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## Market Mechanisms and Supply Adequacy in the Power Sector in Latin America

Latin America has emerged in the recent years as one of the most dynamic regions for electricity markets. The region is characterized by high demand growth rates and strong hydro share. In the 1990s the region has been one of the world leaders in private investments in the electricity sector. The process of reform of the electricity sectors so far has not reached all countries in the region and occurred in “waves” in the countries with deregulated markets. The example of Chile was firstly followed by Argentina in the early 1990s and shortly later by Bolivia and Peru. By the mid-1990s it had spread to Brazil, Colombia, and several Central American countries, concluding the “first wave” of the power sector reform. From 2004-2008 some countries in the region made adjustments in their regulatory frameworks aiming at keeping the positive aspects of the first stage of their reforms, but correcting the issues that have not worked as expected. A convergence to a common market model was observed and ingredients of this “second generation” include: (i) incentives to forward contracts to induce the entrance of new capacity (the so-called competition “for the market”, instead of “in the market”), (ii) in some countries these contracts need to have physical coverage and (iii) the use of procurement auctions to incentive efficient contracting and setting up pass-through price, (iv) the possible complementation of state and market in the expansion of generation and transport.

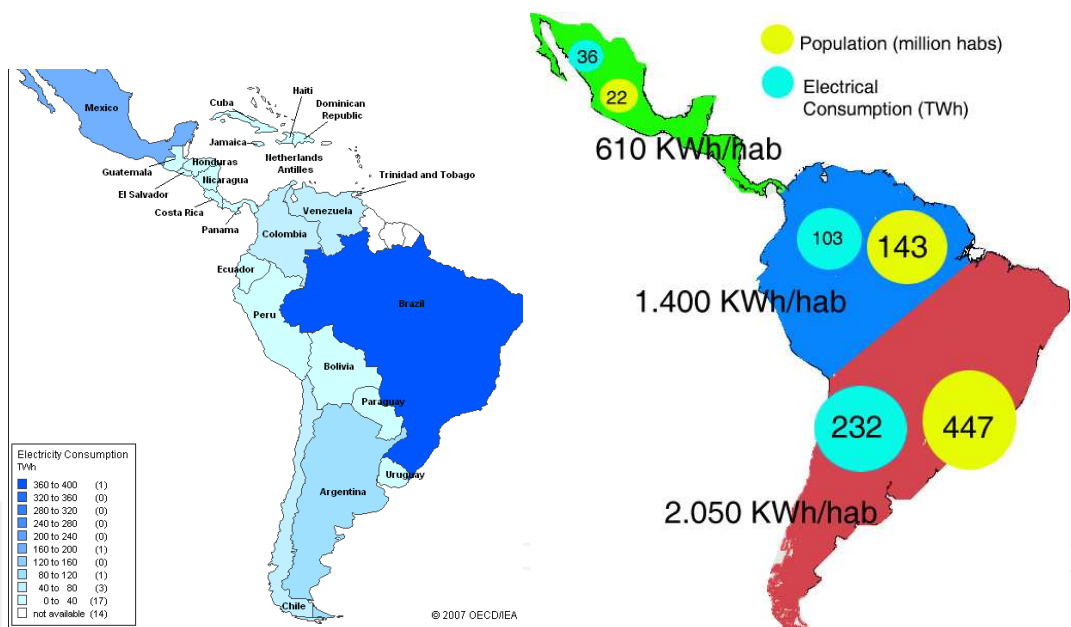
This Chapter reviews the design and outcomes of this second generation of power sector reforms in Latin American countries, aiming at identifying the common challenges and the schemes adopted to tackle them such as the use of contract auctions, strategies to deal with demand uncertainty, capacity expansion and degree of state intervention, among others. With these diverging approaches, their primary challenge is to ensure sufficient capacity and investment to reliably serve their growing economies.

### 17.1 Latin America: Economic Growth and Energy Supply

All developing countries require high investments to respond to a continuous increase in electricity demand, directly linked to economic growth. Only South America requires about 70 thousand million dollars of investment in the power sector in the next ten years. Because electricity consumption per capita is relatively small, it is not surprising that while industrialized countries have had an average annual growth of electricity consumption between 1 to 2%, the Latin American subcontinent has experienced an average growth of over 5% during the last decade. There are 270,000 MW installed in Latin America (2007), with Brazil dominating with 34%, followed by Mexico with 19.5%, Argentina with 12% and Venezuela with 8%. Electric systems in the region are often of a radial nature, with weakly meshed networks and only few incipient international interconnections. The region is rich in

resources (hydro potential, oil and gas). Hydro generation is the dominant supply source in the region with a share of 52% of the total installed capacity (68% as far as energy generation) and often with plants within complex cascades over several river basins with diverse hydrological patterns. The strong share of hydro generation results in a “clean” energy matrix and “leverages” other renewables which have seasonal (e.g., cogeneration from biomass) and intermittent (wind) production pattern: hydro reservoirs are used to compensate for the variability of wind power production and the seasonality of biomass energy production with no need for expensive and polluting thermal plants as backups to the renewable resources. Natural gas has an increasing role in the region, and cross border electricity and gas links are important resources for the region.

A profound transformation took place in the Latin America electricity supply industry organization in the 1990s. Essentially, three electricity markets were developed in the region: the Central American market, the Andean market and the Common Market of the Southern Cone (Mercosur). The one with the largest per capita energy consumption is Mercosur, an integrated market of 230 million people over an area of 12 million square kilometers, comprising the countries of Argentina, Chile and Brazil plus Paraguay, Uruguay and Bolivia (see Figure 17.1).



Source: OECD/IEA, 2007.

Figure 17.1. Overview of Latin America

17.2 The First Generation of Market Reforms in Latin America

While the motivations of the power sector reform in developed countries was introduced to facilitate competition as means to reach the ultimate goal of greater efficiency, the reforms in Latin America had the additional motivation of relieving the government to fund investments in new generation capacity that were required to match predicted load growth. Although differing in the degrees and details of implementation, the power sector reform in the region shared a common two-stage process [1].

The first stage of the power sector reform in the region was purely based on market mechanisms to achieve these goals, inspired by similar reforms in more developed countries. Pure market mechanisms formed the backbone of the regulatory frameworks to achieve the objectives of reliable and efficient guarantee of energy supply and adequate tariffs. In particular, the key driver for decisions was the spot prices in the short-term market, which would then be used to provide the correct economic signal for the entrance of new generation: if there is an imbalance between supply and demand, then these prices should increase and thus create incentives for the construction of new plants. The market risk resulting from the spot price volatility would be managed through pure risk-management instruments, such as forward contracts, options, etc. The only “non financial” instrument would be the capacity charge, whose main objective would be to ensure the remuneration of peaking units and reserve generation. With those market mechanisms in place, State-owned utilities were privatized and consumer choice was introduced in different degrees.

Most Latin American countries reformed their power sectors based on these principles, obviously with differences among the implementation details. The accumulated experience so far has shown many positive aspects, such as a greater efficiency of the private utilities, the positive effect of the eligible consumers as market benchmark and the transparency brought by the regulatory agencies, which provide confidence for investors.

On the other hand, some important difficulties (power crisis, rationings) have appeared, in particular with respect to the security of supply. A recent evaluation carried out by the World Bank [2] shows that about 20 countries around the world had energy supply difficulties (power crisis, rationings) in the late 1990s and early 2000s. Argentina, Colombia, Brazil and Chile are among these countries. A first reason for these supply difficulties is that the economical signal provided by the spot market is too volatile to correctly indicate and stimulate the entrance of new capacity. This is especially true for the countries with a strong hydro-share, where the occurrence of conjuncture favorable hydro conditions can drive downwards the spot prices even if there are structural problems with supply. It has also been observed that in hydro systems the energy spot price increases substantially only when the system is “too close” from a power crisis, when there is not time anymore to make investments. A second reason is the combination of a strong demand growth but with a large volatility in the growth rates (“stop and go” economies that can be heavily affected by international crisis). This makes the generation activity very risky and makes difficult the closing of “project finance” by the financing institutions for new projects, which ends up constraining the entrance of new capacity (see [19]).

Figures 17.2 and 17.3 next show the historical record of energy spot prices in Brazil as well as the historical electricity load and GDP growth. It is possible to see the volatility of prices and load growth, which discourages the fully functioning of an energy-only market and challenges the implementation of merchant projects (load growth volatility may disrupt market growth expectations).

