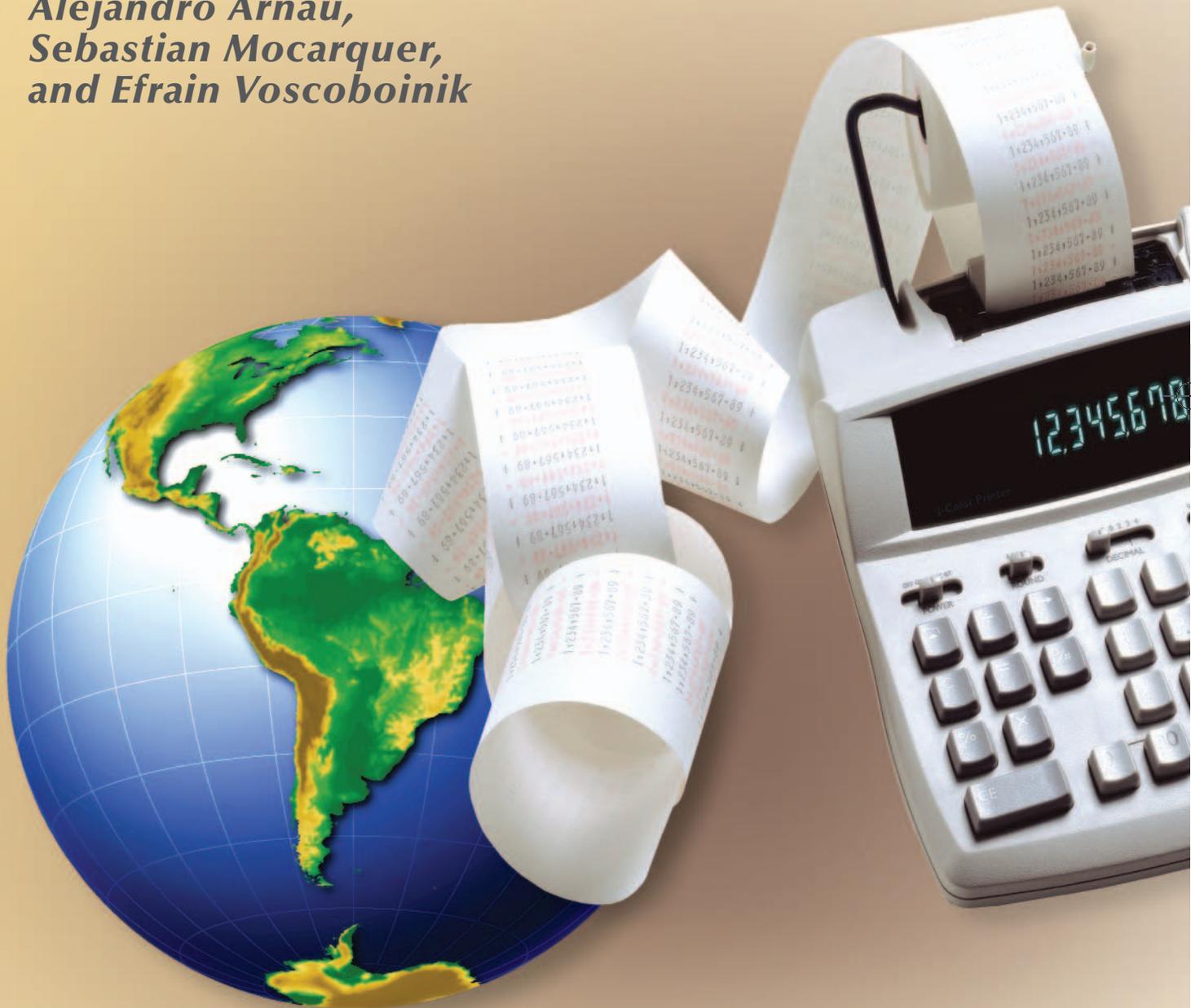


Stimulating Efficient

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Distribution

ELECTRICITY DISTRIBUTION COMPANIES, BEING NETWORK INDUSTRIES, AIM to transport and distribute electric power from specific points in high- or medium-voltage lines to end consumers at appropriate voltage levels for industrial and residential use. This activity is organized in public service utilities that obtain power supply through contracts with generators.

During the last two decades, many countries and geographical areas of the world have made drastic transformations in their electrical sectors, both in terms of segmentation and privatization of state monopolies. Because of these transformations, a major change in the role of the state has been witnessed. The state has transformed itself from a producer and enterprise-owner agent into an agent that regulates those stages of the electrical sector that become natural monopolies, such as electricity distribution. The challenge is to stimulate an efficient service in distribution, similar to that which would be achieved in a competitive environment.

The characteristics of the distribution activity vary from region to region, depending on the nature of the demand. In Latin America, the main challenge in distribution is one of large growths of demand, values around 6% to 8% being common in the region, requiring doubling of capacity every ten years. This, coupled in some countries to the need to extend networks to increase electrification levels, imposes significant challenges to distribution network expansion, different to those faced in North America and Europe. Thus, the need to stimulate efficiency becomes of paramount importance, particularly at the time of privatization of the previously state-owned companies.

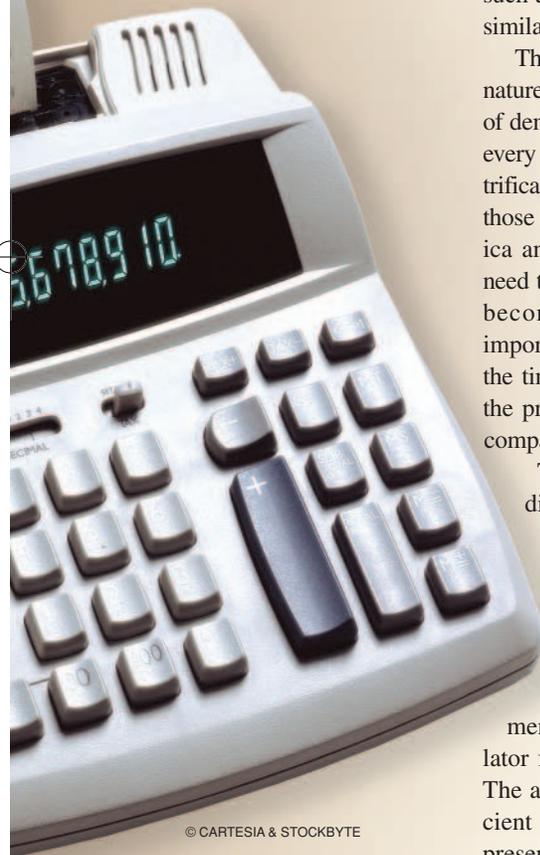
To regulate electrical distribution and stimulate efficiency, most Latin-American countries that have started this transformation have adopted an incentive regulation approach, using the concept of efficient companies that are adapted to demand and that operate under optimal investment and operations plans. Under this scheme, to force companies to be efficient, the regulator fixes prices according to efficient costs, not necessarily considering actual companies. The actual company will get a normal profitability only if it is capable of emulating the efficient performance, reducing its operating and investment expenditure, thus minimizing the present value of its costs. In general, this regulation has implied a reduction trend in distribution tariffs.

This article assesses the 20-year experience in Latin America in applying incentive price regulation to its distribution companies.

Distribution in Latin America

The development and typology of distribution networks in Latin America was conditioned by the historical context in which they were built. In particular, the strategy and technology used to develop the networks is related to the origin of the concessionaire who started the distribution

Incentive Price Regulation Stimulates Efficiency in Electricity Distribution in Latin America



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In Latin America, because of consumption and development levels there is a greater development of low-voltage networks compared to Europe and the United States.

service, which could be either North American or European. Countries such as Colombia and Brazil, among others, were directly influenced by the United States on account of their commercial relationships with this country at the beginning of the century. Their electric power distribution networks show the U.S. topology and distribution, characterized by a medium-voltage network, small transformation centers close to the final user, and a small low-voltage network. On the other hand, countries such as Argentina, Peru, Uruguay, and Chile were influenced by Germany, France, and England, and, therefore, their networks are of the European type, with transformers with greater capacity and low-voltage three-phase distribution networks.

Optimum economic performance in 60-Hz-frequencies is found in low-power transformers. This has allowed for the development of networks of the U.S. type; i.e., distribution in medium voltage with small transformers near the customer. For 50 Hz, optimum performance is produced in transformers with greater power, which justifies the use of European-type networks.

In Latin America, because of consumption and development levels in general, there is a greater development of low-voltage networks compared to Europe and the United States. For similar reasons, the percentage of underground networks is also lower compared to the abovementioned countries. In fact, the development of underground networks is more related to the compliance with city-planning regulations (e.g., to preserve the cultural heritage) than to the electric service regulation.

Distribution Activity

The distribution activity is characterized by the constant investments needed to render good services and to achieve the various scale economies that can be attained by companies when developing their facilities and their management and operation. Although economies of scale add up to efficiency, they also make the revenues generated through a marginal cost tariff not to be enough to cover these companies' total costs. Likewise, the strong interdependence of investments and the long capital-recovery period give origin to a costs function that is clearly under-additive for the relevant demand range. This makes one conclude that it is more socially efficient to have a single company instead of several companies operating in a same geographical area. In this manner, and as it is a matter of guaranteeing maximum coverage, with the highest quality and least price possible, single distribution companies are justified

and they are allowed to operate as a natural monopoly.

