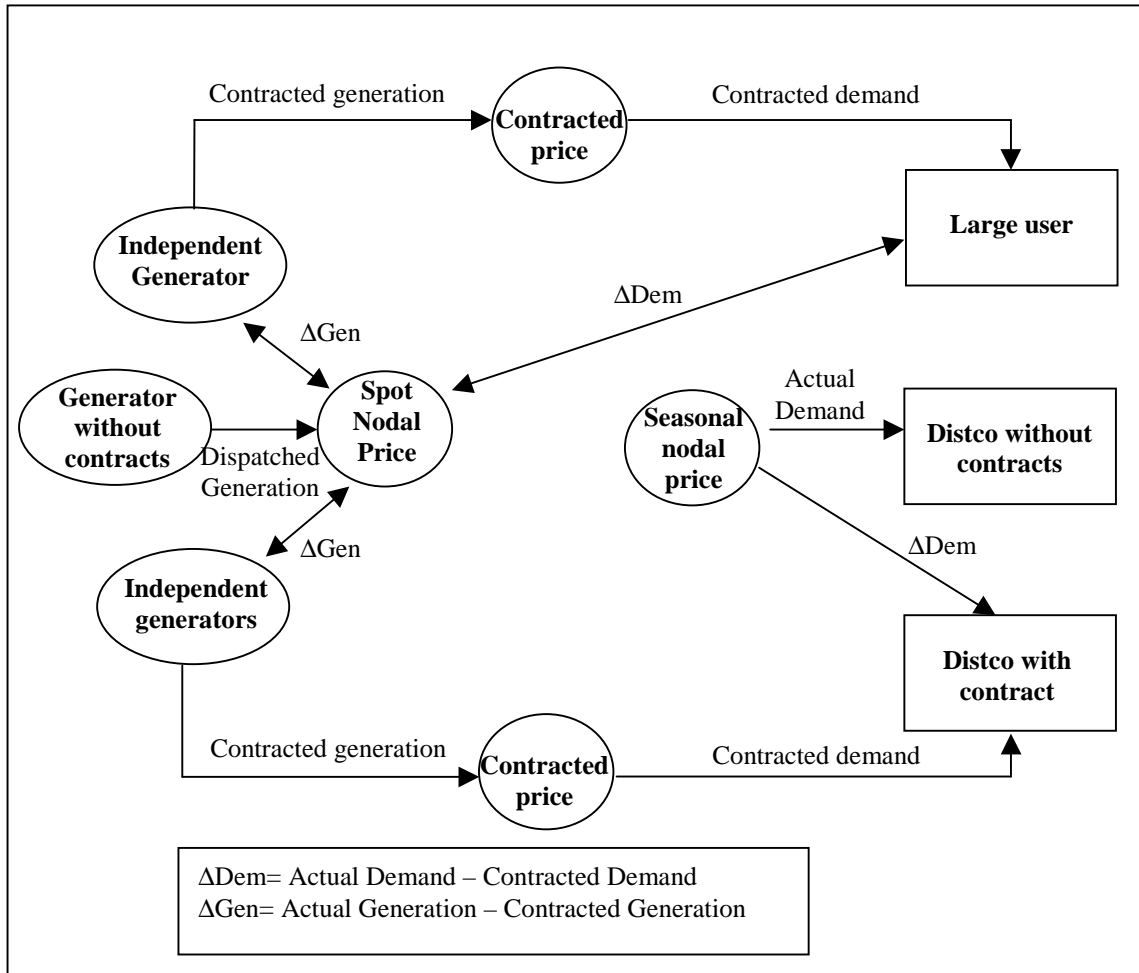


Fig. 2. Argentina: Trading prices in the WEM.

There is a Stabilisation Account that is constituted from the differences between the revenue due to the energy purchased to CAMMESA and the expenditure due to the energy sold to CAMMESA.

THE PRICE SYSTEM

Nodal Factors and Adaptation Factors

The type of pricing used by the Argentine WEM is nodal pricing.

At each node there is a price for the energy and a price for the capacity [1, Annexe 3].

The price for the energy at each node is calculated multiplying the price for the energy at the market, PM (“Precio Mercado”, in english, Market Price) by the FN (“Factor de Nodo”, in english, Nodal Factor).