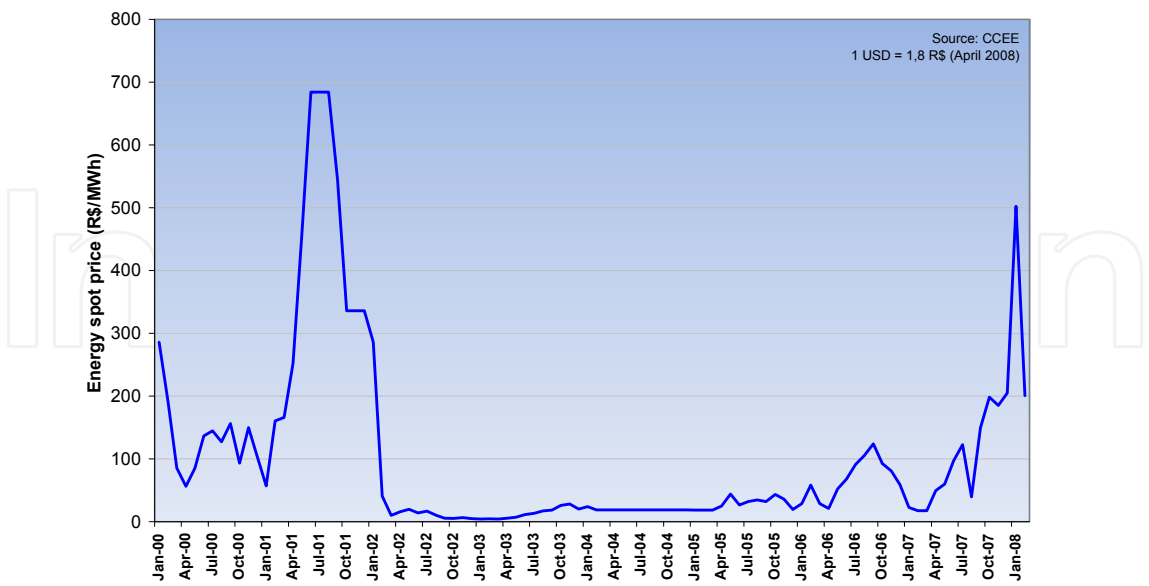


Figure 17.2. Brazil energy spot prices (R\$/MWh)

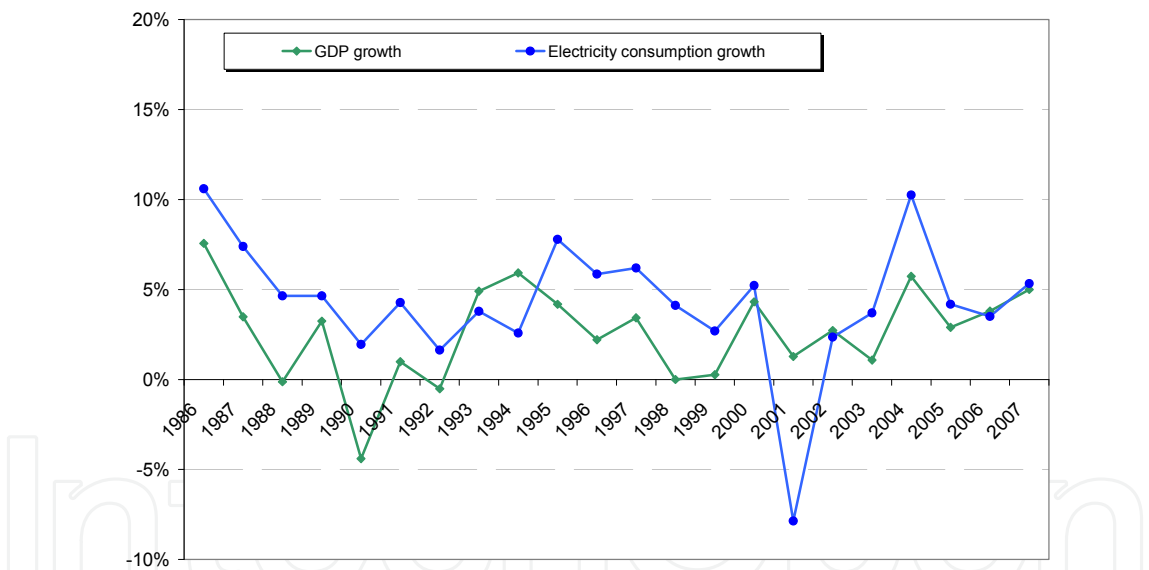


Figure 17.3. Brazil: Load growth and GDP growth

In summary, the fast (and uncertain) electricity load growth and energy spot price volatility introduce challenges for the supply adequacy of a region where projects are financed under a “project finance” basis and long-term stable cash flows are needed to allow the structure of the financial loans (for Greenfield generation).

17.3 The Second Generation of Market Reforms in Latin America

Due to the aforementioned difficulties and challenges, many countries in the region have made adjustments in their regulatory frameworks, adopting special mechanisms to

stimulate the entrance of adequate capacity and ensure resource adequacy with a reliable supply. These adjustments aim at keeping the positive aspects of the first stage of their reforms, but correcting the issues that have not worked as expected.

A convergence to a common market model was observed. The characteristics of this “second stage” include: (i) the key point of the competition is not in the spot market but in the contract market with the demands that result in the entrance of new capacity (the so-called competition “for the market”, instead of “in the market”) and (ii) requirement of coverage of these contracts by physical generation capacity. The core of these proposals lies in two main rules:

- The first rule is that all consumers, both regulated and free, should be 100% contracted;
- The second rule states that all contracts, which are financial instruments, should be covered by “firm energy” or “firm capacity” certificates (FEC and FCC).

For the regulated users, the procurement of new capacity is carried out through public auctions. In one scheme, such as the one adopted in Brazil, the distribution companies (Discos) are required to inform their load forecasts and a contract auction is jointly carried out to meet the total load increase. In an alternative scheme, such as the one adopted in Chile and Peru, each Disco manages its own auction. Aggregating the demand of various interested parties may be possible. In a third scheme, adopted in Colombia, a firm energy option is purchased in an auction for all consumers.

Overall, the advantage of the auction of contracts is to recognize that a Power Purchase Agreement (PPA) provides a degree of certainty in the generators’ cash flow, allowing access to long-term financing. The process can be cost-competitive if procured through international competitive bidding (competition for the market). The next sections described how these challenges in electricity supply are being faced by Brazil, Argentina, and Chile.

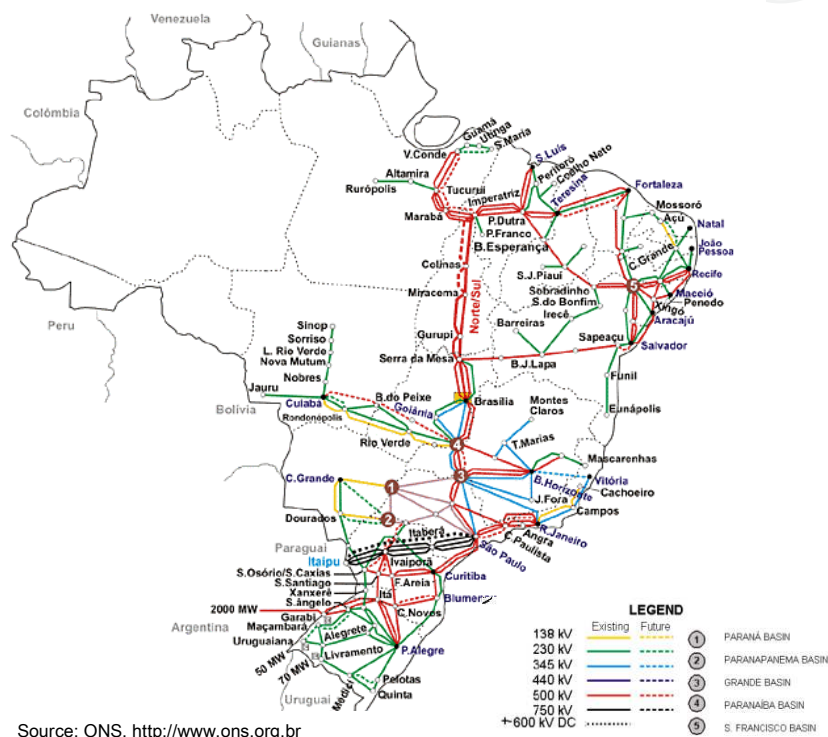
#### **17.4 Brazil: Auctions of Options and Forward Contracts**

The Brazilian power system is the largest in Latin America, with an installed capacity of 105 GW. Almost 90% of the energy produced comes from hydroelectric plants; the remaining generation mix includes natural gas, coal, nuclear and oil. Bioelectricity (co-generation from ethanol production, which uses the sugarcane bagasse as a fuel) is emerging as a competitive new source.