Under monopolistic conditions, consumers have no possibilities to choose, and that makes it necessary to regulate the service in order to prevent unreasonable practices (poor quality, low coverage, high prices). For that purpose, the regulator establishes the rights and obligations of distribution companies, assigning concession zones to install, operate, and exploit public service distribution networks. Likewise, the regulator establishes price levels and creates incentives that allow management improvement since there is no market competition to promote them.

In this manner, the primary goal of any regulatory scheme is to provide the appropriate incentives to companies to force them to be efficient and through adequate price signals to make them to be able to transfer, in the long term, part of their benefits to the users given their efficient investment and operating policies. These incentives will be available for the companies only if the regulator can show a certain level of commitment and stability. This commitment and stability results from ensuring the regulator follows certain general principles on transparency, efficiency, stability, and straightforwardness.

Based on these principles, the regulation of natural monopolies is made through different approaches.

Challenges of Distribution Regulation

Regarding costs associated with the activity that is intended to be remunerated, they are associated to the network exploitation, maintenance, and expansion components. They can be grouped into the items indicated in Figure 1, within what is named the value-added distribution. Each one of these costs is indistinctly affected by climatic, geographical, and demographic factors that are external to the companies. This reveals that tariff regulation is a very complex and demanding process, considering:

- ✓ the need to adequately identify and value the different components
- ✓ the need to fairly and transparently weight the influence of factors such as network type (rural or urban), overhead or underground lines, and the type and density of consumption present in the company's activity
- ✓ the convenience of emitting signals to encourage the adoption of more efficient behaviors by the companies performing in the concession areas.

These challenges have been treated differently in regulations, with some using rate of return and price cap methods,

The tariff scheme in itself is an incentive for efficiency, since it acknowledges the efficiency values the distributor should operate with ex-ante the rendering of the service.

while others adopted a benchmark scheme, using the concept of direct comparison with an efficient company. All methods serve the same final objective, but the context in which they were created was different, making them more suitable than others depending on the general environment of the country. Many regulatory schemes use comparison procedures or benchmarking as a methodology. In incentive regulation, efficiency is measured against a previous benchmark and the results deliver the information required to compare the companies' operation and allow the identification of the actions required to drive efficiency improvements.

Different Regulatory Models

There have been different regulatory models used in Latin America in applying incentive price regulation to its distribution companies. Table 1 summarizes different approaches that are briefly described afterwards for sample countries.

Argentina

The revenue-cap and price-cap tariff scheme in Argentina is based on enough revenues to render an efficient service, and it determines the tariff value for each supply category. The

tariff is the sum of the VAD (distribution added value, in its Spanish acronym for *Valor Agregado de Distribución*) and a quasi-perfect pass-through of the purchase cost of energy and power in the wholesale electricity market.

The tariff scheme in itself is an incentive for efficiency, since it acknowledges the efficiency values the distributor should operate with ex-ante the rendering of the service. The distributor will obtain the expected profitability for its investors only if it adjusts its costs to the acknowledged values. The system transfers risk decisions to the provider since mistakes in deciding investments, expenses, indebtedness strategies, or technological adjustments will be ultimately paid by the investor, who will receive less profits for the capital invested in the activity.

With reference to the use of resources, it is a model based on economic signals, where decisions are taken by agents; by means of their tariffs, distributors inform consumers on the efficiency cost of each consumption alternative and they, in their capacity as demand makers, decide on the use and allocation of resources.

Large users freely agree on the price of their contracts with generators or brokers. Regarding the use of networks, if

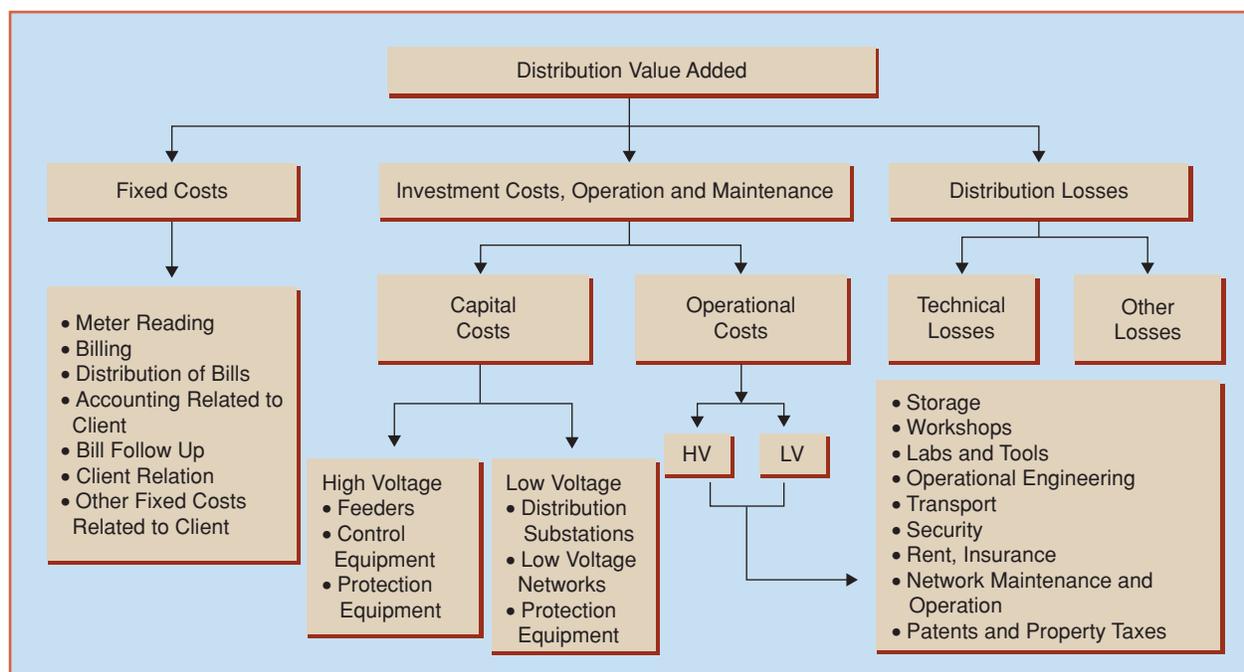


figure 1. Cost components of the distribution activity.

Table 1. Different incentive regulatory models for distribution in Latin America.

	Argentina	Bolivia	Chile	Columbia	Peru
Type of Regulation	Natural monopoly. Price cap with prefixed tariff structure. Free access.	Natural monopoly. Price cap with prefixed tariff structure. Free access.	Natural monopoly. Yardstick competition with cap in tariff structure. Free access.	Price cap. Free access.	Natural monopoly. Yardstick competition with cap in tariff structure. Free access.
Disputability of the Network Market	Concessions (between 35 and 99 years) with area exclusivity that can be eliminated by technological innovation. Competition for the market every 15 years.	There is no disputability in the distribution market. Contracts are awarded on an exclusivity basis for a 40-year period.	Area exclusivity. Final concessions without time limitations.	There are no concessions or exclusivity. There may be parallel networks in the same area.	Area exclusivity. Final concessions without time limitations. They terminate by expiration or waiver. Disputability in expansion areas is solved by means of auctions.
Disputability of the Trading Market	Disputable regarding the unregulated user market (consumptions above 30 kW). Increase in disputability due to decrease in requirements to become an unregulated user. There is no separation of the metering and reading of the service, except for users over 1 MW (real-time metering).	Disputable regarding the unregulated user market (consumptions above 1 MW). There is no separation of the metering and reading of the service. Unregulated users must adapt their metering conditions.	Disputable regarding the unregulated user market for consumptions above 2 MW. Consumptions of clients between 0.5 and 2 MW can decide between the regulated tariff or unregulated market.	There are no explicit barriers but the user must pay for the metering costs.	Disputable regarding the unregulated user market (consumptions above 1 MW).
Supply Obligation	Full obligation to place networks at the disposal of all demand within the concession and supply areas for regulated users. Network expansion is contemplated into a certain distance, as well as expansion with refundable contributions to users when this distance is exceeded.	Obligation to render service to regulated users within the concession and supply area.	Obligation to render service within the concession area to whoever requests it. There are refundable contributions to new supplies and expansions.	The distributor is not obliged to make expansions if they are not profitable; that is, it is only obliged if the expansion is remunerated by the tariff.	Obligation to render service within the concession area and up to 100 m of the electric power line, to whoever requests it. There are refundable contributions to new supplies and expansions.
Existence of the Legal Concept of Broker	Existence of the concept of broker, independent of distribution and without the capacity to serve captive users. There are brokers operating with little volume at the moment.	The concept of broker does not exist.	There is no legal concept of broker. The trading market is taken by generators.	The concept of broker exists.	There is no concept of broker. The trading market has not developed.
Subsidies for Expansion	There are funds for rural or unprofitable electrification.	The executive power, by means of the National Fund for Regional Development, allocates internal and external financing resources. No refundable contributions are contemplated. Users are responsible for the expansions they cause.	No subsidies are expected for expansion. There are rural electrification government programs.	The government guarantees the implementation of projects considered in the investment plan that are not profitable for investors. These projects are financed by the Rural Electrification Support Fund.	No subsidies are expected for expansion. There are refundable contributions from public and private institutions for electrification in favor of users. There is a Rural Electrification Act, which has not been regulated yet.
Capital Base and Capital Return	It is not regulated but is discussed for each case. In distribution there is a tendency to use the VNR of efficient facilities. There is some discussion over this. Review every five years.	Assets designated to the concession, equal to the value of the fixed net asset plus the net labor capital, less the value of long-term liabilities associated to fixed assets. It is fixed every four years.	It is calculated by means of the VNR of the network economically adapted to demand in order to render the service at minimum cost. Capital base is reviewed every four years.	VNR according to the electric and nonelectric asset inventory. Nonelectric assets are limited to 4.1% of the VNR annuity.	It is calculated by means of the VNR of the network economically adapted to demand in order to render the service at minimum cost. Capital base is reviewed every four years.