The price for the capacity at each node is calculated multiplying the price for the capacity at the market, \$PPAD (“Potencia Puesta a Disposición en el Mercado”, in english, Capacity Made Available at the Market) by the FA (“Factor de Adaptación”, in english, Adaptation Factor).

The FN at node i is calculated as:

$$FN_i = 1 + \frac{d(Losses)}{d(Pdi)}$$

where:

$\frac{d(Losses)}{d(Pdi)}$ is the derivative of the system transport losses ($Losses$) with respect to the power demanded at node i (Pdi).

In order to calculate the FN at node i a power flow programme is used simulating a unity variation of demand at i ($d(Pdi)$) and calculating the variation in system losses ($d(Losses)$). The slack busbar for this calculation is the WEM node (market place) or the market local node (“centre of load masses”) for an area not electrically linked to the market. An area may result not linked to the market due to a system constraint. For this cases, the nodal factor of node i (FN_i) with respect to the WEM node is calculated

multiplying the nodal factor of i with respect to the market local node (FNL_i) by the nodal factor of the local market node with respect to the WEM node (FNL), i.e.:

$$FN_i = FNL_i \times FNL$$

where,

FN_i is the nodal factor of node i with respect to the WEM node.

FNL_i is the nodal factor of node i with respect to the local market node.

FNL is the nodal factor of the local market node with respect to the WEM node when no constraints are present (as defined in [The Procedures, Annexe 3, item 2.1]).

As a result, the price for energy at node i is:

$$PN_i = PM \times FN_i$$

CAMMESA calculates hourly nodal factors and seasonal nodal factors in accordance to [1, Annexe 3, Item 2.2]

With the previous considerations, PM results to be the generation marginal cost including transport (which is considered from contribution to system losses), evaluated at the market place. In addition, nodal factors represent the losses marginal cost associated to the link between the market place and the node.

FA is defined as the ratio between the price for the capacity at node i and the price for the capacity at the WEM node, when node i is linked to the WEM node without constraints.

The adaptation factor for a node i takes into account the reliability of the link between the market place and node i .

Due to failures in the transmission network, consumers at different nodes may experience cuts in the power supplied. This situation produces an increment in

marginal prices at those nodes when considering the value of ENS (Energy Not Supplied).

The FA at node i considers the over-costs produced to the consumers at the receptor nodes when a failure in the transmission system occurs.

Two types of failures are considered:

- Long duration failures.
- Short duration failures.

Each type of failure has an associated over-cost defined as follows:

- SCLD_1 (“Sobrecostos producidos por fallas de larga duración en alta tensión de una línea l ”, in english, Over-costs produced due to long duration failures in HV of a line l).
- SCCD_1 (“Sobrecostos producidos por fallas de corta duración en alta tensión de una línea l ”, in english, Over-costs produced due to short duration failures in HV of a line l).

During the Summer Seasonal Programming, CAMMESA calculates the annual over-costs due to long duration failures and short duration failures (SCLDE_1 and SCCDE_1 respectively) for each line l . These over-costs are calculated averaging the expected over-costs for the next four seasonal periods, as follows,

$$SCLDE_l = \frac{\sum_p SCLDE_l, p}{2}$$
$$SCCDE_l = \frac{\sum_p SCCDE_l, p}{2}$$

where,

$SCLDE_l, p$ is the over-cost due to large duration failures of line l during seasonal period p calculated in accordance to [1, Annexe 3, Item 3.1.1].

$SCCDE_l, p$ is the over-cost due to short duration failures of line l during seasonal period p calculated in accordance to [1, Annexe 3, Item 3.1.2].

Note: Each seasonal period corresponds to a 6 month period. One is the summer seasonal period and the other is the winter seasonal period.

The over-price due to transmission system reliability ($IPCONST_l$) reflects the annual over-costs due to large and short duration failures per unit power linked through line l . $IPCONST_l$ is calculated as follows,

$$IPCONST_l = \frac{(SCLDE_l + SCCDE_l)}{(PMPT_l)(NHFV)}$$

where,

$NHFV$ are the number of non-valley hours during the working days in the two seasonal periods considered.

$PMPT_l$ is the average power linked through line l , calculated in accordance to [1, Annexe 3, Item 3.1.3].