The main hydro system is composed of 140 plants, with capacities ranging from 30 MW to 14,000 MW (Itaipu binational plant at the border with Paraguay), and located in a dozen river basins throughout the country. Because of Brazil’s large area (equal to the continental USA plus half of Alaska), the basins have a wide variety of weather and stream flow patterns. For example, when the well-known climate phenomenon “El Niño” occurs, the Northeast region faces droughts, whereas the Southern region has an increased rainfall. In order to take advantage of this diversity, the Independent National System Operator (ONS) dispatches the whole hydro system as a “portfolio”, with transfers of huge energy blocks from the “wetter” regions to the “drier” ones. Hydro plants are dispatched with basis on their expected opportunity costs (“water values”), which are computed by a multi-stage



stochastic optimization model that takes into account a detailed representation of hydro plant operation and inflow uncertainties (see [4]). As a result, the overall supply reliability is increased and the use of fossil fuels in the thermal plants is minimized. This type of countrywide dispatch optimization requires an integrated and robust transmission network, able to accommodate different export/import patterns among regions. The main grid has 90 thousand km, with voltages from 230 kV to 765 kV AC. There are also two 600 kV DC links: a 900-km line, which is part of Itaipu’s transmission system and a 2200 MW back-to-back interconnection with Argentina (for more details, see [3]).



Source: ONS, <http://www.ons.org.br>

Source: ONS, Brazil, 2007.

Figure 17.4. Brazil – physical system

17.4.1 The Market Design

The first rule in the Brazilian regulation is that all consumers, both regulated and free, should be 100% contracted. The contract coverage is verified ex-post, comparing the cumulative energy (MWh) consumed in the previous year with the cumulative energy contracted. If the contracted energy is smaller than the consumed energy, the user pays a penalty related to the cost of building new capacity. For regulated consumers, it is allowed to be over contracted in up to 3%. The second rule states that all contracts, which are financial instruments, should be covered by ‘firm energy certificates’ (FEC)<sup>1</sup>. For example, in order to sign a contract for 1000 average MW<sup>2</sup>, the generator or trader must show that it

<sup>1</sup> This is because the Brazilian system is 85% hydro and is energy-constrained, not peak-constrained.

<sup>2</sup> Average MW = GWh/ #hours

possesses firm energy certificates that add to the same amount. The FECs are tradable and can, along the duration of the contract, be replaced by other certificates; the only requirement is that the total firm energy of the certificates adds up to the contracted energy.

FECs are issued by the regulator for each generator in the system, and reflect their sustainable energy production capacity. For hydro plants, for example, the FEC corresponds to the yearly (firm) energy production capacity in dry years. For thermal plants, the FEC is given by the available capacity (discounting average maintenance and forced outage rates), adjusted by a 'derating' factor that depends on the variable operating cost<sup>3</sup>.

The joint requirement of 100% coverage of loads by contracts and 100% coverage of contracts by firm energy certificates creates a link between load growth and construction of new capacity. For example, if an industrial user forecasts that its load will increase by 200 average MW three years from now, it will start to procure contracts, in order to avoid the penalties. If supply is tight, the generators and traders will not have enough FEC to cover the contract; the only option will be to offer a contract for an investor to construct a new plant. In other words, the contract coverage requirement makes load growth the driver for the construction of new capacity, and the FEC coverage requirement ensures that the constructed capacity is adequate to cover this load growth. If the system is 100% contracted and contracts have physical coverage, then supply reliability is assured.

In this scheme, deregulated consumers can negotiate bilaterally their energy needs and are free to contract their "new energy" as they wish. On the other hand, in order to promote the most efficient purchase mechanism for regulated (captive) consumers, the contract obligation scheme for distribution companies was coupled with the use of regulated procurement auctions as the main mechanism for contracting energy. Regulated energy contract auctions are therefore the backbone for the induction of efficient purchases on behalf of captive consumers by distribution companies. The auctions for energy purchase by distributors are separated into regulated auctions for contract renewal (existing energy auctions) and auctions for new ("Greenfield") energy (new energy auctions). Two public auctions carried out every year for new energy delivery 3 and 5 years ahead Auction for renewable energy (wind, solar, small hydro and biomass) can also be called. Note that the Brazilian approach bundles two products: the FEC and the energy contract. This section discusses the new energy auctions.

## **17.4.2 Regular Auctions for Existing and New Energy**

### **17.4.2.1 Auctions for new energy**

The new energy auction is intended to exclusively promote the construction of new capacity to cover distribution companies' load increase. In these auctions, standard long-term energy

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<sup>3</sup> The idea is that an expensive plant, for example, diesel-fired, is only dispatched late in a drought situation, whereas a cheaper plant, for example combined cycle natural gas, is dispatched earlier. As a consequence, the cheaper plant's contribution to the overall 'firm supply' is more significant than that of a more expensive plant. Taken at the extreme, a thermal plant whose variable operating cost was equal to the rationing cost would have a firm energy certificate of zero average MW.



contracts (15 – 30 years) are offered to potentially new generators. Every year, two types of new energy auctions are carried out:

- *Main auction* (A-5) – this auction offers bilateral contracts for new capacity with duration between 15 and 30 years, which will enter operation in five years' time (hence the name), such as hydro plants. The idea is that this contract will allow the investor (auction winner) to obtain the project finance, and have enough time to build the plant. Besides ensuring the expansion of supply, the decrease in the investor's risk should lead to a reduction in new capacity costs. One of the main aspects of this auction is that distributors will have to estimate energy demand five years in advance in order to better estimate its energy needs on A-5 auction.

- *Complementary auction* (A-3) – this auction also offers bilateral contracts with duration between 15 and 30 years for new capacity. In this case, however, the plants should enter operation in three years' time (such as a thermal plant), not five. The idea is that this auction complements the A-5 auction carried out two years earlier, because “now” there is less uncertainty about future load growth.

In order to avoid a contracting strategy where “everything” is contracted in this auction, the amount contracted by a distributor on an A-3 auction is limited to 2% of its total load observed 2 years before. This “two-stage” auction process is a strategy for dealing with load growth uncertainty, which is an important issue in Brazil, and also to account for the needed construction time for the new plants. One important consequence of this scheme is that new capacity additions in the system will be a consequence of the willingness of the distributors to buy energy in these auctions. Since the regulated market (captive consumers) accounts for about 75% of the total market, the results of the new energy auctions will drive the system supply expansion for the regulated market. Finally, the new energy auctions are not exclusive for distribution companies. Large consumers and self-producers can have access to new hydro concessions through these auctions by making bids for the available projects.

#### **17.4.2.2 Auctions for existing energy**

Existing energy contracts complement the new energy contracts so as to cover 100% of the load. They are also auctioned. The objective of these auctions is to recontract yearly the existing energy, i.e., to supply the current market. The contract duration is between 5 and 15 years and they start on January of the following year. For this reason, the Existing Energy auctions are known as “A-1”. Besides the duration, the existing energy contracts have other special characteristics that make them different from the new energy contracts: the existing energy contracted amount can be reduced, at any time, to match the distribution utilities' load reduction in case a qualified captive consumer becomes a deregulated consumer. In addition, the existing energy contracted amount can be reduced, at the utilities' discretion, up to 4% in each year to make up for demand uncertainty. In other words, the existing energy contracts are more similar to financial “put” options.

17.4.2.3 Adjustment auctions

These auctions are intended to “fine tune” the match between contracted supply and load. The adjustment contract duration is up to two years and auctions are carried out three or four times a year, with the contract starting within the same year. For this reason, they are also known as “A-0” contracts. The amount contracted by a distributor on an adjustment auction is limited to 1% of its total load contracted.

17.4.2.4 Summary of energy auctions

Figure 17.5 presents the overall scheme of the regular existing and new energy auctions, which are yearly offered:

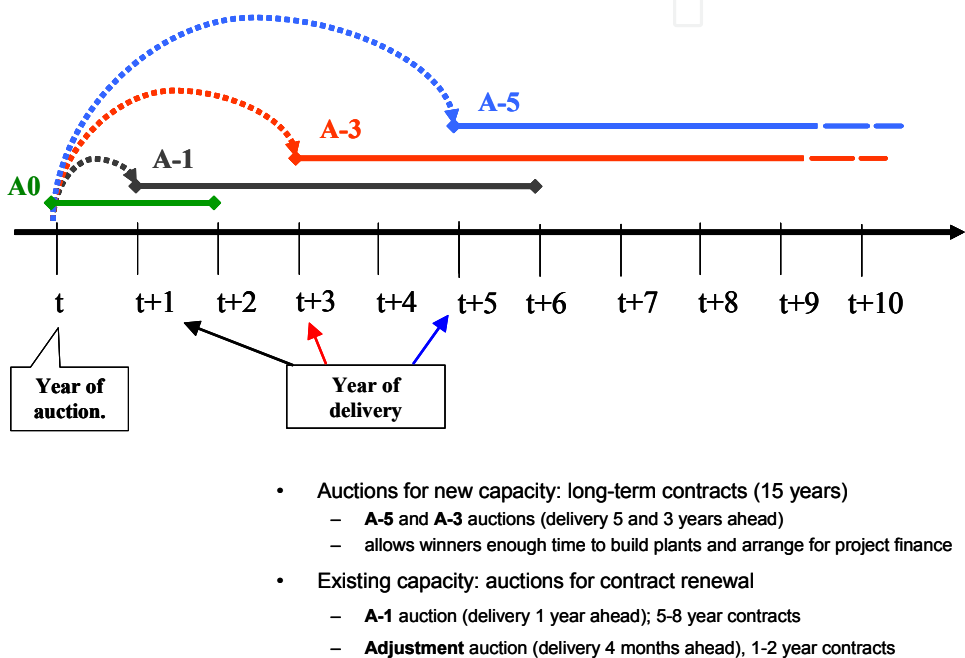


Figure 17.5. Existing and new energy auctions products and delivery dates

The portfolio of energy supply contracts of a distribution company is then formed by a mix of existing and new energy contracts.

