Restructuring in South America: successes and failures

Governments in Latin America have pioneered reforms in electricity markets. The changes started taking place in 1982, when Chile formalized an electric power reorganization, with other countries following suit in the 1990s. These reforms have not been trouble-free, and insights gained and problems identified in the operation of the markets, transmission access and distribution pricing are outlined here.

Professor Hugh Rudnick
Chairman, EBRD, Russia

Latin America is a region in political and economical transition, with a growing tendency to open economies and democratic governments. The debt crisis is coming to an end, irrespective of dramatic but transient slow downs like that of Mexico. Significant economic reforms are creating growth, and the USA and Europe are investing in the region, partly as an alternative to the troubled South East Asia economies.

A further development is the contribution of new international agreements to economic development. Among them is the Mercosur pact, that created a market of 300 million people over a area of 12 million square kilometres, incorporating Argentina, Brazil, Paraguay, Uruguay plus Bolivia and Chile.

The electricity industry in Latin America has faced a profound transformation, with no parallel worldwide. New electric sector regulations were introduced in Chile in 1982, Argentina in 1992, Peru in 1993, Bolivia and Colombia in 1994, and the Central American countries of Panama, El Salvador, Guatemala, Nicaragua, Costa Rica and Honduras in 1997. Brazil is also joining the group and Venezuela and Ecuador have initiated reforms.

The diversity in the size of countries and power demand is striking – Brazil has a population of 160 million and an installed capacity of 58,000 MW, while Bolivia has 4.4 million people and 396 MW – but all are following similar paths for reform.

HISTORICAL DEVELOPMENT
Electric power was introduced in Latin America soon after electric light was inaugurated in New York City and London at the end of last century. Initially the power sector developed based on private investment, with no special regulation. During the economic depression of the ‘30s, private investment dried up throughout the region, to the detriment of electricity supply to cities, industry, and mining. In most countries, the governments seized the initiative and from the ‘40s to the end of the ‘70s put aggressive electrification programs into effect. Electrification in Brazil, Endesa in Chile, Electrorural in Peru, ISA in Colombia, CFE in Mexico and ENDE in Bolivia were among the national electricity companies that were created.

In general, power system development was concentrated in the hands of private companies, and they built hydropower plants and transmission lines tying previously isolated networks into interconnected systems. Private firms still exist, but mostly at the electricity distribution level in the main metropolitan areas. In most countries, however, the state-owned, vertically integrated electricity monopolies failed in the end to adequately manage the electricity business and diverse technical and financial problems became endemic.

Oversization in the Argentinean electricity system was accompanied by a severe deterioration of the electricity service under state supervision. In Colombia, prolonged power rationing had to be introduced because of droughts caused by El Niño. In Brazil, a financial downturn halted public investment in the power system, in an economy with increasing energy needs. Meanwhile, in Bolivia and Peru, government agencies were failing to raise sufficient funds for their electricity sectors, yet at the same time subsidizing rates for poor users. A similar situation is present in Venezuela and the Central American countries.

POWER MARKET REFORMS

The reasons for deregulation in Latin America vary, but must have been essentially economic or political, fired by the endemic problems indicated above.

Free-market ideas gained currency, starting in Chile, and gave rise to the notion that government control over the economy should be reduced and the role of the private sector enhanced. Market forces are recognized as a basic mechanism in the correct allocation of resources in the electricity sector, with competition being welcome wherever it can take place. Breaking up, decentralizing, and finally privatizing electricity companies has been recognized as necessary for the efficiency and stability of the system.

Speeding up the process, international lending banks, the World Bank included, started making loans conditional on the initiation of privatization or deregulation processes.

It has been recognized that generation, transmission, and distribution each have different economic characteristics. Generation is the sector where a competitive environment can be stimulated. The drive for deregulation has been emphasized. In spite of that, the South American countries chose to force the unrestricted generation markets into a competitive equilibrium by creating independent coordination pools that are responsible for both the physical operation and the clearing of the market.

To complicate the deregulation process, neither electricity transmission nor distribution can be classified as perfectly competitive or contestable markets. A re-regulation process has arisen, aiming to stimulate efficient behavior of companies in those monopolistic activities.