The price for capacity at node i ($\$PPAD_i$) is calculated adding the total over-price at node i due to transmission system reliability to the price for capacity at the market ($\$PPAD$):

$$\$PPAD_i = \$PPAD + \sum_l IPCONST_i_l$$

where,

$IPCONST_i_l$ is the over-price due to transmission system reliability at node i . When line l is out of order, node i keeps linked to the market with constraints.

Then, using the previous definitions, the adaptation factor at node i is calculated as follows,

$$FA_i = 1 + \frac{\sum_l IPCONST_i_l}{\$PPAD}$$

Payments to generators

Generators are paid for the energy produced when dispatched and also for the capacity made available and accepted by CAMMESA.

The payments the generators receive for the hourly energy is given by the marginal cost of producing and transporting the next MWh to the market place. Thus, generators receive, for the energy produced, the nodal price at the busbar they are connected to.

During the weeks with failure risk an overprice is paid (SPRF) for the energy generated during the working days at peak hours [2]:

$$SPRF = \frac{ENS}{D} \times (CENS - PM)$$

where:

SPRF is the overprice due to failure risk

ENS is the probable energy not supplied.

D is the forecasted demand.

CENS is the cost of the energy not supplied.

PM is the market price.

The payments for capacity are done over the working days at peak hours.

During the weeks without failure risk, CAMMESA organises a price competition between generators. The result are the generators which will remain as cold reserve. The price for capacity is paid to all the available generators scheduled and to all the generators that provide reserve.

Seasonal Prices for Distcos

The prices for distribution companies are calculated for seasonal periods of 6 months duration.

One period correspond to winter-spring with high contribution of hydroelectric energy. The other period correspond to summer-autumn with low contribution of hydroelectric energy.

These prices remain fixed during the first 3 months of the period. If at the end of the trimester there are differences with respect to the original hypothesis considered in the Seasonal Programming, the SE could modify the prices for the remaining period.

In order to determine the Seasonal Prices CAMMESA uses optimisation models calculating the optimum hydrothermal energy dispatch. The database used is provided and agreed among the WEM members.

In addition, the service quality is agreed with the Distcos. From the service quality agreed, the reserve requirements and correspondent costs are obtained.

The result of the Seasonal Programming is the price of energy for each Distco, determined for each tariff period; e.g. peak, valley and remaining period. These prices are the weighted averages, for each week, of the PM plus the differences for the energy valued at a different price (local prices, operation costs, etc.), modified using the nodal and adaptation factors.

On the other hand, an estimation of the SPRF is also obtained.

Integrating the payments for the \$PPAD and the SPRF over the period, the capacity payments for the Distco in the seasonal period may be calculated.

The seasonal price for the capacity of each Distco is defined as a fixed monthly payment. For the calculation, two facts are taken into account:

1. The power contracted by the Distco.
2. The total payments forecasted in one semester for the PPAD paid to generators.

The tariff for distribution companies consists in two terms:

- an unique energy price for each tariff period for the whole semester.
- a fixed charge for capacity.

TRANSMISSION TARIFFS

The transmission tariff that must be paid by entities engaged in generation and distribution activities and by large users can be broken down into:

1. A connection charge that underwrites the costs of operating the equipment that links them to the transmission system.
2. A transport capacity charge that corresponds to the payments associated to operation and maintenance of the equipment used for the electricity transport service.
3. A charge based on the aggregate amount of electric energy transported which is calculated from the difference of the value of the energy at the receiving busbar and the value of the energy at the sending busbar.

DISTRIBUTION TARIFFS FOR FINAL CUSTOMERS

Retail tariffs for the biggest distribution companies (EDENOR, EDESUR and EDELAP), which represent the 44 % of the electricity market, are established by indexed rate formulas in their concession contracts for an initial five-year period. They are based on the sum of the nodal price and the VAD (“Valor Agregado de la Distribución”, in english, Value for the distribution service).

The VAD are set to cover the distribution system operating costs, taxes, and amortisation.

The VAD incorporates a rate of return to encourage the enterprise's efficiency, as well as an investment return expected for activities with parallel levels of risk.

Penalties are applied for failure to meet established quality of distribution service criteria.

The ENRE (“Ente Nacional Regulador de Electricidad”, in english, National Electricity Regulator) oversees these tariffs and will apply new tariff formulas based on defined criteria once the five-year period is over.

Provincial authorities set tariffs for distribution utilities in their jurisdiction according to economic criteria promoted by sector reforms at this level. Before the reforms, retail

tariffs in the provinces have historically been subjected to a political, rather than an economic basis.