17.4.3 Auction Procedure

Each auction (new energy, existing energy and renewables) is jointly carried out by all distribution utilities. Sixty days before each auction, each utility declares the energy demand (MW average) that it wants to contract. The auction announcement then calls for offers that will cover the total demand (sum of all declarations). The joint contracting scheme is a mechanism for creating economies of scale in the contracting process of new energy for small Discos as well as for equalizing tariffs among consumers aiming at assuring tariff adequacy.

Also, each separate winner of an auction will sign individual bilateral contracts with each distributor participating in the auction, being the energy amount of each contract proportional to the Disco’s declared demand, and the total contracted quantity for each generation company (GenCo) matches its offered quantity. This allows the benefit of

cheaper energy to be shared by all consumers. Although a “central procurement” is made, Discos are responsible for deciding how much energy they want to contract (i.e., responsible for load projections), thus avoiding the ‘optimistic’ government bias that in many countries has led to over-capacity and expensive energy contracts. Contract costs can be passed through to customers up to a benchmark price (overall resulting weighted price of the auction), and winners of an auction will sign individual bilateral contracts with each Disco. In other words, this is not a single buyer model, the Government does not interfere in the contracts nor provides payments guarantees.

In both existing and new energy auction, the objective is to contract energy at the lowest possible cost to consumers. Therefore, the auction design is chosen accordingly. Auctions carried out so far have used a two-phase hybrid auction, where in the first phase an iterative descending-price clock auction design is applied and the auction ends with a final round of bids using a pay-as-bid scheme (second phase). Figures 17.6, .7 and .8 show the main steps of the auction mechanism. In the case of auctions for new capacity, the country has used two contract types: standard financial forward contracts and energy call options.

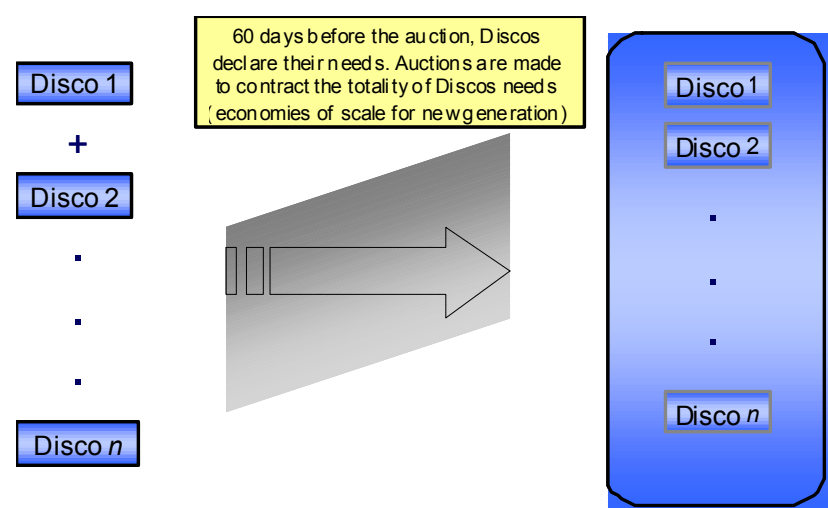


Figure 17.6. Auction scheme: before the auction

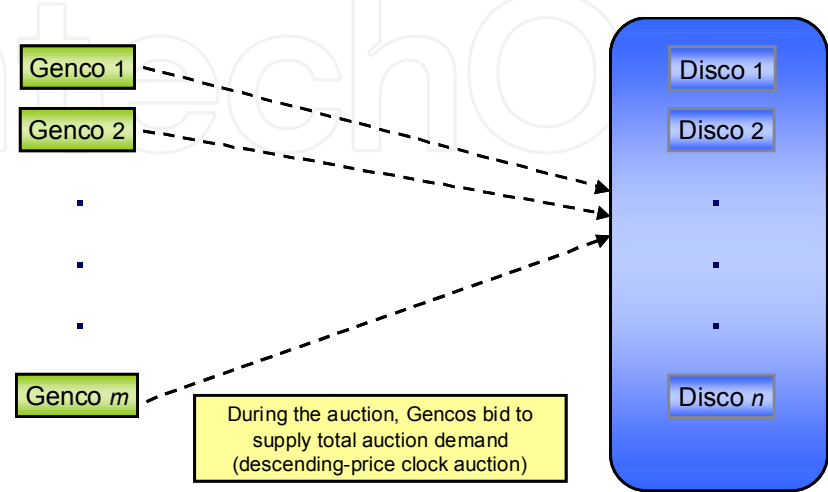


Figure 17.7. Auction scheme: during the auction

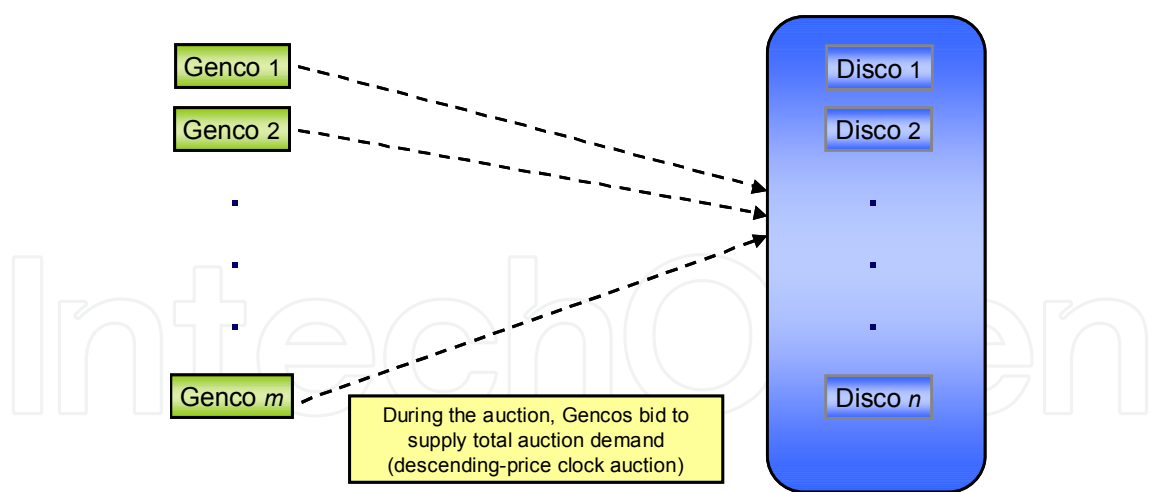


Figure 17.8. Auction scheme: after the auction

The Ministry of Mines and Energy sets up a committee to organize these auctions. This committee is in charge of proposing all the relevant documents, including auction design, design of energy contracts and price caps for each auction.

17.4.4 Types of Contracts

The contracts auctioned in the new energy and existing energy auctions are financial instruments and can be of two types:

- (i) *standard financial forward energy contracts*, also known as contracts “by quantity”. These are standards “take or pay” energy contracts in which the buyer pays a fixed \$/MWh for the energy contracted and the seller has the delivery risk, clearing the difference between energy produced and energy contracted at the spot market;
- (ii) *energy call options*, also known as contracts “by availability”. These are contracts where the consumer “rents” the plant from the investor, paying a fixed amount (\$/kW.month), and reimburses the plant for the variable operating costs (\$/MWh) whenever its flexible part is dispatched or the consumer bears the spot market transactions costs otherwise. For details, see [5].

Contract prices are adjusted every year for inflation and have fuel price indexation. The government has the right to decide which type of contract will be offered in each auction. The objective is always to provide to distribution companies the best portfolio of contracts to minimize the consumer costs. Overall, MME has been applying the contract type (i) for the existing energy auctions. As for the new energy auctions, type (i) has been applied for hydro plants and type (ii) for thermal plants.

17.4.5 Auction Results

The implementation of the regulated auctions started in 2004, when the first existing energy auction was carried out. This represented the largest electricity auction in world history. Since then, several other auctions for existing and new energy were carried out, involving a total energy volume of almost 31,000 average MW (firm energy, not peak capacity) and involving about 85 billion USD in financial transactions. A summary of the blocks contracted and weighted average resulting auction prices are depicted in Figures 17.9 and 17.10.