Transmission, because of both lumpy investments and the need for redundancies to meet security requirements, is recognized as a part of the chain where there are economies of scale. Power lines with higher nominal voltage and transmission capacity have a lower average cost per unit of power and per kilometre transmitted. The need to regulate an intrinsically monopolistic activity arises, because the transmission system is the instrument for competition among geographically dispersed generators.

Finally, distribution has clear economies of scope or density, where one distribution network can provide a cheaper service than two or more networks serving a single area. Regulation gives geographical concessions to distribution companies that must supply electricity to all consumers in the area, with regulated tariffs and quality.

With this knowledge, several Latin American countries have developed new legal and regulatory frameworks for the electricity sector. Explicit separation of the three businesses has been defined, making room for competition where possible and stimulating efficiency of monopolies through yardstick regulation. New pricing systems have been introduced, where both generation and transmission businesses have operational or capacity expansion marginal prices, or both. Distribution prices are based on capacity expansion average costs, which are evaluated using model distribution companies or price cap schemes.

Reforms have followed similar, but not
identical, in all countries involved, each one benefiting from the experience of those that have made the changes earlier. To reduce market power, restrictions on cross-ownership amongst different categories of companies were introduced in Argentin, Bolivia, and Peru, but they were not defined in Chile where market power has developed. Argentina and Bolivia further limited any generating company from holding more than 10 per cent or 30 per cent of the market, respectively.

The system operator in charge of coordinating grid operation is run only by generators in Chile. In Peru the operator also includes transmitters, and in Argentina and Bolivia distributors, large consumers and the regulator. In Chile, Peru, and Bolivia generation is dispatched based on market prices, bid prices are used in Argentina and Colombia.

Most countries have formulated two-part tariffs for transmission services based on multilateral marginal spot price, coupled to tolls, but Colombia has used capital expansion marginal costs. While in Peru, Colombia, and Bolivia the transmission system is in the control of a single company, Argentina and Chile have relied on market forces, favoring the development of several private transmitters. Argentina, Chile, and Peru have chosen the concept of model distribution companies to set distribution rates; Bolivia has opted for the British price cap scheme, where rates are adjusted by inflation minus a yearly efficiency factor (i.e., RPI-X).

Different privatization schemes have been used in each country. Private pension funds provided financing for the privatized electricity system in Chile, while in Argentina, Bolivia, Brazil, Colombia, and Peru, major foreign investment joined the limited local capital market. Bolivia developed a new privatization program called "capitalization." Foreign investors commit to the company's expansion, controlling the company as shareholders who contribute a predefined amount to finance further investment. Stranded assets have been sunk in all deregulation processes and absorbed by the State.

IMPACT ON ELECTRICITY SERVICE

The reforms have had radical results in all countries. In Chile, two power suppliers have given place to seven generating companies competing in the main grid. In neighboring Argentina, over 30 private generator rivals have replaced two state-owned companies. In Buenos Aires and Lima, two distribution companies compete not only against each other but also against an ideal model.

The countries that have restructured and privatized their power sectors have attracted investments from numerous US, Canadian, French, Portuguese, and Spanish companies. Chilean companies have grown into electricity multinationals present in generation, transmission and distribution investments in Argentina, Bolivia, Peru, Brazil, Colombia — and they are awaiting better conditions in Venezuela and Mexico before doing the same there. Chilean companies Chilgencor and Endesa own more installed generation capacity outside the country than inside. In addition to Santiago, three other capital cities, Bogota, Buenos Aires and Lima, are now supplied by countries where deregulation has taken place.

In Chile, Energy Theft included, were halved in seven years (Figure 4) and in just three years in Argentina. During roughly the same period in Argentina, investment in the generation-transmission-distribution chain dropped from S6000/jkW of installed capacity to around $2000/jkW, indicating a tripling of the productivity of money put into the system.

At the same time, very strict electricity standards have been set in Argentina, Bolivia, and Peru, with penalties for not complying. More efficient maintenance, the upgrading or replacement of existing equipment, and more sophisticated control systems have all been used to increase reliability and postpone further capital investment. Development has been stimulated by the search for more efficient technologies and investors have sought to build combined-cycle units, with related investments in transporting natural gas across international frontiers.