THE ELECTRIC SYSTEM

Power System overview

By the end of 1998, Argentina had an installed capacity of 23046 MW with a total electricity generation of 68460 GWh during the year [15]. Electricity consumption in that same year was 64711 GWh growing 5 % from the previous year [6].

Planners expect electricity demand will continue to grow at the same average annual rate during the next decade. The capacity additions contemplated for the coming years are mostly thermal, using natural gas-fired plants.

Electricity service covers around 95 % of the total population, but the level of electrification in isolated areas is only around 70 % [6].

The MEM (“Mercado Eléctrico Mayorista”, in english, Wholesale electricity market) is the largest system in the country with a total installed capacity of 19271 MW in 1998 [15].

The MEMSP (“Mercado Eléctrico Mayorista del Sur de Patagonia”, in english Southern Patagonia wholesale electricity market) operates the southern region and had an installed capacity of 831 MW in 1998 [15].

Participants and Degree of Private Sector Participation

Generation

There are currently forty generating companies in the MEM and four in the MEMSP. Except for bi-national projects (Yaciretá, Salto Grande), the commercial nuclear enterprise (ENASA), and minor plants owned by provincial utilities and co-operatives, virtually all generation in the country is in private hands. Foreign investors hold a major ownership stake in these units. There are also various co-generators and auto-generators in both regions.

Transmission

The transmission activity in Argentina is subdivided into two systems: The High Voltage Transmission System (STEEAT), which operates at 500 kV and transports electricity between regions, and the regional transmission systems (STEEDT), which operate at 132 / 220 kV and connect generators, distributors and large users within the same region.

TRANSENER is the biggest company of the STEEAT, and five regional companies are located within the STEEDT (TRANSNOA, TRANSNEA, TRANSPA, TRANSCOMAHUE and DISTROCUYO). In addition to these companies, there are also provincial transmission companies and independent transmission companies. These companies operate under a technical license provided by TRANSENER, which in turn will make their assets available in the MEM in exchange for an established fee.

Retail Distribution

The three distribution companies divested from SEGBA (EDENOR, EDESUR and EDELAP) represent 44 % of the electricity market in Argentina. Including the companies divested from some regional utilities (Entre Rios, San Luis, Córdoba, Mendoza, Formosa, Santiago del Estero, Tucumán, Río Negro, Catamarca, Misiones, Jujuy and Santafe), private participation in the distribution market has increased to 60 %. The remaining distribution companies have remained in the hands of the provincial governments, but this ownership structure is expected to change with the expansion of the new regulatory framework to the different regions of the country.

Sectors problems after de-regulation

Some observations have been made on the problems arisen after de-regulation [6]:

- Some confusion and lack of confidence regarding the ability of the current transmission pricing system's ability to provide incentives for new investment in capacity is a critical issue of debate. The transmission system has experienced some bottlenecks, but the regulatory entity has not yet actuate to allocate the responsibility for expansion or allocate costs among the relevant interest groups. Therefore,

investors are reluctant to build new facilities. The SE has established a fund to support an emergency expansion of the system to relief the immediate pressure.

- The impact of sustained, low spot prices on the wholesale market may have a negative impact on generating companies' financial health and interest in new investments because the capacity charges may not adequately reflect long run marginal costs for supply. Nevertheless, this condition will disappear if demand increases, including export to other countries.
- Undertaking restructuring and privatisation of the provincial utilities is occurring at an uneven pace due to the local governments reluctance to lose (as they perceive it) a ready-made source of revenues.
- The prolonged blackout that has occurred in Buenos Aires have raised questions about the operating conditions of the privatised distribution companies. The overseeing and penalty procedures affecting the distribution companies should be as strict as possible, guaranteeing that the concessions are following the contracts that they signed.

The New Electricity Supply Industry in Chile

INDUSTRY STRUCTURE

Law DFL N° 1 from 1982 (Energy Act) [9] divides the electricity industry into three sectors: generation, transmission and distribution.

There is competition in generation but no competition in transmission and distribution.

Transmission and distribution businesses are regulated because of their inner characteristic of being natural monopolies.

The electricity companies are subject to regulation of its prices and other aspects of its business in Chile under the Chilean Electricity Law. Three government entities have primary responsibility for the implementation and enforcement of the Chilean Electricity Law.