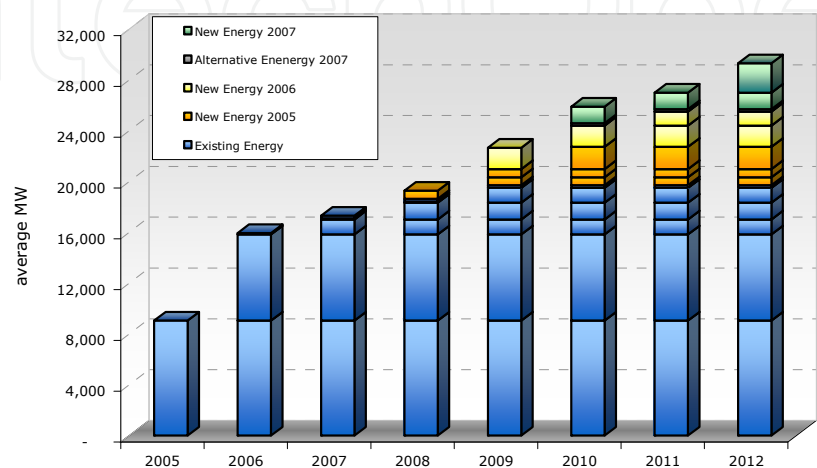


Figure 17.9. Energy blocks contracted (energy average MW, not peak)

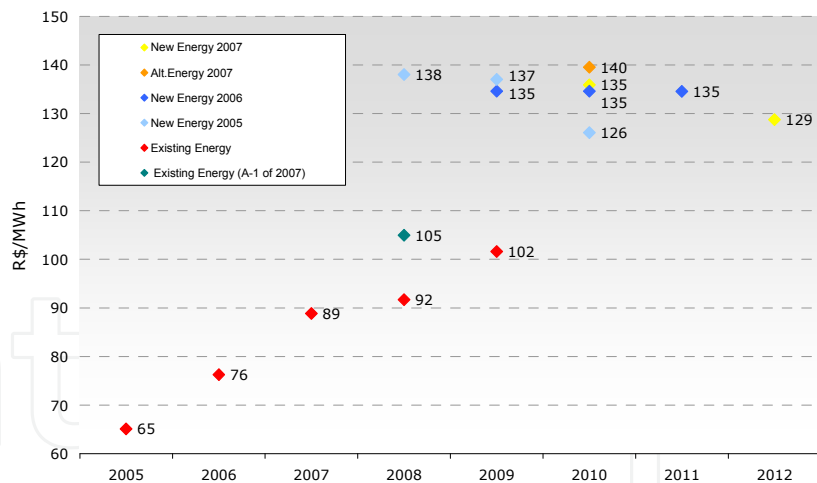


Figure 17.10. Average contract prices (1 USD = 1,85 R\$)

Overall, the auctions for new capacity in Brazil have been of great interest to local and international investors looking to South America’s energy market: the candidate suppliers list has been high and contracted generation has included a mix of a wide variety of technologies, comprising new hydro projects, gas, coal and oil-fired plants, sugarcane biomass and international interconnections.

### 17.5 Argentina: Successful Reform Clogged By Government Intervention

Argentina has 24,000 MW of installed power capacity for a peak load near 18,000 MW, with additional 2,200 MW of firm exportations committed to Brazil should be added to. Domestic natural gas demand averaged 90 Mm<sup>3</sup>/day in 2004, while exportations represented near 25 Mm<sup>3</sup>/day extra. Roughly 50% of total energy requirements are covered by natural gas. Although the country was completely energy self-supplied up to 2004, the hydrocarbons reserves horizon was significantly reduced in the last years mainly due to small investment on exploration. Natural gas reserves have now a horizon near 13 years versus 20 years in 1999. Oil reserves present a similar trend but smoother: current horizon is near 12 years. Alternative energy resources to natural gas for power generation include potential hydro developments mainly concentrated in plain rivers, which imply high investment requirements. Use of other energy resources is limited. Historically, coal represented a small proportion of energy balance, while 1,000 MW in two nuclear power plants were developed in the 1970s.

At the beginning of the 1990s Argentina reformed its energy sector as part of a wider economic reform whose main basis was the implementation of a fixed currency exchange rate regime that tied local currency 'Peso' to the US Dollar at a 'one to one' ratio combined with a free regime of importation and exportation of capitals. Inefficient performance of vertically integrated state-owned utilities during the previous decades led to an integral transformation of the energy sector. This process included the implementation of a completely new regulatory framework established by both the Electricity and the Natural Gas Acts, passed in 1991 and 1992 respectively. State-owned utilities were vertically and horizontally unbundled and further privatized or given in concessions. Wholesale markets for natural gas and electricity based on private participation were implemented. Transportation and distribution mainly remained as regulated monopolies within their concession areas, with the only exception of electricity transmission expansions for which an innovative scheme based on market participants' decisions was adopted. Production was completely deregulated, allowing entry of private companies in oil and gas exploration and production, as well as in electricity generation. Oil sector reform based on a new Hydrocarbons Act also included the privatization of public company YPF during 1992, which had the monopoly on upstream activities, and the deregulation of retail fuel prices.

Performance of the Argentinean energy sector after reform was largely reported as successful, and was often cited as a model of deregulation. In power generation, Argentina developed one of the most competitive markets worldwide. Wholesale electricity prices decreased from near 5 cts/kWh in 1992 to 3 cts/kWh in 1994 and less than 2.5 cts/kWh in 1997, while domestic consumption grew at an average annual rate of 5.7% between 1992 and 2000. Also, two private interconnectors of 1,000 MW each were built to export electricity to Brazil. Increase of energy exports also included oil and gas. The country stopped importations of gas from Bolivia in 1994 while started exportations to Chile and Brazil. Thus, Argentina became the benchmark for successful deregulation processes worldwide. This rosy situation worsened and decayed under a severe economical crisis that affected all the country's economy sectors at the end of 2001.



### 17.5.1 The Crisis

As described in [14], after nearly 10 years of a fixed currency exchange rate regime, Argentina faced a severe political and economical crisis at the end of 2001. President De la Rúa resigned on 20 December 2001. Within the next 10 days it defaulted on its international debts. On 6 January 2002 the Congress passed a special law that gave the “emergency” status to the economy and abolished the fixed currency exchange regime. Since most of public and private contracts signed during the last decade were at prices and/or tariffs nominated in US Dollars, this law established the legal basis for unilateral government’s intervention on such prices, what included tariffs of regulated activities. These actions further motivated foreign investors to litigate against the Argentine government on international institutions such as CIADI.

To meet the economic crisis, the Peso was allowed to float. Within first six months of 2002 it had fallen from parity with the US dollar to 3.6 pesos/dollar, although several months later it stabilized around 3 pesos/dollar with some intervention of the government in order to avoid a higher appreciation of the Peso.

### 17.5.2 Energy Policy after the Crisis

Under the umbrella set by the “Emergency Act” passed in early 2002, which is still in force, the Government took several decisions regarding the energy sector aiming:

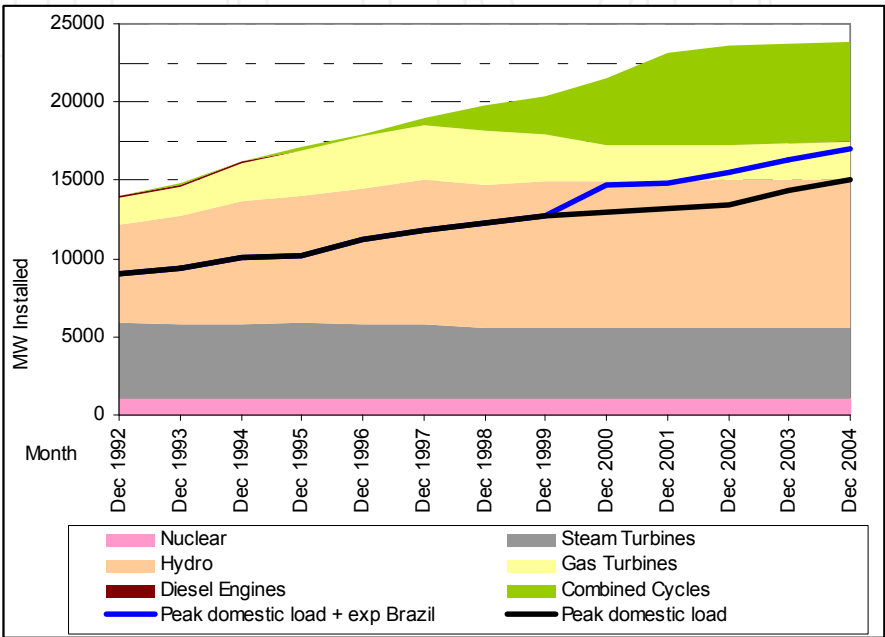
- to minimize devaluation effects on end user’s prices, that in practice meant frozen tariffs in case of gas and electricity, and the implementation of withholding taxes on exports, that reduced the market reference price for oil and gas exporters in order to avoid increasing domestic prices and, at the same time, increase government income.
- to guarantee end users’ supply, ensuring covering of operational cost to existing producers but not fixed costs recovery, and promoting new expansions, most of them still in project status.