Not expressly defined. Reasonable capital cost. There is a tendency to use WACC/CAPM.

Evaluation of each case by means of studies by the regulator and the company. VNR or average incremental cost (CIP) methods are used. Acknowledged investments are those resulting from specific studies. They are not reviewed ex post.

O&M, A&G, and trading costs (no margin for purchase in the WEM), nontransferable taxes, and technical and nontechnical losses are efficiently acknowledged depending on the case.

Not expressly defined. In general, it is considered in a benchmarking as a percentage of investment or in a certain model company.

They are reviewed in every tariff review, and those that remain constant during the tariff period are acknowledged. An acknowledged loss coefficient, also working as an incentive to reduce them, is allocated. In some cases, nontechnical losses are acknowledged. Agreement with the government to treat robbery. They are valued at transfer price.

Remuneration is calculated in dollars. It is adjusted by weighted American CPI/PII Average. There is no current X factor.

It is not mandatory although the supplier's responsibility is ultimately the contracting signal.

Determination of capital cost by benchmarking. It is determined on the basis of the average return rate of the last 3 years in American utilities.

Studies ordered by the company to specialized consultants, pre-qualified by the regulator, who will prepare the terms of reference and will receive the studies. Investment plans are analyzed on a case-by-case basis.

Consumers costs, taxes, operation costs, maintenance costs, administration and general costs, financial costs, and other costs related to supply.

Case by case, considering the expected growth of demand, expansion plans, and operation indicators, and that of unit costs defined for a four-year period.

A technical loss coefficient is acknowledged, in accordance with the concession area and network characteristics. It is usually <10%. In addition, a loss reduction factor is applied by means of a monthly efficiency factor.

Different X factors for each type of costs: losses, O&M, A&G, commercial. Cap prices are adjusted by variations in consumer inflation indexes, tariff rates, exchange rate.

They must have valid contracts with generation companies guaranteeing to cover 80% of their peak demand for a minimum three-year period. There are no incentives to contract due to the acknowledged transfer price scheme.

10% over capital base. Profitability of the industry as a whole should be between 6% and 14%.

Evaluation by VNR. Assets corresponding to a network technically and economically adapted to demand will be acknowledged. The regulator will define typical areas and calculate their VAD. Studies are carried out for each typical area and they correspond to model companies.

Standard operation, maintenance, administrative, and commercialization costs will be acknowledged as well as a percentage of technical and nontechnical losses.

They are determined every four years and correspond to model companies for each typical area.

The VAD determination process incorporates the level of technical and nontechnical losses.

Tariffs are applied in local currency and are adjusted by variations in: local consumer inflation index, imported goods index, and industrial price index.

Distributors are required to maintain three years of contracts at all times. Recent changes in wholesale markets introduced auctions for regulated consumptions.

14.06% over the replacement value of the assets for level IV and 16.06% for levels I, II, and III.

Evaluation by VNR or CIP (but only in LV and when the marginal cost exceeds the average cost).

O&M and A&G costs and a percentage of losses by voltage level will be acknowledged.

They are determined as a percentage of the replacement value of electric assets: 2% for levels III and IV, 4% for level II, and for level I there is a costing process per activity.

For each voltage level there is an acknowledged percentage for nontechnical losses. For level I it was 1.68% in 2003 and 0.67% in 2007.

Tariffs are applied in local currency and are adjusted by variations in inflation indexes, exchange rate.

At first there was the obligation to contract at 80%, which gradually decreased. Currently there is a contracting procedure for the regulated market.

12% over capital base. Profitability of the group of concessionaires should be between 8% and 16%.

Evaluation by VNR. Assets corresponding to a network technically and economically adapted to demand will be acknowledged. The regulator will fix typical areas and calculate their VAD. Studies are carried out for each typical area and they correspond to model companies.

Standard O&M, A&G, and commercialization costs will be acknowledged as well as a percentage of technical and nontechnical losses.

They are determined every four years and correspond to model companies for each typical area.

The VAD incorporates an acknowledged level of technical and nontechnical losses. Every four years, values are adjusted according to technological advances and to management results in the previous tariff period. They are the government's political decision. Fixing an acknowledged level works as an incentive to reduce them.

Tariffs are applied in local currency and are adjusted by variations in consumer inflation indexes, export duty, exchange rate, salaries, and price of copper.

Through auctions up to 25% of peak demand; the rest must be guaranteed by contracts with generation companies. Imbalances are negotiated on the spot market.

(continued)

Table 1. Different incentive regulatory models for distribution in Latin America (continued).

	Argentina	Bolivia	Chile	Colombia	Peru
Acknowledged Transfer Prices	The seasonal market price is acknowledged, this is a quarterly projection, it is a market with a stabilization fund that minimizes volatility. It is adjusted quarterly.	It is based on the different energy and power prices in the node allocated to each distributor, with a projection of demand for the following 48 months.	Node prices are acknowledged. They result from a combination of a 48-month projection and auctions for regulated consumptions.	According to distributor's average purchases (both forward (transparency and free competition) and spot) and to the average price in the Colombian market.	Node prices are acknowledged. They result from a 48-month projection and must be +/- 10% of the average price of energy agreed with unregulated users. Otherwise, they are adjusted.
Type of Tariff Structure	Prefixed tariffs (no tariff options) by voltage and usage level (only in LV). Adequate price signals.	Prefixed tariffs (no tariff options) by maximum demand and voltage and usage levels (only in LV). There are tariffs for usage in small demands and irrigation.	Tariff options in LV and MV restricted to metering conditions and voltage levels. There is a tariff chart for each typical area within each company.	Postage-stamp tariffs by voltage level.	Tariff options in LV and MV restricted to metering conditions and voltage levels. There is a tariff chart for each typical area within each company. Prepayment is a tariff option.
Existence of Crossed Subsidies	As a rule, they do not exist. There have been, however, gradual elimination mechanisms.	The regulation scheme does not show crossed subsidies. But, in fact, there are some in certain cases.	As a rule, they do not exist.	Tariffs affected by factor destined to subsidize low-income consumers. Maximum 20% cost for service rendering.	As a rule, they do not exist.
Neutrality in the Transfer of Supply Costs	As a rule, it should be neutral but deficiencies in the tariff parameters do not generate the desired neutrality.	According to the regulation, it is neutral although there are actually cases where it is not.	Neutral.	Not entirely neutral. May create losses or premiums.	In general, it is neutral.
Tolls for Unregulated Users	There are regulated caps. In general, they produce neutrality in the distributor's remuneration. There is a territorial jurisdiction conflict.	There is a mechanism to determine the toll. It is adjusted by indexation to maintain remuneration in real terms.	Tolls are calculated so they produce neutrality in distributor's remuneration and are set by regulator.	Regulated tolls for all users (free and captive).	Regulated tolls for free users.
Type of Control	Stages, each with greater requirements. Product, service, and commercial quality are controlled.	Product, service, and commercial quality are controlled. Four stages of increasing requirements.	Concessionaires are obliged to guarantee quality and reliability determined in bylaws, which is supervised by Electricity Superintendence	Quality regulations were issued subsequent to tariff sanction to control product and service quality. There are compensations for users, and quality goals are currently being reviewed.	Concessionaires are obliged to guarantee the quality fixed under contract. There is a technical regulation (subsequent to the law and the concession contracts) to control product, service, commercial, and public lighting quality.
Penalty Scheme	Nonsupplied energy (NSE) resulting from the measured indexes is valued.	Penalties on the basis of NSE according to the indicators in each stage and type. The maximum remuneration reduction must be 10% of the annual turnover.	Penalties can be imposed by Electricity Superintendence and consumers compensated if quality and reliability measured indexes do not meet standards required.	NSE resulting from the measured indexes is appraised.	Compensations to users on the basis of NSE and the difference between rationing cost and tariff.
Tariff Period	Every five years.	Every four years.	Every four years.	Every four years.	Every 4 years.

In Chile, the regulated distribution price corresponds to the mean added value of the activity determined from model firms operating in the country.

they do not agree with the transporter or distributor, a regulated tariff is applied, which must coincide with the VAD.

Another issue, of a circumstantial nature and exogenous to electric power regulation, is that originated by the passing of the Emergency Act (Law No. 25561) dated 9 January 2002, which abandoned the convertibility system in force in the country since 1991 and unilaterally decided to implement a substantial modification of certain basic conditions in concession contracts. All these measures have had a negative impact on the electric power industry in general and on the companies' profitability.

Bolivia

Under the local regulations, maximum distribution prices are fixed according to the average distribution cost and, taking into account operation and unit-cost indicators, the evolution of the assets designated for concession, taxes, and enhancements in the distribution company's efficiency. Base tariffs are determined by considering average values representing supply costs for a period of four years and a profit margin on equity defined by law. Intratariff period indexation formulas basically reflect the retail inflation indicator and the efficiency indicators.

Regulation is completed with a series of resolutions by the regulator, which establishes methodological guidelines to define detailed review parameters. It is important to mention that when Bolivia's regulation fixes the capital cost rate in tariff reviews, it makes a difference between an owner's capital (equity) and a third-party's capital, with regulatory differences in the manner of estimating each rate.

The Superintendence of Electricity of the Government of Bolivia has a regulatory system for electric power distributors that requires statistical cost analysis. The system is detailed in the price and tariff rules (RPT).