CNE (“Comisión Nacional de Energía”, in english, National Commission of Energy) has authority to set tariffs and node prices and to prepare the Indicative Plan, a 10 year guide for the expansion strategy of the electric system.

SEC (“Superintendencia de Electricidad y Combustibles”, in english, Secretariat of Electricity and Fuels) sets and enforces the technical standards of the system.

In addition, the Ministry of Economy grants final approval of tariffs and node prices set by CNE and regulates the granting of concessions to electric generation, transmission and distribution companies.

The sector is almost completely unbundled vertically and horizontally, though legally the functional separation of commercial activities is not required. However, major concerns persist regarding horizontal and vertical integration [6]. The ownership of the SIC (“Sistema Interconectado Central”, in english, Central Interconnected System) is under a corporate entity, TRANSELEC, which has the same shareholders as ENDESA, the largest generator in the region. In addition, ENERSIS, the holding company for the largest distribution company in Chile, owns around 25 % of ENDESA’s shares.

DISPATCH AND PRICING

The Chilean power network consists of two systems, the SIC, which includes the capital Santiago and its surroundings, and the SING (“Sistema Interconectado del Norte Grande”, in english, Great Northern Interconnected System), which supplies the mining region in the north. These two systems are not interconnected to each other and the SIC has approximately three times the installed capacity of the SING. There are also various small interconnected systems in the south.

There is a CDEC (“Centro de Despacho Económico de Carga”, in english, Centre for Economic Load Dispatch) for each system. The CDEC co-ordinates the operation of the corresponding interconnected system. For example, there is one CDEC for the SIC and an one CDEC for the SING. Any other electricity system with more than 100 MW of installed capacity must have its own CDEC. Each CDEC is controlled by the largest generators of the system where that CDEC operate.

The SIC and the SING are intended to be near perfect markets for the sale of electricity in which the lowest marginal cost producer is used to satisfy demand before the next lowest marginal cost producer is dispatched. As a result, at any specific level of demand, the appropriate supply will be provided at the lowest possible cost of production available in the system.

Generation companies meet their contractual sales requirements with dispatched electricity, whether produced by them or purchased by them in the spot market. A generation company may be required to purchase or sell energy or capacity in the spot market at any time depending upon its contractual requirements in relation to the amount of electricity from such company to be dispatched. Purchases and sales made in the spot market are traded at the “spot marginal cost” of the interconnected system in which the companies are located, which is the marginal cost of the last generation facility to be dispatched.

Sales to distribution companies for resale to regulated customers (customers which demand for capacity is equal or less then 2 MW) must be made at the nodal seasonal prices. Two nodal prices are paid by distribution companies: nodal prices for peak capacity and nodal prices for energy.

Nodal prices for peak capacity and energy consumption are established every six months.

Sales to unregulated customers (customers with demand for capacity of more than 2 MW), whether directly by a generation company or through a distribution company for consumption by such distribution company's customers, are not regulated and are made at negotiated prices.

In Fig. 3, the various possibilities of trading electricity in the WEM are shown. The diagram also shows how the imbalances are traded in the market.