Frozen tariffs of regulated activities were implemented subject to future renegotiation of concession contracts, which in practice has not happened yet. Consequently, the devaluation augmented relative competitiveness of the Argentine economy with respect to the rest of the world. Local industry was benefited from frozen tariffs of gas and electricity and distorted oil-derivatives prices.

An agreement between natural gas producers and the government was signed in 2004. The latter committed to increase regulated tariffs to industrial customers in order to allow a gradual recovery of natural gas prices (wellhead prices in the Neuquina basin had decreased from 1.40 US\$/MBTU in 2001 to 0.40 US\$/MBTU in 2002). The energy sector, with frozen or distorted prices, would undoubtedly contribute to finance the local industry’s higher competitiveness in the post-crisis years, in what seems to have been a political decision.

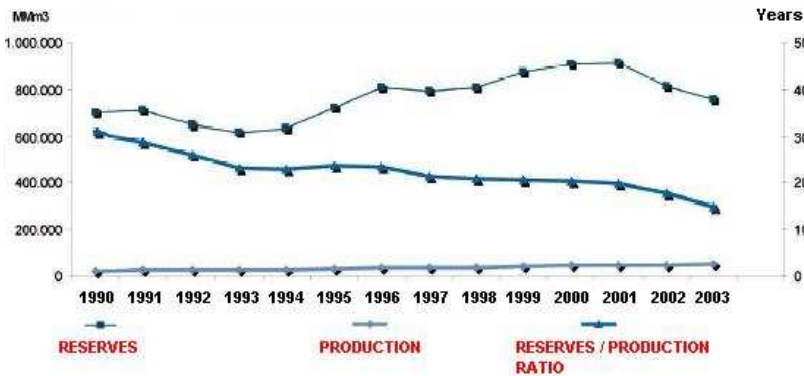
17.5.3 Consequences of the Post-Crisis Policy and Later Developments

The energy sector faced, and still faces, an economic long-run mismatch between what the economy needs from the energy industry and what this industry can offer to the economy under the current “relative prices scenario”. In practice, this has meant lack of investments in all energy sub-sectors since end of 2001. Consequently, domestic demand grow was gradually absorbing installed capacity, including those investments originally committed to exportations, as the horizon of hydrocarbons reserves was significantly reduced, particularly on natural gas. The next figures illustrate these effects.



Source: CAMMESA and Mercados Energeticos

Figure 17.11. Argentina - installed power capacity vs peak load



Source: Annual Report on Hydrocarbons Reserves 2003 – Energy Secretariat

Figure 17.12. Argentina - Performance on natural gas E&P

These facts were evidenced in April 2004, when the government announced reductions on natural gas exports to Chile in order to avoid curtailments on domestic demand. Consequences on electricity exportations to Brazil are yet unknown, since exportations contracts roughly have the characteristic of an option for the Brazilian demand: while

electricity prices in Brazil are lower than the price of Argentine energy, which works as a strike price, interconnectors are not dispatched. Given the fact that the Brazilian power market had lower prices since 2002, Argentine options actually have not been significantly exercised. In case they do in the future, similar restrictions to those applied to gas exports to Chile should not be discarded.

But restrictions to exports were not enough to supply the domestic energy demand. In view of this situation, the government restarted permanent importations of natural gas from Bolivia in 2004, as well as occasionally imported electricity from Brazil. In addition, significant quantities of fuel oil and diesel were imported from Venezuela during 2004 in order to ensure full fuel supply for thermal power plants in case natural gas was not available. In mid 2003, the government together with private Argentine companies announced the construction of a new pipeline from Bolivia to Buenos Aires, which would allow an increase of natural gas offer by 20 mm<sup>3</sup>/day. This project was recently discarded in light of the severe institutional and political crisis in which Bolivia is currently involved. Frozen tariffs and distorted prices blocked most of investment recovery for those existing companies at the time that crisis started. In the particular case of the power market, measures adopted lead to a significant imbalance between what the demand paid and what generators had to receive that resulted in a significant credit requested from generators. The government proposed to swap such credits with shares of a new company to be created for building and operating a new power plant. It should be noted that all the described actions, most included in the denominated "Energy Plan 2004-2008" published by the government, were oriented to ensure full supply of future energy demand reducing the expected average total cost by allowing special tariffs for them and, simultaneously, avoiding recovering of 'old' investment costs by private investors. More than 4,000 MW of new combined-cycle thermal plants were installed in Argentina between 1997 and 2001. Investors questioned that these plants were considered as 'old' investments, less than five years after they were installed.

#### **17.5.4 The Government as a Leader in Energy Development**

A new state-owned company promoted by the government, ENARSA, was created in October 2004. Main initial assets of ENARSA were full exploration and exploitation rights of most of oil offshore areas, but its business scope covers all energy-related activities. It is argued in Argentina that withdrawal of the government from the energy sector during the 1990s was excessive, and consequently more significant presence is now required. However, the question arises if the optimal way to achieve such presence is through a company that, in theory, is able to develop any energy business, and consequently compete with the private sector under unknown rules that, in addition, can be changed by the government itself.

The government said that ENARSA will allow them to follow what happens in the energy sector 'from inside', and consequently evaluate whether private energy companies' behavior is adequate or not. On the other side, many private companies see ENARSA as a tool by which the government may press them to agree conditions that, otherwise, would not be accepted. An agreement signed between ENARSA and PDVSA for acquiring retail network of gas stations currently owned by Dutch-British company Shell increased this perception in the private sector, since this is part of a wider strategic agreement between Argentinean and Venezuelan governments on energy matters that gives other dimension to the ENARSA's threat.

### 17.5.5 Domestic Problems Dominate the Energy Agenda

The energy plan presented by the government just seems to be a palliative for the expected consequences of about four years of lack of investments, rather than a strategic positioning of the country towards the possible international scenarios. Recent history seems to show a country that, worried by its self-created problems, perhaps has not given adequate importance in the last years to the development of its own energy resources as a strategic positioning of the country towards the complex possible international scenarios. This could represent a high cost for the country in the next years, but nothing indicates that this situation can be reverted in the near future.

### 17.6 Chile: The Difficulties of Modernizing the Reform Process

The Chilean power sector, that started a deregulation process back in 1982, has been another example in the region of sound sector reforms that have kept private power investment flowing, while reducing prices of electricity. The main difficulty in Chile has been to modernize its original outdated reform. The power sector has experienced several crises over its developments that have surfaced the weaknesses of its market model. The most recent crisis started when, as indicated in Section 17.5.3, the Argentinean government started facing problems with its gas supply and in April 2004 decided to reduce gas exports to Chile.

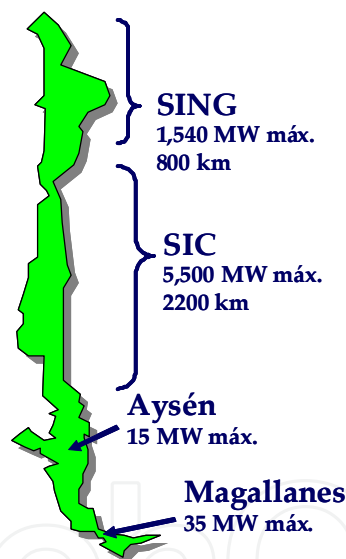


Figure 17.13. Chile

Chile, with 12,000 MW installed capacity in its two main interconnected systems (SIC and SING), is a country with limited energy resources except for its hydro reserves in the Andes Mountains. Its own oil only provides less than 10% of the country's needs, while its coal is of poor quality, so that imported coal has to be used for electric generation. Hydroelectric generation has been developed by using most of the low cost resources in the central part of the country. More expensive remaining significant reserves are over two thousand kilometers south from the main load center (Santiago). Argentinean natural gas arose as an attractive abundant cheap alternative and so an energy integration protocol was signed in 1995 with this neighboring country. Under that protocol, both governments agreed to establish the necessary regulations to allow free trading, export, import and transportation

of natural gas. Private investors were strongly behind this process, and heavily invested in several pipelines that crossed the Andes and defined an energy supply path that would significantly rely on the efficient combined cycle generation plant technologies. The protocol worked very well and Chile fully relied on Argentina to provide the necessary energy required to sustain its important economic growth. Gas exports steadily grew through several pipelines. The petrochemical industry and the thermoelectric generation became the main users of natural gas. The arrival of this cheap fuel and the efficient generation technologies meant a significant reduction in the electricity prices in the main interconnected systems as shown in Figure 17.14. As explained before, these good days were finished since the rise of partial gas curtailments in 2004. The crisis has growing effects, as partial curtailments have become total curtailments from 2007. This situation has led to a sharp electricity price increase as shown in Figure 17.14.