Under the RPT, distributors must operate under price control schemes lasting four years. Four different types of reference tariffs must be fixed: peak demand, off-peak demand, energy, and customer services. These tariffs may vary with high-, medium- and low-power consumers. The off-peak consumption tariff covers the cost of electric power distribution and general and administrative costs.

Maximum reference prices depend on base tariffs that are adjusted monthly by means of indexes. Indexation formulas attempt to reflect variations in the price of supplies and in operative efficiency. The impact of inflation is measured by the consumer price index.

Efficiencies in electric power loss control are reflected in calculation formulas through "X factors" called "loss

reduction indexes." X factors for energy and demand losses are calculated independently. Changes in the efficiency to manage other supplies different from capital are reflected in calculation formulas through X factors called "cost reduction indexes." Factors for distribution, consumption, and administrative and general expenses (A&G) are calculated independently.

The RPT establishes that tariff bases must be calculated by using the projected average cost of the service during the four years of the planning study. These cost projections must be approved by the Superintendence through resolutions.

For cost projections for the four-year period, the Superintendence will establish a set of indicators relating costs to other parameters such as: asset value, number of clients, energy sales, length of lines, etc. Such indicators will mark levels of efficiency that include the analysis of the fulfillment of the indicators in the previous period, and which cannot be lower than those resulting from the actual operation of the company in such period.

Chile

In Chile, distribution networks are those whose voltage is under 23 kV.

The regulated distribution price corresponds to the mean added value by this activity determined from model firms operating in the country. The final price paid by a regulated consumer integrates the regulated generation-transmission price, with which the generators supply the distributing firms and an added value for the distribution service.

The regulation mechanism determines its distribution tariffs from the optimization of a real firm that serves as a reference for the construction of a model firm, and such model firm is benchmarked with all the distribution concessionaire firms. Thus, this scheme corresponds to an incentive tariffs model of the yardstick competition type, where the relative performance of the industry is assessed, assuring in theory a specific minimum return to those firms that have a performance similar to the model firm.

A core element to determine distribution tariffs is the dimensioning of the model firm. In the international application of the yardstick competition mechanism, the regulation of monopolistic activities is determined through the comparison of costs and performance of similar firms or mirror firms or the reduced comparison of heterogeneous firms corrected for differences. In the Chilean distribution monopoly regulation model, there is a hybrid benchmarking scheme between different firms. On one hand, groups of firms of similar

In Columbia, efficient management focuses on investment management, administrative costs, operation and maintenance, and losses.

characteristics are compared, identified through typical areas, with a model firm. Then, the performance of heterogeneous firms 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 of similar firms and in the latter case efforts are made to produce a horizontal comparison that fits the theoretical model with the average reality of heterogeneous firms.

The electric legislation determines the distribution tariffs based on the VAD value that is based in a model firm and that considers the three main components that form part of the distribution business cost: infrastructure and equipment costs, energy and power losses, and operating expenses such as administration, operation, and maintenance expenses. The law groups them as follows:

- ✓ fixed costs for administration, invoicing, and user service expenses, independent from their consumption
- ✓ mean distribution losses in power and energy
- ✓ standard investment, maintenance, and operating costs associated to the distribution by unit of power supplied. The annual investment costs will be calculated considering the new replacement value (VNR, the Spanish acronym for *Valor Nuevo de Reemplazo*), the facilities adapted to the demand, and a discount rate equal to a real 10% per year.

The components indicated are calculated for a specific number of typical distribution areas defined by the National Energy Commission, with a previous consultation with the firms. The process to determine the VNR has the objective of calculating the “cost to renew all the works, facilities, and physical goods dedicated to provide the distribution service in the respective concessions.” The concept of VNR used by the Chilean legislation to be applied to distribution activities has been a hybrid between the substitution and replacements costs.

The law requires that when the model company is to be calculated, two independent studies must be done, one by the distribution company and a second one done by the National Energy Commission. The results of these two studies must be averaged considering a weight of two thirds for the government and one third for the distribution company. Tariffs are then cross checked so that the industry as a whole has profitability between 6–14%.

Colombia

In Colombia, distribution networks are those whose voltage is under 220 kV. There are no concessions or franchises. Distribution only includes the transmission of energy through the network. Electric power distribution in Colombia is separated from the sale and purchase of energy, which are part of another activity (trading) together with metering, reading, billing, and collecting. Therefore, distribution is limited by

regulation to the “network business,” whose remuneration is determined by the so-called “usage charges.” These “usage charges” of the local or regional distribution system are the regulated retribution that the distribution companies receive to run their business. They consist of the annual revenues for efficient operation, following the theoretical criterion of remuneration of the distribution activity presented above.

Trading is a different business and is open to free competition. There is competition in the distribution business. Since there are no concessions or franchises, there can be more than one distributor in each area (parallel networks). The distributor has no obligation to expand, but it must grant free access to its networks in case it has surplus capacity. If the

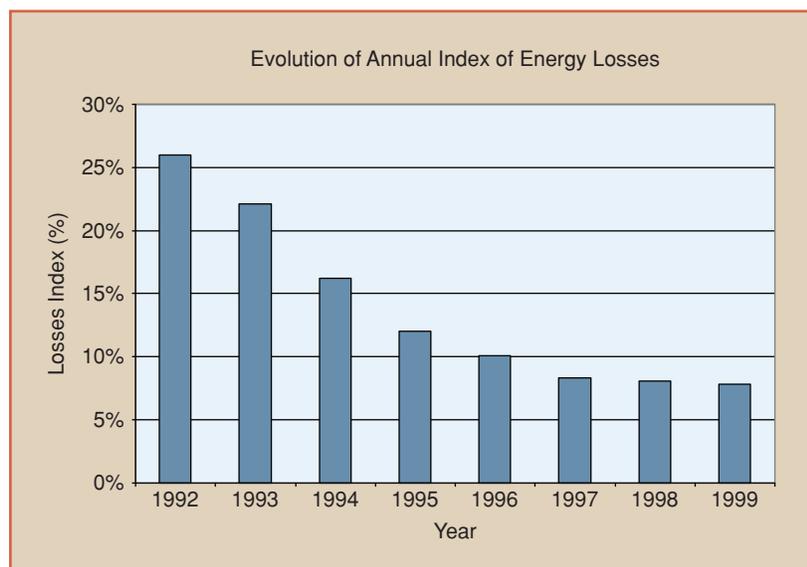


figure 2. Evolution of Edesur's losses.

Greater fairness in efficiency sharing is an objective that, although partially achieved, should be revised, in order to allow a larger transfer of benefits of the scheme to end users.

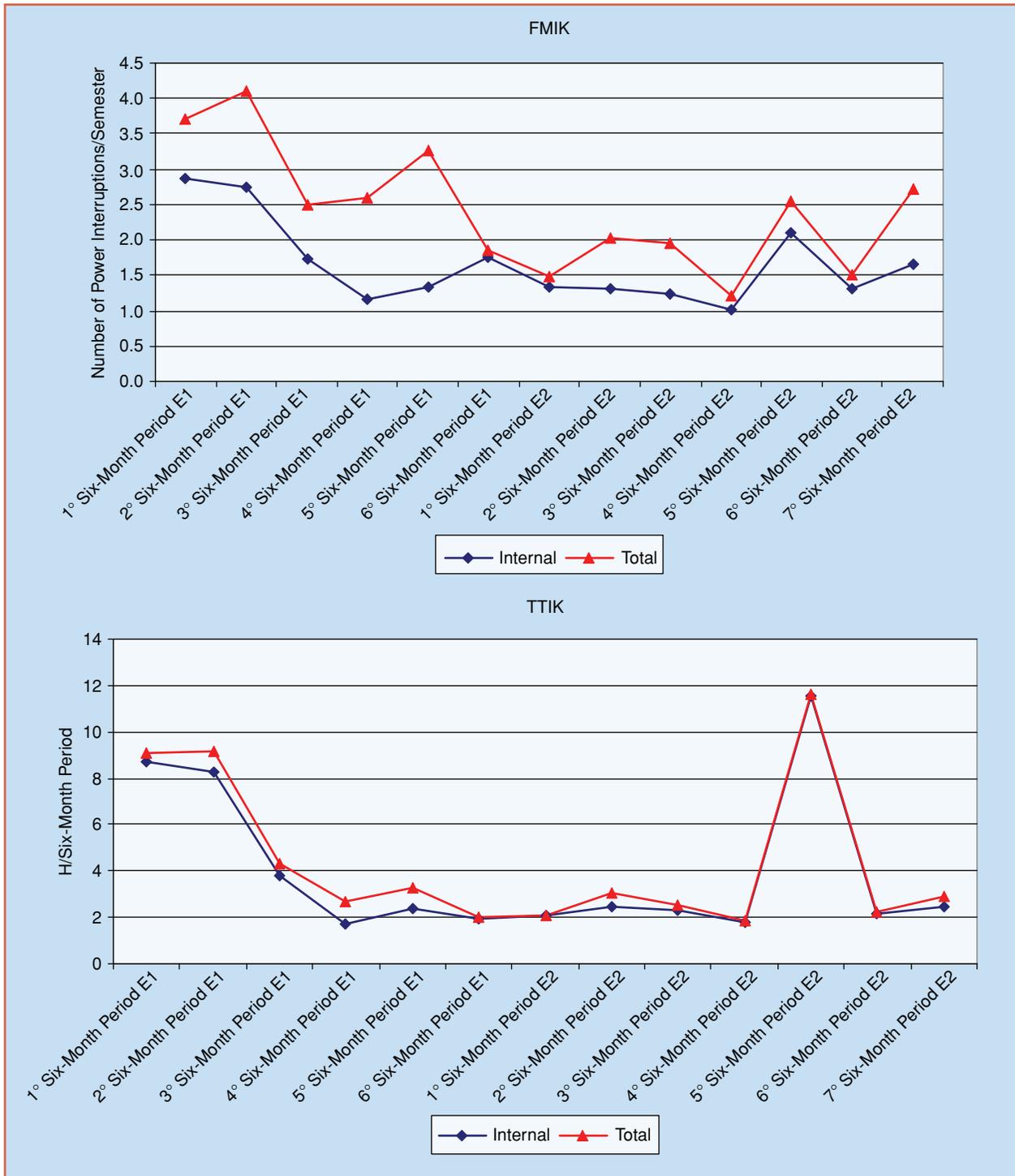


figure 3. Evolution of quality of service indicators.