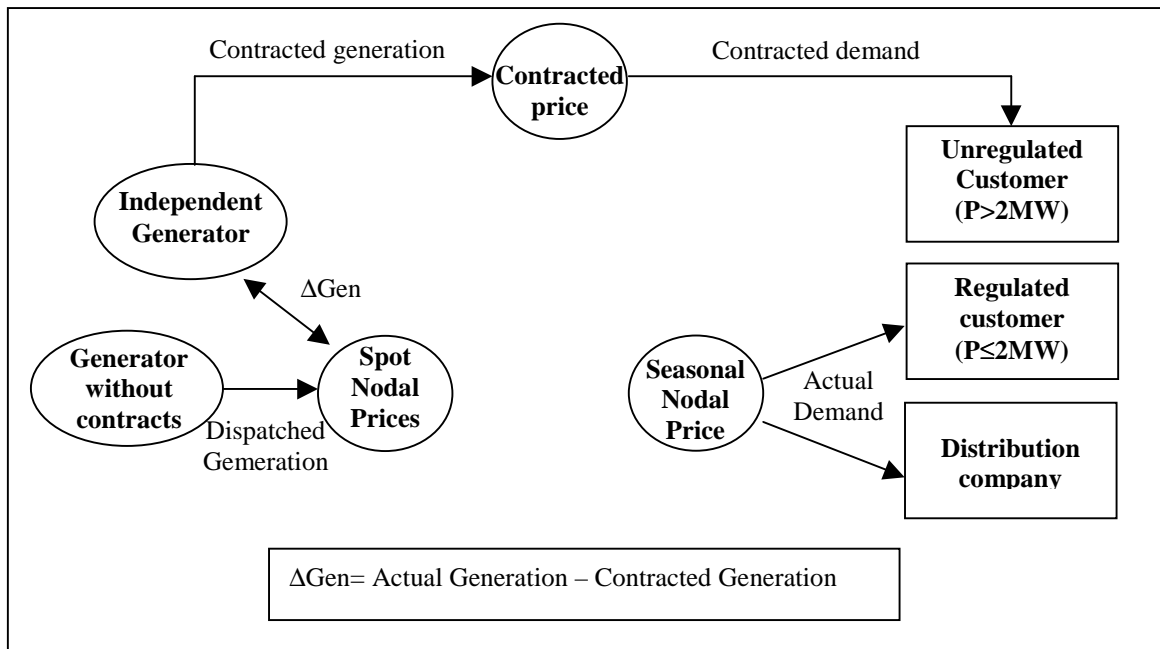


Fig. 3. Chile: Trading prices in the WEM.

PRICE SYSTEM

The type of pricing used in Chile is Nodal Pricing.

CNE must calculate nodal prices at each relevant substation where distribution companies are connected to the system. This calculation is done every six months.

Nodal Prices have two components: Nodal Price for Energy and Nodal Price for Peak Capacity [9].

Basic Prices for Energy

In order to calculate Nodal Prices for Energy, CNE determine Basic Prices for Energy at one or more reference substations known as Basic Energy Substations. These substations are chosen taken into account:

- Geographical location of marginal generators.
- Sectors of the transmission system where relevant transfers of power occur.
- Demand busbars (busbars where demand is greater than local offer of energy).
- Local demand at the substation compared to total demand.

Basic Prices for Energy are then calculated at the Basic Energy Substations using the expression:

$$P_b = \frac{\sum_{i=1}^{i=N} (CMG_i \cdot D_i) / (1+T)^i}{\sum_{i=1}^{i=N} (D_i) / (1+T)^i} \quad (\text{Art. 275, DS N}^\circ 327 [10])$$

where:

N correspond to the total amount of periods of equal duration considered (which its summation results in between 24 and 48 months).

T is the equivalent rate for each period considering an annual capital cost of 10%.

CMG_i is the expected marginal cost of energy at basic energy substations at period i (average system cost of providing an additional unit of energy at the substation considered, with optimal system operation).

D_i is the expected demand at period i .

Expected marginal costs of energy result from an optimisation that minimises the summation of the actualised operation and rationing cost during the period of study.

Basic Prices for Peak Capacity

In order to calculate Nodal Prices for Peak Capacity, CNE determine Basic Prices for Peak Capacity at one or more substations. In order to achieve that, CNE determine the most economic units that could provide additional power during the hours of peak demand.

The Basic Price for Peak Capacity will be equal to the annual marginal cost of increasing system capacity using that type of units. For the calculation a percentage equal to the theoretical reserve margin is added to system capacity.

Nodal Prices

CNE calculates Nodal Prices for Energy, at the relevant substations of the electric system, multiplying Basic Prices for Energy by an Energy Penalisation Factor.

In the same way, CNE calculates Nodal Prices for Peak Capacity, at the relevant substations of the electric system, multiplying Basic Prices for Peak Capacity by a Capacity Penalisation Factor.

The calculation of the penalisation factors is done considering the marginal losses of energy and peak capacity transmission respectively using the economical adapted system.

Node prices must fall within 10 % of deregulated prices.

Trading of energy between generators

Transfers of energy between generators are done at spot prices taking into account marginal cost of energy and marginal cost of peak capacity.

The marginal cost of peak capacity (CMgP) is calculated using:

$$CMgP = \frac{CMCG}{DUPA}$$

where,

CMCG is the annual marginal cost of increasing the actual generating capacity of the electric system.

DUPA is the annual availability of the most economic units that could provide additional capacity during the hours of annual peak demand of the electric system.