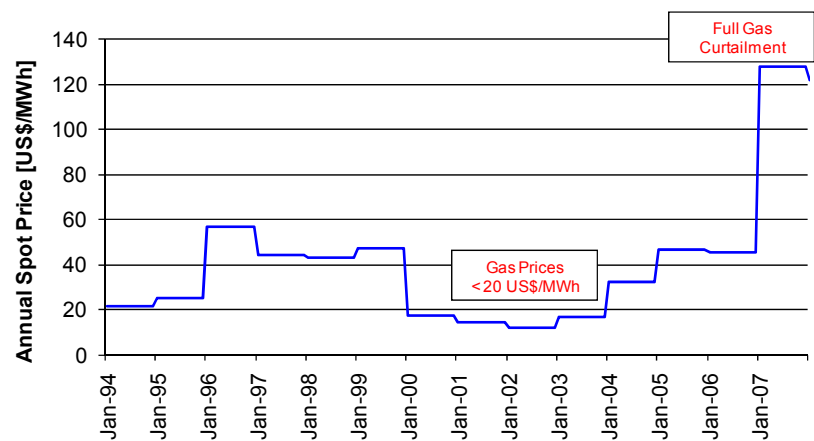


Figure 17.14. Spot price in the Chilean Central Interconnected System (CIS)

17.6.1 Looking for Market Alternatives to Face the Crisis

The crisis brought by the reduction of Argentinean gas left Chile with no alternatives. Although, next-door Bolivia has significant natural gas resources and it has increasing exports to Brazil and Argentina, it denies the fuel to Chile due to its long-term border disputes with Chile (Bolivia lost its access to the Pacific Ocean in a 19th century war with Chile). In addition, Peruvian gas is not yet an alternative, given the distance from the Camisea gas fields to the main consumption centers in Chile. Chile was not prepared for the surfacing conditions. As a demonstration, the National Energy Commission, in its Indicative Plan of April 2004, projected the construction of seven combined cycle natural gas plants in the next ten years, all fed by pipelines from Argentina. Based on this fact, large expansions of existing electric transmission corridors were included in that plan. Also, major new hydro plants and interconnections with other systems were postponed until 2010 or later and therefore gas continued to be the major driver of expansion in a market with demand growing around 7% year. With the rise of the crisis, the Indicative Plan of October 2004 introduced radical changes to the energy supply government’s point of view and so only one combined cycle plant based on Argentinean gas was considered. The government decided to bet on liquefied natural gas (LNG) as the alternative and defined a project to



build the necessary installations to import it from abroad (Indonesia, Australia and Algeria being supply alternatives). But in the deregulated privatized Chilean power market, where private capital is the one making investment decisions, there is little space for the government to act, unless changes of laws were introduced. This is what happened in 2005. But changes were towards market mechanisms.

17.6.2 Chile: The New Market Model

In Chile, according to the 1982 regulatory model, the energy price for the regulated consumer was calculated by the government every six months as a unique value that represented the expected marginal cost of generation and losses in the transmission system. It was computed for each node of the interconnected system by means of penalty factors. This centralized calculation of prices, the volatility of the spot market due to the high hydro participation and the curtailments of natural gas imported from Argentina since 2004 (22% of the capacity of the main Chilean interconnected system corresponds to natural gas turbines) created a very risky environment for generation investment when new capacity was strongly needed. Therefore, the government looked for solutions by exploring long-term contracts at a price fixed by a free bidding process in order to ensure profitable cash flows for investors and thus stimulate the entrance of new capacity. Thus, as described in [16], a new regulatory model was implemented in the country by incorporating a real market signal in consumer prices through auction mechanisms. The old energy price calculation will fade out, as auctions replace existing contracts. The aim is to reflect cost expectations of generators and investors and the existence of an attractive market with high, but competitive, yields. Although, each distributor must auction its own demand, the new law allows them the accomplishment of a large auction, in which generators and new agents can bid for the added demand of several distributors. As in the Brazilian case, the Chilean auction process also obeys the rules described in section 17.3. Figures 17.15 and 17.16 describe the functioning of the Chilean system before and after the new scheme.

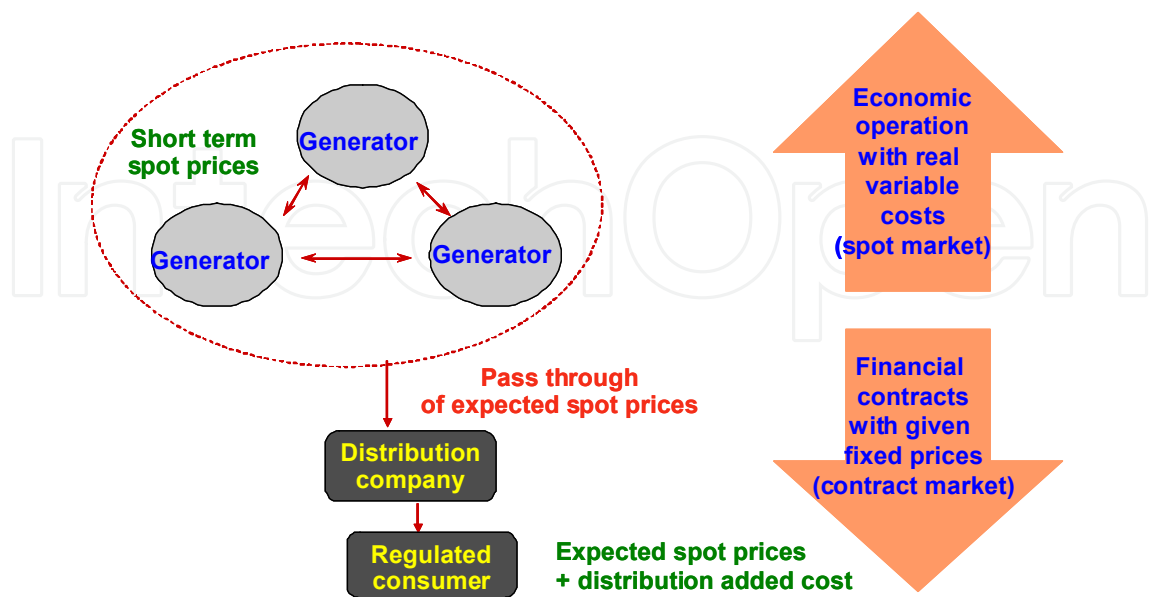


Figure 17.15. Previous Chilean model: spot prices all through the chain



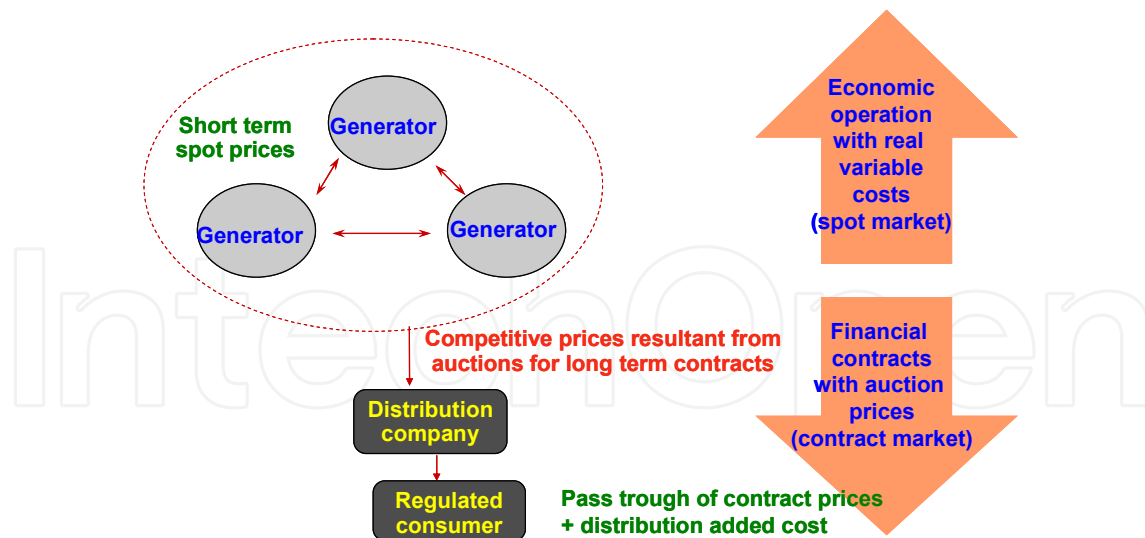


Figure 17.16. Current Chilean model: Contracts through market to stabilize revenues

Specific characteristics of the Chilean energy auctions are:

- Distributors must be 100% contracted all the time, at least for the next 3 years
- Distributors must contract their energy through auctions. Auctions must be public, open, transparent and without discrimination
- Each distributor auctions its consumption requirements according to its own needs
- Each distributor must design and manage its own auction. However, several distributors can organize a process to auction their added demand
- Distributors can offer contracts for 15 years at a fixed price (indexed according to changes in main variables)
- The government set a price cap for the auction
- A capacity price is fixed by the government (indexed according to CPI)
- Generators offer a price and an amount of energy (the amount of capacity is computed by means of a load factor)
- Auction winners will be the agents who bid the cheapest energy price alternative.