Electric power distribution in Colombia is separated from the sale and purchase of energy, which are part of another activity (trading) together with metering, reading, billing, and collecting.

expansion is not profitable, it is not obliged to make it. In this case, the expansion is made by the distributor who finds it profitable to expand the network and serve that demand.

The new user connecting to the network pays the entrance costs and the facilities become the users' property. Tariffs are of the postage-stamp type by voltage level. The VNR is calculated with an actual profitability of 14.06% for level IV and 16.06% for levels I, II, and III, and operation and maintenance (O&M) expenses of 2% for levels III and IV. Level II has 4%, and in the case of level I, there is a costing process per activity.

The nontechnical losses acknowledged in the tariff are 0.67% in level I in 2007. For each voltage level there is a percentage of acknowledged losses. Once the VNR has been calculated with profitability and O&M expenses, the postage-stamp is determined by dividing the cost accumulated in each voltage level by the useful energy considered by the regulator. That is the actual energy running through the network according to the acknowledged loss factor.

From a conceptual point of view, payments to third parties work as a pass-through of costs beyond company management. In addition, the assets profitability or capital

opportunity cost is determined by regulation. Therefore, efficient management focuses on the remaining aspects: investment management, administrative costs, operation and maintenance, and losses.

Peru

Peruvian regulation has many elements in common with Chile. In order to fix electric power tariffs, the regulation stipulates that the VAD must be calculated for each of the typically defined areas, taking a model company as a reference. The VAD includes costs associated to the user, standard losses in the distribution system, and standard investment, operation, and maintenance costs. The investment cost implies the VNR annuity of the economically adapted system, considering its useful life and the restatement rate fixed at 12%.

Tariff regulation is indirect. A tariff is established by adding up bus prices with their acknowledged losses plus a VAD. The VAD is calculated and recalculated every 4 years, and it is restated within each period by means of polynomial formulas. It includes capital returns based on a reference network economically adapted to demand and the costs of exploitation and trading of a model company.

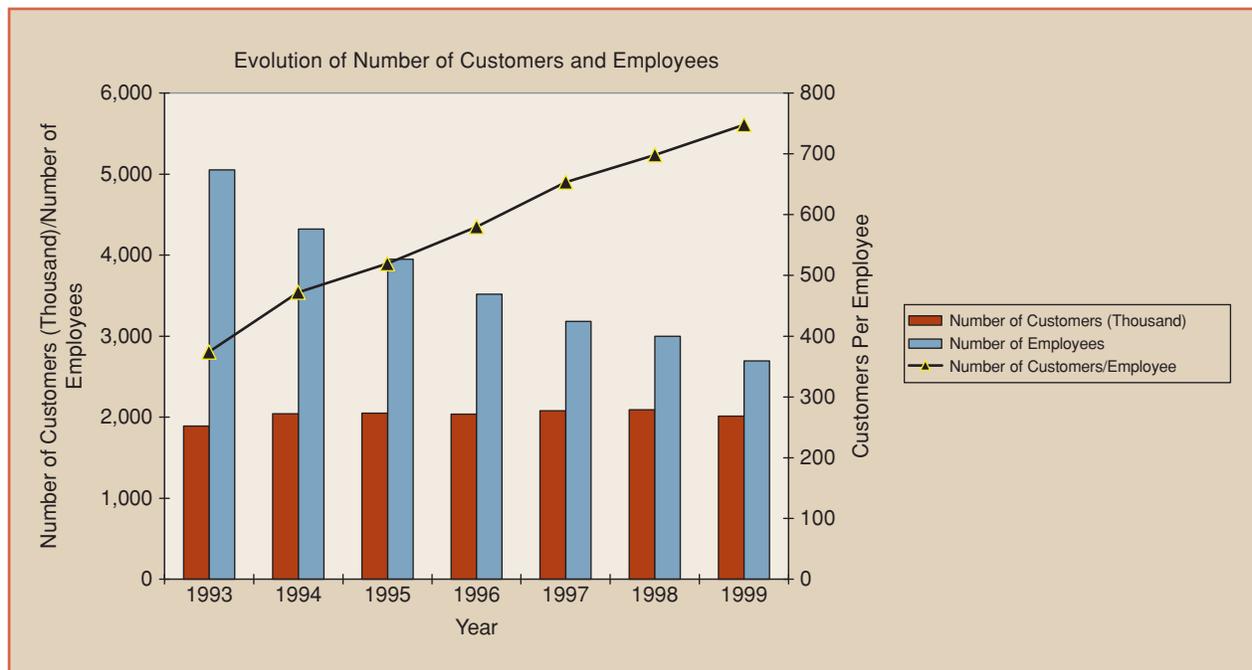


figure 4. Evolution of number of clients per employee at Edesur.

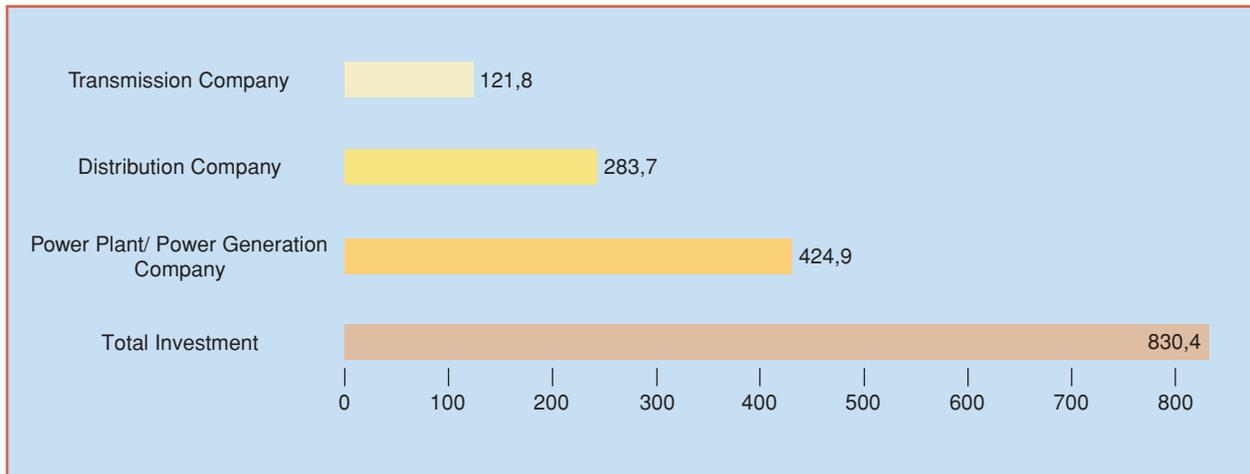


figure 5. Investment during the period 1996–2005.

The tariff system itself is an incentive for efficiency as it acknowledges the efficiency values the distributor must operate with ex ante the rendering of the service; the distributor will obtain the profitability expected by its investors only if it adjusts its costs to the acknowledged values. The system transfers decision risks to the provider since mistakes when deciding investments, expenses, indebtedness strategies, or technological adaptations will be ultimately paid by the investor, who will receive less profit for the designated capital.

Regarding the use of resources, it is a model based on economic signals where decisions are made by agents. Through their tariffs, distributors inform consumers on the efficiency cost of each consumption alternative and they, in their capacity as demand makers, decide on the use and allocation of resources.

Results of Regulation

The application of incentive price regulation to the distribution companies has been a successful process in Latin America, with difficulties experienced that vary from country to country. Specific examples of positive results are given for the same sample countries.

Argentina

The case of the Edesur distribution company can be regarded as representative of regulatory incentives in metropolitan distributors. In the period between the beginning of the company's privatization (September 1992) and the end of 2000, total investment was US\$1,061.7 million, which corresponds to an annual investment value of 118 million dollars/year. This investment allowed for a reduction of losses (Figure 2), an enhancement of quality of service, and the introduction of new technologies. Loss control programs changed from a loss index of 26% at the beginning of private management to 8% in 1997. With ref-

erence to quality of service, regulation generated appropriate economic signals to improve indicators. Figure 3 shows the evolution of the average interruption frequency per kVA (FMIK) and the average interruption time per kVA (TTIK) since the beginning of private management.

Function outsourcing programs allowed contractors to perform those tasks Edesur believes are not part of the company's business core, which resulted in staff reduction and its corresponding cost savings. As a result of these programs and a change in the working method, the ratio of the number of clients per employee increased from 374 in 1993 to 748 in 1999, with a substantial growth in the distributor's productivity (Figure 4).

Bolivia

During a ten-year period of regulation of the distribution sector (1996–2005), investment reached US\$283.7 million (see Figure 5). Total investment during this period exceeded the value of all investment performed until 1995, which shows the strong incentive of the new regulatory framework to invest. Figure 6 shows the evolution of investment in distribution during the 1999–2005 period, after the process of reform was initiated.