The marginal cost of energy is the average system cost of providing an additional unit of energy at the substation considered, with optimal system operation.

It results from an optimisation that minimises the summation of the actualised operation and rationing cost during the period of study.

TRANSMISSION TARIFFS

As transmission companies' assets were constructed through concessions granted by the Chilean government, the Chilean Electricity Law requires such companies to operate the covered transmission system on an "open access" basis. New users may obtain access to the system by participating in the investment to expand the system.

Law DFL N° 1 [9] allows transmission enterprises to receive an income which covers the long run annualised average costs (investment, operation and maintenance) for economically adapted system operations, as well as a return.

The transmission tariff has basically, two components:

1. Marginal revenue.
2. Basic toll.

The marginal revenue is the resulting amount of money for differences between nodal prices (nodal price at the generator busbar and nodal price at the buyer busbar).

The basic toll results from the summation of the O&M costs and investment costs of the network involved in the service.

Additional tolls are paid in the case that the generator asks to withdraw electricity from nodes different to those agreed for the basic toll.

As needed, a commission comprising representatives of both transaction parties is formed to solve disputes over the service or fees.

DISTRIBUTION TARIFFS TO FINAL CUSTOMERS

Retail tariffs for regulated end-consumers are obtained by adding the VAD to the node price for energy and capacity. Periodic tariff adjustments according to established criteria are allowed for distribution companies to change nodal prices.

The VAD is based on costs for a model distribution enterprise operating in a similar type zone (i.e., of similar density and other features) established for 4 year periods through CNE authorised consultant studies.

The VAD incorporates [9, Article N° 106]:

- Fixed costs for administration, billing and customer service expenses.
- Standard investment costs and, operating and maintenance (O&M) costs for distribution per unit of power supplied.

The annual investment costs are calculated using the VNR ("Valor Nuevo de Reemplazo", in english, New Replacement Value) considering the facilities adapted to the demand, the network life and an annual discount rate of 10 %.

The VNR for the installations of a distribution company given in concession is defined in Article N° 116 of DFL N° 1 [9] as the cost to renew all the works, facilities and physical goods dedicated to provide the distribution service in that concession. The VNR is re-calculated every 4 years.

- Mean distribution losses in power and energy.

The indicated components are calculated for a specific number of standard distribution zones determined by the CNE, previous deliberation with the companies. These standard zones represent distinctive distribution densities (high density, urban, semi-rural and rural).

In the Chilean regulation model [14], there is a hybrid-benchmarking scheme between different companies. On one hand, groups of companies of similar characteristics are compared with a model company, identified through typical zones. Then, the performance of heterogeneous companies is compared in an integrated manner, with an assessment of the global adequacy of the industry with a single standard. In the former case and through a theoretical model and through direct comparison, efforts are made to provide the efficiency signal to similar companies and in the latter case efforts are made to produce a horizontal comparison that fits the theoretical model with the average reality of heterogeneous companies.

To prevent a theoretical approach, the regulation specifies that the cost study of the model company for each typical zone will be based on an efficiency assumption in the investment policies and in the management of a distributing company operating in the country [9, Article N° 107]. Consequently, the analysis is limited to a model company that works in an environment similar to the one existing in reality and that it faces the same restrictions.

The methodology to determine the model company and the steps to be followed in the analysis can be essentially grouped in four stages [14]:

1. In the first stage, the information of the real company is collected and validated.
2. In the second stage, the efficient company and its organisation structure is defined and dimensioned.
3. In the third stage, the costs and their allocation to three fields (high voltage, low voltage and customers) are determined.
4. In the fourth stage, the VAD and the corresponding adjustment indexes to be used in the following four years is determined, together with the identification of special circumstances.

The global rate of return is set to a level between 6 % and 14 % [6]. The pricing mechanism does not include either quality of service issues or financial penalties.

THE ELECTRIC SYSTEM

Power System overview

Total installed capacity in Chile was 7858 MW in 1998 [6]. Electricity generation and demand were 33417 GWh and 29180 GWh respectively, which represents 12.7 % in losses. Growth in electricity demand has been steady at 7 % per year. More than 95 % of the population has electricity service. Since the entrance of the new gas pipelines from Argentina, most capacity additions have been gas fired combine cycle. As it was previously said, the Chilean power network consists of two big systems, the SIC and the SING, and also various small independent systems.