A chronic problem in Latin America has been the illegal use of electricity, which usually imposed severe burdens on the utilities. Losses of over 20 per cent were not uncommon, and even now, some utilities in Venezuela lose more than 50 per cent of energy bought. A political solution previously chosen by some countries was to share this burden among all paying consumers, assuming electricity theft was a social problem. However, in the new regulatory schemes, where distribution companies are asked to compete with a model or a price cap, control over these strictly non-technical losses is necessary if company revenues are to be increased.

CASE STUDIES IN MARKET DESIGN

The independent operator in Chile, Chile, has two interconnected systems, the larger one is 4858 MW, 22 426 GWh [1996], with a 500 kV and 220 kV transmission grid.

Companies engaged in the generation of electricity in Chile must coordinate their operations, through a single autonomous entity integrated by the principal generating companies for each interconnected network, known as Economic and Dispatch Center (CDEC). The CDEC, as an independent operator, plans and coordinates the operation of the plants to ensure security and economic efficiency in the electricity system, irrespective of ownership. Demand is therefore set by dispatching the available units according to their variable production costs, from lowest to highest, and is thus always done at the minimum attainable cost. The assumption behind this is that with perfect competition, prices would be optimal marginal costs. Another assumption is that pool governance is better achieved by agreement among all participants. Therefore, the law indicates that agreements in each CDEC are to be achieved unanimously; otherwise, the Ministry of the Economy intervenes.

Concentration concerns contractual sales requirements with dispatched electricity, whether produced by them or purchased from other generators in the spot market. Therefore, they sell to the following three markets:

- Spot market: includes energy transactions between generating companies. Transfers are determined by the CDEC and are valued

![Figure 1. Productivity has increased: Enesd
![Figure 2. Unsecured energy demand in Argentina, January 1988 to December 1995
![Figure 3. Evolution of energy prices in Argentina
![Figure 4. Energy loss reductions in Chile (technical and non-technical losses)]
hourly at the system marginal cost.

- Unregulated market: consumers with a demand of over 2 MW, normally industrial or mining companies. These are customers who are not subject to price regulation and able to freely negotiate electricity supply prices with generating or distribution companies.
- Regulated market: customers whose demand is for less, usually located within a distribution company’s concession area. Sales by generating companies in this market are made to the distribution companies, under regulated prices determined by the Ministry of the Economy. To ensure price stability, the National Energy Commission (NEC) sets them for six-month periods, based on projected marginal costs in the system. These prices provide a hedging mechanism for generators signing contracts with distribution companies.

The COL in the central system started operating with a specific bylaw enacted in 1995. It operated well for ten years, with competition taking place on cost of supply — efficiencies were increased by generators, new technologies like CCGT were being introduced — and on commercial actions (contract portfolios). However, as extreme drought conditions damaged hydro businesses and competition increased with the arrival of natural gas, unanimous agreements became the exception. Disagreements arose on the determination of spot prices, on capacity payments, on the dispatch model, on transmission modelling and on operation standards. Since then, the regulator has been effectively directing the actions of the pool, where it has no interest in doing so. Even reliability was endangered by the disagreements, and fines had to be applied to participants after a recent blackout. The government has defined changes to the bylaw, increasing the number of participants (transmission, smaller generators) and maintaining the government, while at the same time introducing a two-thirds majority rule. An expert committee is to act as a problem solver, and reliability obligations as well as fines are also being increased.

The transmission open access scheme in Bolivia and Chile. Most countries have chosen a nodal pricing scheme, with a two-part tariff for transmission services, adding supplement tolls to an income resulting from nodal prices, to cover replacement costs.

All the countries, except Peru, have allocated the payment of tolls to those that make a "natural" use of the lines, where natural use is measured based on incremental impact at optimal dispatch. The payments have no relation to commercial use and contracts among agents. The argument is that natural use determines the pressure on the transmission network imposed by generators and consumers, by the simple fact that they are connected to the grid, irrespective of their commercial supply agreements. The argument behind this tariff scheme is that those agents that cause transmission expansion have to account of those costs in their investment decisions, whether generators or consumers. Argentina and Chile consider that generators, needing to reach the market, are fully responsible for transmission expansion and have to cover tolls.