Quality control in the service was introduced through several six-month periods. The first six were called transition periods and the following were scheme periods with stricter indicators than the previous ones. Figure 7 and Figure 8 show the evolution of interruption frequency and average time and customer service average time, respectively. They show that all these indicators have had a descending trend and that there has been constant improvement during the entire 1999–2005 period.

The new investment in transmission, generation, and distribution projects allowed for the introduction of new technologies, especially in substation equipment, control system equipment, software, SCADA, generator automation, etc.

The application of incentive price regulation to the distribution companies has been a successful process in Latin America, with difficulties experienced that vary from country to country.

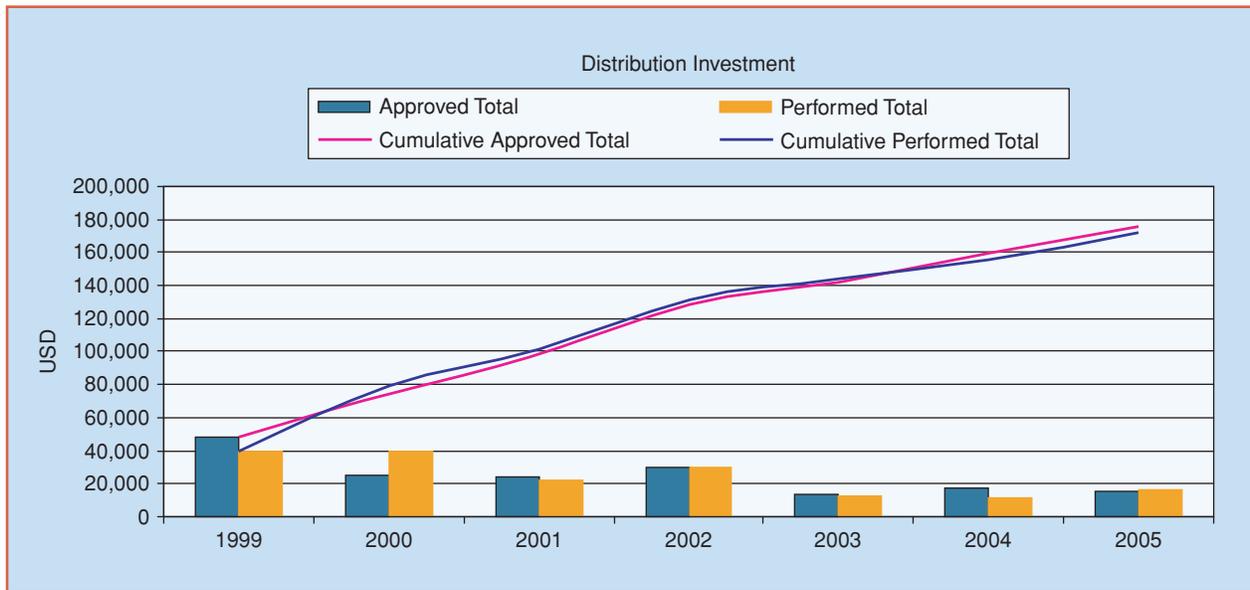


figure 6. Evolution of investment in distribution.

Chile

Chile has had 20 years of experience in applying benchmark regulation to its 36 distribution companies. As Figure 9 illustrates for the low-voltage segment of the largest Chilean distribution company, the remuneration of the distribution business has followed a downward pattern, with an overall reduction of 44% since 1984.

Despite the cost reductions, returns for the distribution companies have been very favorable, concentrating between 10–20%, as can be seen in Figure 10. This is what leads to question if fairness has been achieved and if there has been an adequate transfer of benefits to the final consumers, given the distribution companies efficient investment and operating policies.

It is clear that distribution companies have been able to gain efficiency throughout time, reflecting the clear incentives of the benchmark methodology. Reductions of technical and nontechnical losses for the largest Chilean distribution company are shown in Figure 11. Reduction of losses has been achieved over time, reducing them more than 50% in less than ten years.

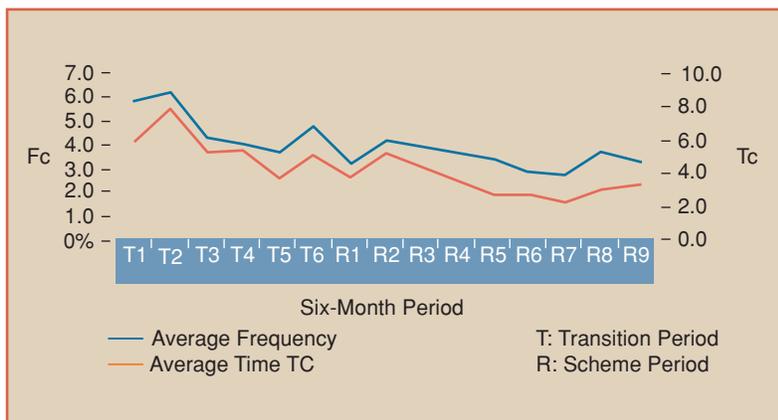


figure 7. Evolution of interruption frequency and average time.

Colombia

Reforms in Colombia were introduced in all utility services, electricity included. The new framework has had a very positive impact on coverage, company sustainability, and quality of service. Figure 12 shows coverage response to the introduction of

reform and the regulatory framework for different utility services. In Bogotá and Medellín, electric power companies reached almost global coverage (100%). In Barranquilla, Cali, and Bucaramanga, coverage reported for 2002 was 86%, 92%, and 96%, respectively.

Service interruption frequency (SIF) and service interruption duration (SID) indicators measure the duration and frequency of service interruptions. According to the Superintendence of Residential Utilities (SSPD), the SID indicator, accumulating electric power service interruption hours, was reduced to almost 50% between 2000 and 2001, falling from 38 to 21. Likewise, the SIF indicator, which accumulates the number of interruptions in electric circuits, fell from 43 to 20 in the same period.

The results of reform in company efficiency are conclusive. The indicator showing employees per 1,000 connections has definitely fallen in the five companies in the sample (Table 2), with especially strong adjustments in those that were in worse conditions and whose management was transferred to the private sector. Those on the coast changed from an index of 8.7 in 1998 to 1.8 in 2001.

A pending issue in relation to brokers is what is known in regulation texts as “market skimming.” Incoming brokers concentrate on users with higher consumption and lower trading unit costs. The incumbent broker cannot compete for these customers. Since under regulation prices cannot be discriminated, a competitive offer to a user of the incoming broker would imply a decrease in charges for all its market. Skimming may cause the incumbent’s bankruptcy, the loss of its market, and the appearance of inefficient brokers.

Peru

After eight years of operation of the reform, results can be summarized as follows. The electrification coefficient in the country has grown from 56% to 73%, with electric power service coverage of 3.3 million users. Electricity loss levels have decreased from 22% to 10%. Market agents have received price signals that have allowed the

Table 2. Evolution of the number of employees per customer.

Company	Number of Employees				Employees/1,000 Customers			
	1998	1999	2000	2001	1998	1999	2000	2001
EE.PPM	2,735	2,149	1,476	1,668	3.5	2.6	1.7	1.9
ESSA	1,044	1,018	852	836	2.7	2.5	2.1	1.9
EMCALI	658	572	563	524	1.5	1.3	1.3	1.2
ELECTRICARIBE	2,314	1,251	1,300	1,224	8.7	1.8	2.0	1.8
CODENSA	1,904	1,213	996	841	1.4	0.7	0.6	0.5

SOURCE: SSPD (Superintendence of Residential Utilities) Energy Representative.

Peruvian electric power system to develop by means of competitive tariffs, compared to other countries with similar regulatory, economic, and geographical frameworks, such as Argentina, Chile, and Bolivia. The regulatory framework signals have impacted on company efficiency; for example, the cost of staff and third-party services over total revenues has fallen from 26.5% to 13.7% in the distribution sector (Figure 13).



figure 8. Evolution of customer service average time.

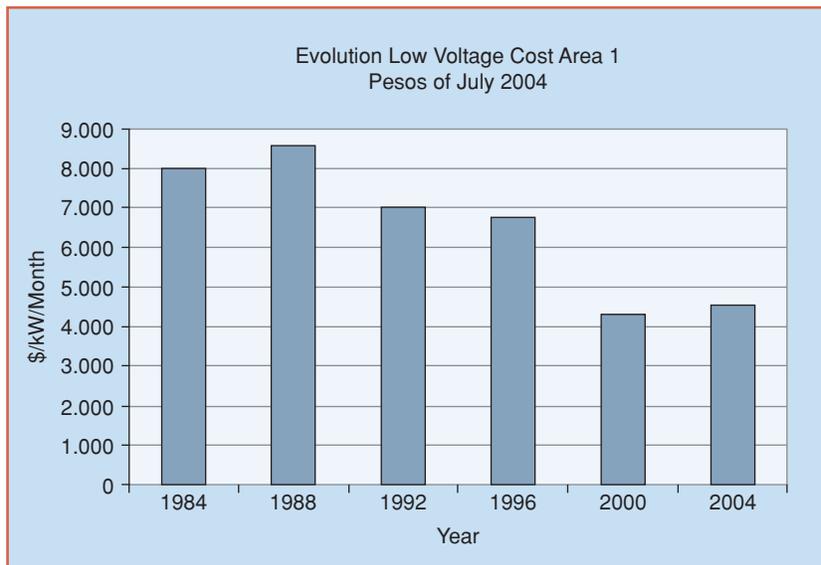


figure 9. Costs recognized for low-voltage distribution.

The average collection period has also been optimized; in the distribution sector it has fallen from 115 days to 61.1 days, as shown in Figure 14.