Participants and Degree of Private Sector Participation

Generation

Private generators, including self-generators, represent about 90 % of the nationally installed generating capacity. There are 11 main generating companies, under private (majority) ownership.

Ten private generators supply electricity in the SIC. The largest generator, the privately owned ENDESA and its subsidiary PEHUENCHE, own over 60 % of the SIC's installed capacity and supplies 65 % or so of the system's total generation. GENER is the second largest generator, with around 1600 MW of installed (mostly thermal) capacity, holding around 24 % of the market. GENER's affiliate GUACOLDA S.A. is building another 300 MW of capacity with COCAR. The third generator is COLBUN-MACHICURA, which owns two hydro stations with a combined installed capacity of 560 MW (15 % of the market). Smaller private generators in the SIC include the GUARDIA VIEJA, PULLINQUE and PILMAIQUEN plants.

EDELNOR is a privately owned vertically integrated utility with 277 MW of installed capacity. It also owns (with CODELCO, a copper mining company) and operates the SING.

CHILGENER's SING affiliate, NORGENER S.A. owns the 274 MW Nuevo Tocopilla plant. The 614 MW Tocopilla plant, the largest plant in the SING, belongs to the state owned copper mining company (CODELCO) and to a holding company composed of CODELCO and a private consortium consisting of TRACTEBEL (Belgium), IBERDROLA (Spain), and ENAGAS (Chile). In early 1996, this consortium bought the controlling 26% interest in the plant through the holding company. ENDESA owns 73 MW of installed capacity in the SING. Like CODELCO, many of the major mining industries located in the SING have considerable self-generating capacity, which they developed prior to the power sector reform.

Transmission

TRANSELEC was created as an ENDESA affiliate in order to own and operate the SIC's transmission assets when they were spun off from ENDESA in March 1993. This new entity aimed to provide more transparency and alleviate concerns about the generator's potential for self-dealing transmission access on a priority basis.

TRANSELEC's shareholders were initially the same as ENDESA's shareholders, but are evolving independently over time with changing investor interests.

EDELNOR, through its subsidiary, SITRANOR, owns and operates the transmission system of the SING.

Retail Distribution

There are a total of 23 distribution utilities in Chile. ENERSIS is the holding company for the largest distribution utility, CHILECTRA, which serves the Santiago metropolitan area (roughly 40 % of the total retail market). CHILECTRA and CHILQUINTA are the largest of the 17 investor-owned distribution utilities operating in the SIC. There are also very important companies like CGE, EMEL and SAESA which have been growing up very fast specially geographically over their concessions. EDELNOR and two smaller distribution utilities provide distribution service in the SING.

Generally, small vertically integrated companies under private ownership provide distribution service in the smaller, isolated systems (EDELAYSAN, EDELMAG).

There are also three small municipal utilities and a few electric co-operatives supplying retail electricity service in remote areas.

Sectors problems after de-regulation

Some observations have been made on the problems arisen after de-regulation [6]:

- There are doubts regarding the independence of the CNE because of Ministerial involvement, insufficient staffing and expertise, and also because the regulatory role of the CNE is not absolute depending on the Ministries and the SEC. In addition, the regulatory agencies face difficulties in obtaining the necessary level of detailed information from sector enterprises, particularly regarding costs, which may cause difficulties in their ability to perform effectively on issues dealing with pricing and competition.
- As the long-term projections showed a reduction in the node prices, both in the SIC and in the SING, generators began to be concerned regarding their investments.
- There is concern about competition and the feeling that greater competition could lead to decrease benefits. These limiting factors on competition ultimately have an impact on new investments, economic cost of service, quality of service, and end-consumer options and prices.

For instance, limiting factors include:

- ENDESA 's market power, as a single generator has been too overwhelming, representing more than 60 % of the capacity and 65 % of the generation in the SIC.
 - The exclusion of smaller generators as members of the CDEC committee (e.g., in the SIC, only the 5 largest generators are represented) has raised other issues on fair competition, pricing and rulemaking.
 - The coupling of the ownership and operation of the main transmission system with ENDESA 's dominant generating capacity has led to major concerns about the transparency and fairness of ENDESA 's marketing and wheeling terms.
- The pricing in the de-regulated market, representing about 27 % of total demand, is seen as being constrained by the regulated bulk power prices, whereas the node prices cannot vary by more than 10 % of the de-regulated prices.

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