Bolivia distributes responsibility among generators and consumers.

Another central difference arises. While Argentina and Chile evaluate transmission natural use on the basis of incremental impact at peaking conditions, Bolivia averages impact at different load levels. The first approach assigns responsibility to agents that used all transmission capacity, assuming each line is used at full capacity at system peaking time. The second approach attempts to measure economic use in a full cycle of system utilization, corresponding to an energy flow approach rather than a power flow one. It assumes that transmission line design and investment are conditioned by the flow of energy.

In practice, these incremental approaches have proved to be very troublesome. Disputes have arisen in Bolivia and Chile among agents regarding use determination, dispatch models used and marginal bus location. In fact, the natural use is conditioned by the location of the marginal bus in the system economic dispatch. If the location varies over time to the allocation of transmission flow volume among generators and consumers, Bolivian generators have complained that variability of the toll does not provide a stable coherent economic signal for system expansion. In Chile, generators disagree on the dispatch model to use and its handling of transmission models. Neither scheme has a clear definition on how network restrictions and the economic dispatch should be handled in relation to transmission pricing. The distribution pricing scheme in Chile. A fundamental reform in the Chilean case was the introduction of "pseudo" market principles in distribution. This activity was to be developed through geographic monopoles, so it was considered necessary to introduce economic efficiency incentives by making the regulatory framework with a reference efficient model firm, a "yardstick competition" or "benchmark regulation" approach. The profitability for each distributor depends on the results of its relative efficiency compared with the reference model upon which base the tariffs are calculated.

Therefore, an additional distribution component is added to the regulated generation and consumption. This value added component (VAD) recovers costs of operation, including allowed losses, and a return on investment for "efficient" distribution companies. It is based on the new replacement cost of assets employed in distribution with different efficiency standards applied to operation and system expansion. The tariff is not based on actual costs incurred by any given distribution company, but on an investment, operation, maintenance, and general administrative standards and overall efficiency of operations of a model company, which is used as a benchmark.

VAD values are determined every four years. Tariff studies are performed both by the NEC and by the distribution companies. Each party hires consultants to perform a parallel tariff study. The tariffs are calculated as a weighted average of the results of the NEC-commissioned study and the companies’ study, with the results of the NEC’s study bearing twice the weight of that of the companies. The VAD studies provided increasingly diverging results, as obtained by the NEC consultants and those of the distribution firms. This became critical in 1992 and drove the parties to intense negotiations, with some companies resorting unsuccessfully to legal action. This caused public turmoil and mutual recriminations among small distribution companies, and had a severe impact on the Stock Exchange. The conflict had a scope that went beyond tariff fixing due to the important presence of pension funds as owners of distribution firms’ stock, which started to fall in value.

With this history, in 1996 tariff process all the involved parties made an effort to reverse this divergent trend. It was agreed to reduce room for divergence by means of concerted efforts on technical and economic analysis of the construction of the model reference firms. As a result, differences between the studies were much reduced. However, conflict still developed and ultimately the process ended in the Supreme Court, where tariffs were set on the basis of arguments filed by both the regulator and the regulated. Nevertheless, the court decided mainly on procedural matters, leaving open the essential issues discussed.

The Chilean government is assessing changes to regulation, and the idea of using an arbitrator has been considered. There are no plans to introduce retail competition, with effort being concentrated on extending open access to distribution systems to increase competition in supply. Nevertheless, the court decided mainly on procedural matters, leaving open the essential issues discussed.

The Chilean scheme was decided that only one study would be developed by the distribution companies, supervised by the regulator. However, conflict also arose over the results values. Bolivia chose a price-cap RPI-X approach, but it is too early to draw any conclusions about the results.

CONCLUSIONS

In much of Latin America, electricity industry reforms have had a dramatic effect, with all agents involved compelled to increase their efficiency, either in supply or demand. The challenges have posed difficult questions to all concerned, particularly as competition increases beyond geographical and political boundaries. Private generation investment has taken place without government intervention, increasing supply in countries where electricity growth is a basic requirement for economic development.

Market design has been based on a new understanding of the technical and economic characteristics of power systems. Without any previous models or experiences to rely on, it has been difficult to achieve truly competitive markets.

Biography

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