Regarding service coverage, there is a significant increase in the service, from 55.9% at the end of 1993 to 72.2% in 1999. When the new regulatory framework was implemented, companies received adequate incentives to achieve these results, as is shown in Figure 15.

Regarding losses in distribution companies, which went through a rather difficult situation in years such as 1993, when losses hit a record of 21.8%, companies have managed to reduce losses to 10.4% in the 1993–2000 period (Figure 16). This is due to the loss reduction schedule of the regulator as well as to the tariff mechanisms companies can apply as a result of profits resulting from cost reductions.

In summary, as seen in the different country examples, the

balance of incentive regulation in distribution has been positive, for the following reasons:

- ✓ increase in levels of electrification and supply coverage
- ✓ increase in efficiency of the distribution service/reduction of costs (investment, operation, and management)
- ✓ reduction of losses
- ✓ introduction of new technologies
- ✓ increase in quality of service.

Challenges of Incentive Price Regulation

The application of incentive price regulation has not been exempt from difficulties over the years, with conflicts arising over its application between the regulators and the companies involved. While the regulators in general aim at reducing tariffs as much as possible, the companies aim at increasing their revenues. Some of the areas of conflict are described.

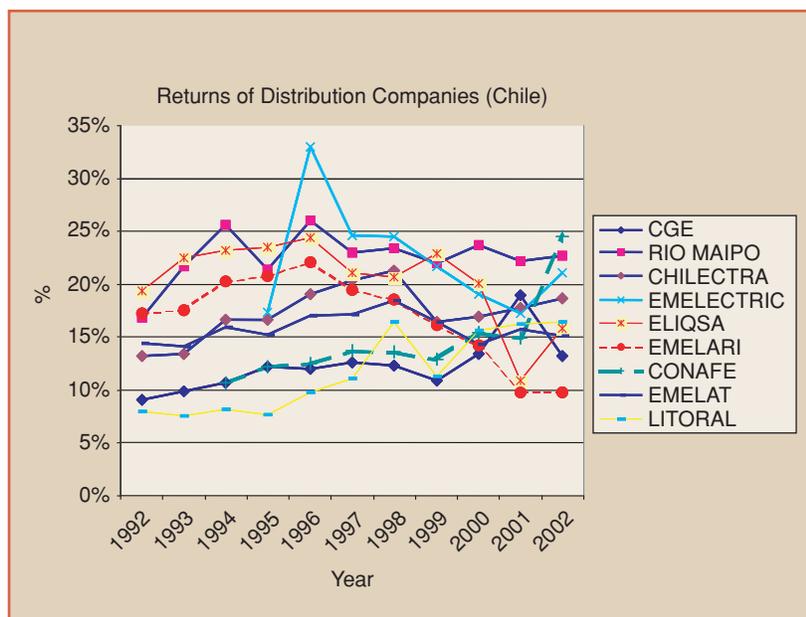


figure 10. Return of distribution companies in Chile.

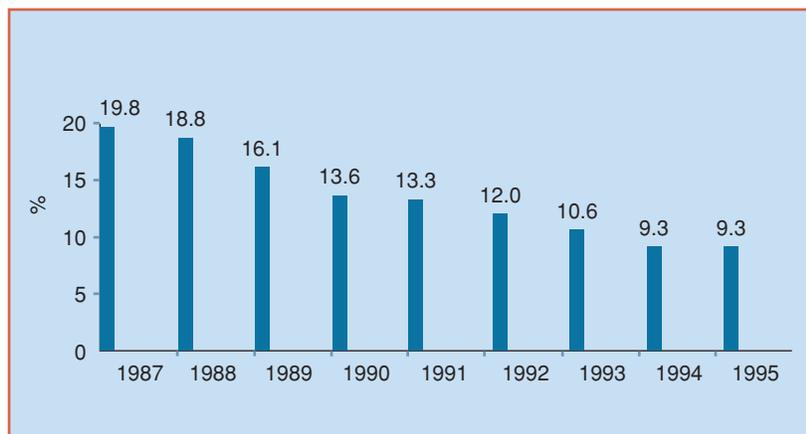


figure 11. Reduction of distribution losses.

Technologies

The search for efficiency in distribution requires evaluating different technological alternatives that are not necessarily in use by the concessionary company, leaving aside the historical practices. In this sense, the evaluation of conductor technologies is a matter of permanent discussion; e.g., the use of copper versus aluminum, the determination of distribution voltage, the range for optimal use of the conductors, and the compared length of networks of low and high voltage. The studies show that an efficient expansion process would install practically the same amount of network of low voltage, but with a greater transport capacity, mainly correlated with the street layout, and install a high-voltage network of smaller length, conditioned by the optimization of the secondary transformers.

In relation to secondary transformers, the total installations are evaluated, considering both location and capacity. The studies show that an efficient company would install a smaller number of transformers of greater capacity that are better located, which nevertheless results in a greater total installed capacity with a lower cost than the concessionary company, essentially due to economies of scale.

Management

Certainly an area that causes conflict in the efficiency analysis bears relation to the design of the organization and

The application of incentive price regulation has not been exempt from difficulties over the years, with conflicts arising over its application between the regulators and the companies involved.

infrastructure necessary to administer, operate, and maintain the distribution network of the company. Aspects such as organization design and the number of workers and level of outsourcing of functions (such as maintenance or commercial areas) are permanently discussed and subject to different views between the regulator and the distribution companies.

Another subject of discussion is the price to consider for commodities at the time of the study, such as steel, copper, and aluminum, with the discussion arising in relation to valuing at a cost that does not correspond to the one historically incurred by the monopoly. Possibly, it can mean

Economies of Scale and Prices

With the objective to determine the value of the efficient distribution activity, it is necessary to have studies of market prices of the necessary items for the installation and operation of the distribution network, as well as studies of wages for the employees of the company. There is a permanent discussion on different issues, such as the concept of market price, given the difficulty to obtain price references of specific equipment, which often forces use of actual information from the company, and the level of wages adapted for the distribution company, which is generally obtained from a survey of prices and benchmarks with other companies.

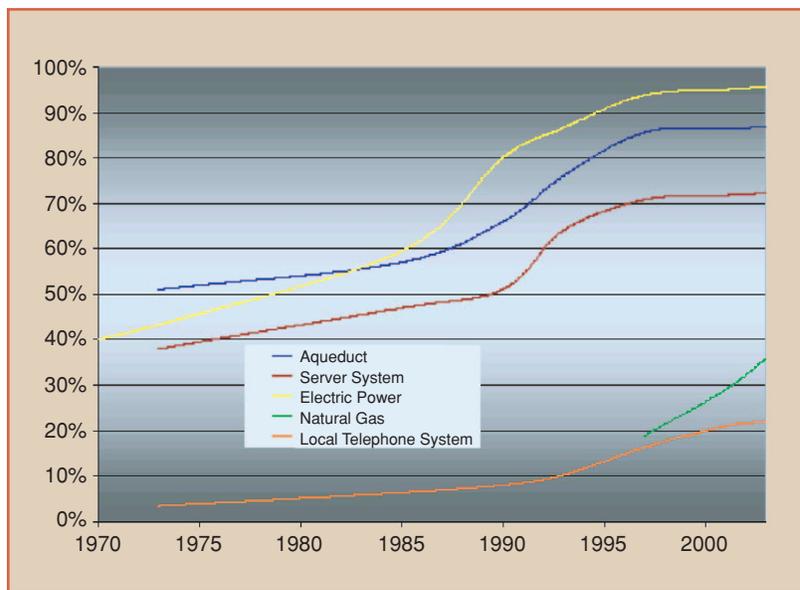


figure 12. Evolution of utility coverage.

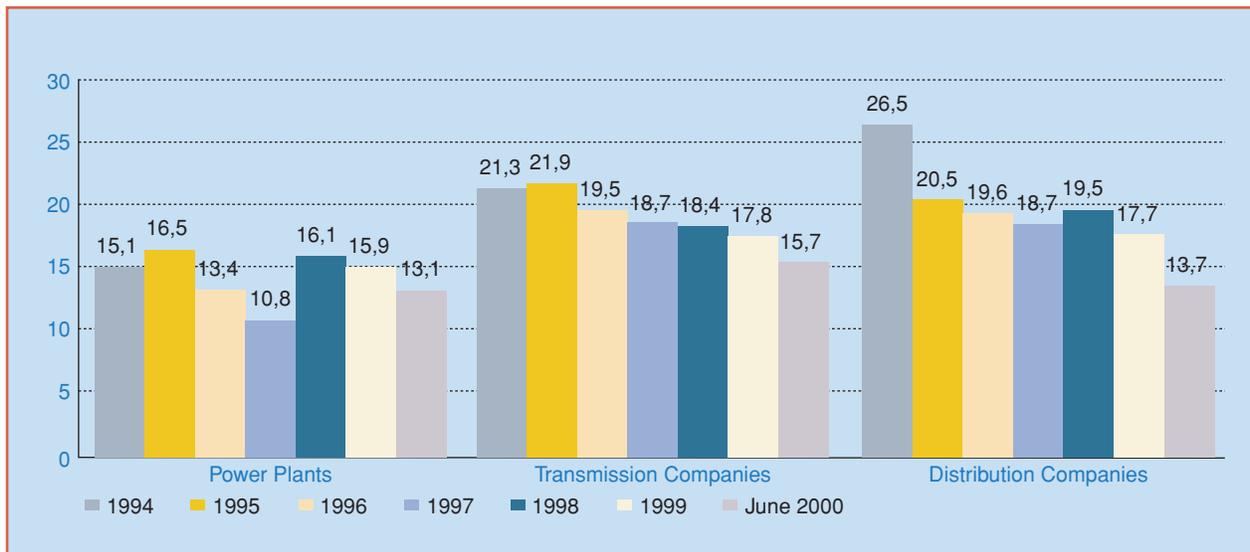


figure 13. Evolution of the cost of staff and services over total revenues.

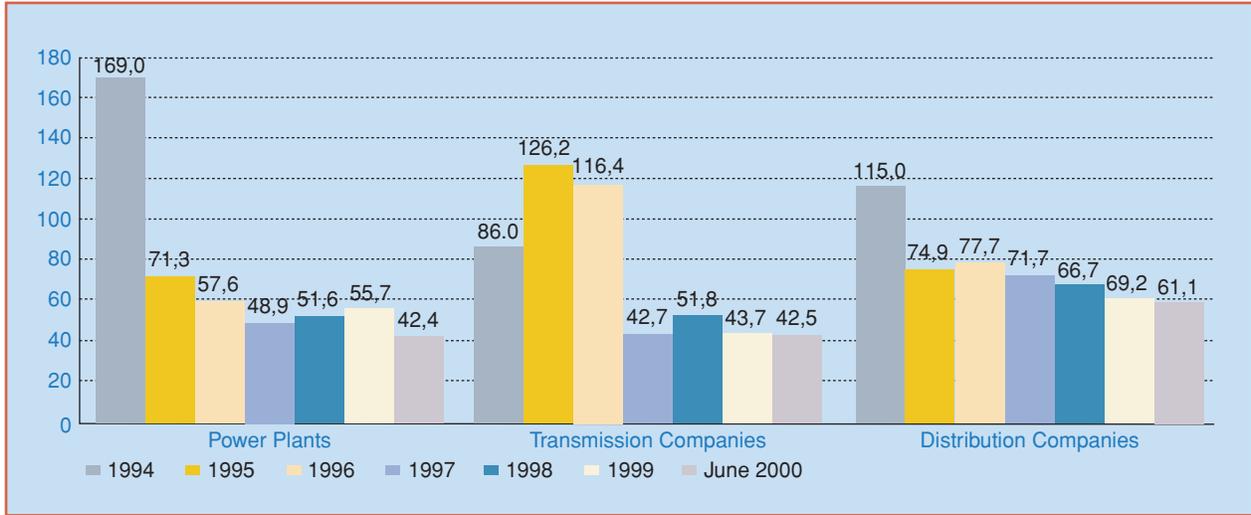


figure 14. Evolution of collection period.

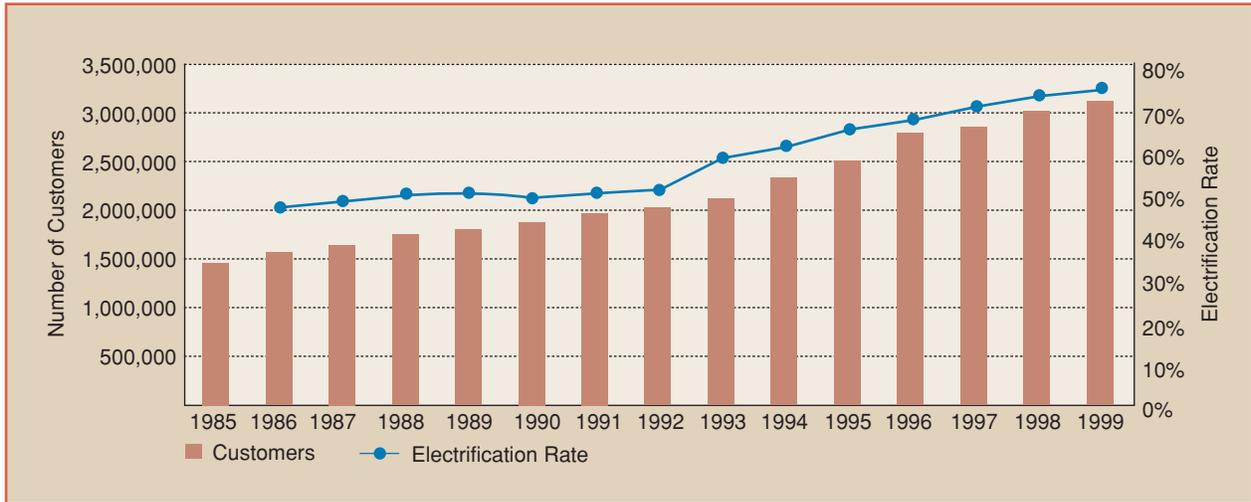


figure 15. Evolution of customer coverage.

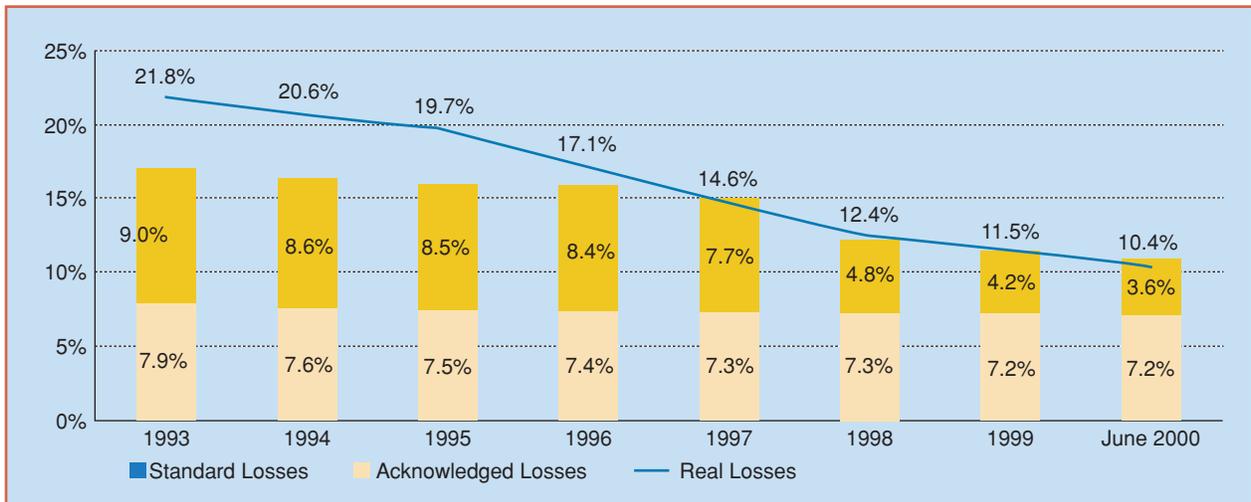


figure 16. Reduction of distribution losses.

In incentive regulation, efficiency is measured against a previous benchmark and the results allow the identification of the actions required to drive efficiency improvements.

a subvaluation of the company if the commodities at the time of the fixation correspond to historical lower of prices, or vice versa.

In general, the incentive regulation process needs to follow general guidelines that may also be difficult to achieve. For example, it is very important to assure regulator independency from monopoly pressure and avoid regulator capture. This is a key issue in any of the schemes that have been formulated to tariff the distribution segment. The incentive regulation exacerbates conflictive interests between regulator and monopoly. On the other hand, there is always the risk that the regulator could manipulate the prices with other objectives, such as political interests to lower rates.

Also, it is very important to consider reliability and quality of supply, especially since the companies have to necessarily comply with current reliability and quality regulations. Therefore, there has to be a consistency between the standards of quality and reliability that are required and the level of income set by the resultant tariff.

Conclusions

The Latin America experience of incentive regulation for distribution companies has resulted in a sustained evidence of efficiency, through clear incentives for cost reductions, and attraction to investors, given adequate returns to investment capital. Nonetheless, greater fairness in efficiency sharing is an objective that, although partially achieved, should be revised, in order to allow a larger transfer of benefits of the scheme to end users.

There are no major implications in the application of regulatory reforms in network development technology, except for specific cases such as commercial loss reduction. In fact, regulation signals for loss reduction have motivated distributors to adopt distribution models of the U.S. type even in countries with European distribution, since they have proved to be efficient against energy theft.

For Further Reading

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Biographies

Hugh Rudnick is a professor of electrical engineering at Pontificia Universidad Católica de Chile. He graduated from the University of Chile, later obtaining his M.Sc. and Ph.D. from Victoria University of Manchester, United Kingdom. His research and teaching activities focus on the economic operation, planning, and regulation of electric power systems. He has been a consultant with utilities and regulators in Latin America, the United Nations, and the World Bank. He is a Fellow of the IEEE.

Alejandro Arnau graduated as an electrical engineer with an M.B.A. from the University of La Plata, Argentina. His expertise in economic and technical projects was developed in numerous studies on different regulation environments for distribution companies in Latin America, particularly in Argentina, Chile, Uruguay, Bolivia, Peru, Colombia, Venezuela, Guyana, Nicaragua, Panamá, El Salvador, the Dominican Republic, and Guatemala.

Sebastian Mocarquer graduated as an industrial electrical engineer from Pontificia Universidad Católica de Chile. He is currently the development manager at Systeem Ingeniería y Diseños. He has directed several tariff studies in Chile and has made regulatory studies with utilities, regulators, and investment banks in Chile and abroad.

Efrain Voscoboinik is an electrical engineer who graduated from the University of La Plata, Argentina. He also took a postgraduate course in maintenance management at the same university. He has been an assistant professor of electric facilities at the University of La Plata and is a professor of engineering at the Universidad Tecnológica Nacional, Argentina. Since 1999, he has been working for Mercados Energéticos, actively participating in several regulatory studies and due diligence processes.