One of the most important aspects of the Chilean framework is that distributors design and manage their own auctions. This fact has opened a discussion about the incentives for distributors to design a mechanism that obtains lower end-consumer prices. It is important to consider that contract prices are passed directly to the consumers by using a pass-through mechanism. Thus, distributors have a constant yield for their assets, irrespective of the auction results. Distributors auction their demand at any time, depending on their needs. Although distributors design their own auctions, the regulator must approve the final designed mechanism.

Generators must give a yearly justification to the National Energy Commission (NEC) of their firm capacity to supply all the regulated contracted demand (unlike the firm energy used in Brazil, firm capacity is required in Chile). Generators can use a mix of existing plants and new ones to justify their capacity. Thus, the general auction process is not divided into existing capacity and new capacity auctions as in the Brazilian case.

The new regulatory model has a complex methodology to determinate the adequacy capacity (or firm capacity) of a plant:

- 1) Firm capacity of hydroelectric plants is computed by using the two driest historical hydrology profiles and their regulation capacities among others. So, run of river plants and reservoir plants could present very different firm capacities for the same amount of nominal capacity.
- 2) Firm capacity of thermal plants is computed by using the available capacity (discounting average maintenance and considering force outage rates). Gas plants consider gas supply curtailments.

Finally, the new model considers contracts with energy delivery, at least, 3 years ahead. It allows investors to obtain project finance and have sufficient time to build new plants. Hence, the new mechanism represents a business opportunity for new investors in the generation business. The generators that are participating in the auctions compete by offering energy prices, which are indexed during the contract period. NEC administratively defines capacity price previous to the auction, and it is indexed according to changes in CPI during the contract period.

In the Chilean mechanism, each bidder together with its supply offer proposes indexing formulas. The mentioned formula must be built according to the power source of the bidder. However, it is important to highlight that, according to the designers (Discos), due to the unpredictability of fuel prices, these formulas are not taken into account by the auctioneer during the auction process. This fact has caused several discussions in the Chilean electricity market because contract allocation can change dramatically if price projections are incorporated into the mechanism. Consequently, generators that present expected fuel prices dropping in time need to bid high prices at the beginning of the period in order to get enough revenues. On the other hand, generators with high-expected prices can bid a low price at the beginning of the period. Thus, when indexing formulas are not taken into account for the allocation mechanism, bidders with high-expected fuel prices are favored, and vice versa.

Although generators bid only quantities and prices of energy, the final contracts include volumes and prices of both capacity and energy. Thus, every block of energy auctioned contains the capacity needed by each Disco that is computed before the auction by means of a load factor. The existence of a capacity payment included into the contract motivates Discos to manage their loads in order to present a higher load factor and, consequently, a better use of the system capacity.

### 17.6.3 The Auction Design

The Chilean bidding process allows distributors to auction their demand in one single simultaneous process, in which every generator bids for a specific set of products (a Chilean product corresponds to a specific block of demand from a distributor). Generators can bid for a net amount of demand higher than their capacities. Nevertheless, each of them must specify its maximum capacity and the process could assign at most this amount. All blocks of demand are assigned to every generator at the same time by means of a combinatorial sealed bid mechanism as shown in Figure 17.17.

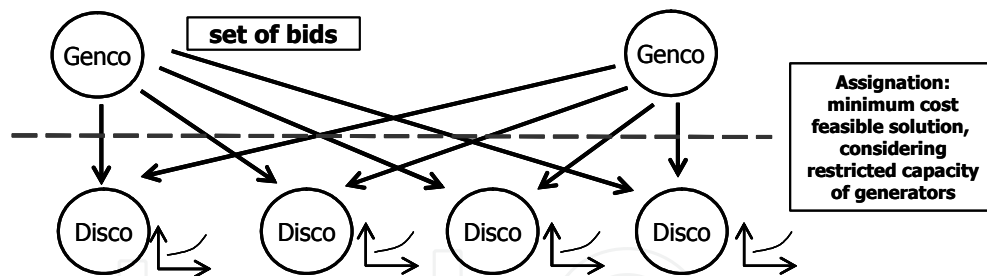


Figure 17.17. Auction mechanism

This mechanism has led to a large price differential among different products and distributors due to generators can choose a diverse set of bidding strategy for each auctioned contract.

As explained in [9], the auction design is crucial to get a good performance of the market, differences in price (and allocation) can be observed when applying various bidding rules.

#### 17.6.4 Results, Difficulties and Next Steps

Overall, the first auction was carried out on October 2006, where about 1,300 average MW (30% of energy sales of the main interconnected Chilean system expected for 2010, 90% of the auctioned demand) was covered by the main Discos at an energy price of 53 US\$/MWh in average, involving about 7 billion US\$ and supply contracts until 2024. No new agents made bids in the first auction process due to the short time given to prepare the offers. After this, two more auctions have been carried out for contracting energy by 2010. Whilst new generation projects have been activated due to the new framework, difficulties have arisen such as:

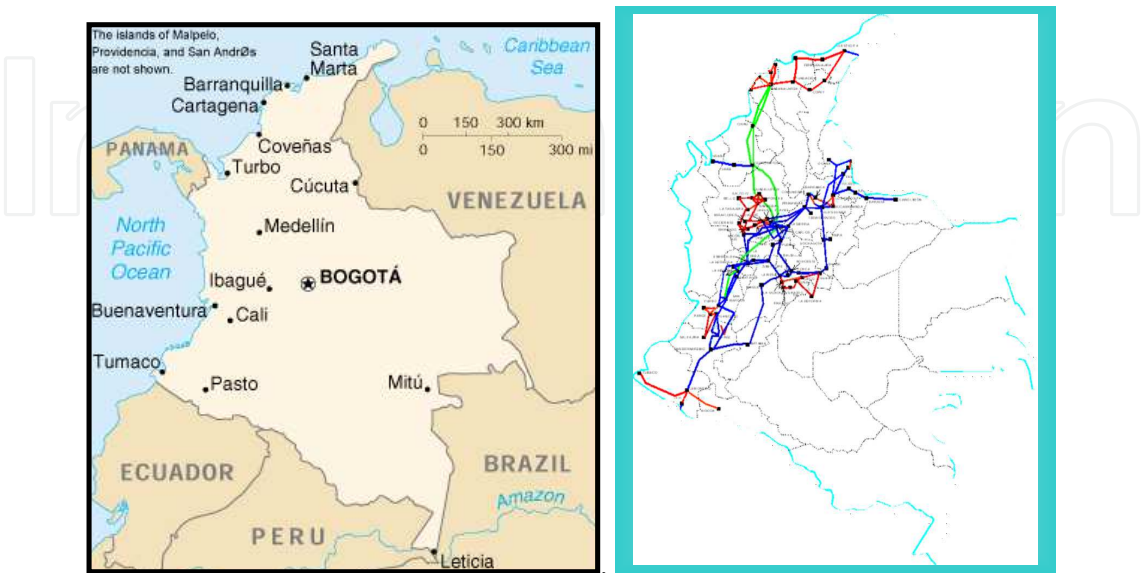
- High prices driven by the indexing formulas which are not considered in the allocation process
- Lack of new investors participating in the auction and high presence of the current agents
- Large price differential and level of competition among contracts (distributors).

In despite of these facts, the new framework has been well evaluated by the market in order to ensure adequacy in generation by including real market signals in regulated contract prices. Future auction improvements must increase competition and the entrance of new agents, as explained in [10], along with a better policy to spread prices among distributors.

#### 17.7 Colombia: Auctions for Long-Term Reliability Options

Colombia is located in the North West corner of South America. It is interconnected with Ecuador to the south and with Venezuela to the east and to the northeast. An interconnection line is in the last study stages with Panama and Central America, to the North West. The installed capacity in 2007 was about 14,000 MW, of which 66% was hydro, 27% gas, 5% coal. The remaining 1% corresponds to cogeneration and wind. Total demand is about 50 TWh, growing at a 5% annual rate. The electric energy in Colombia comes mainly from hydro-generation plants (77%) and a minor proportion from thermal-generation plants (18%). The dependency of the Colombian electricity market on hydro

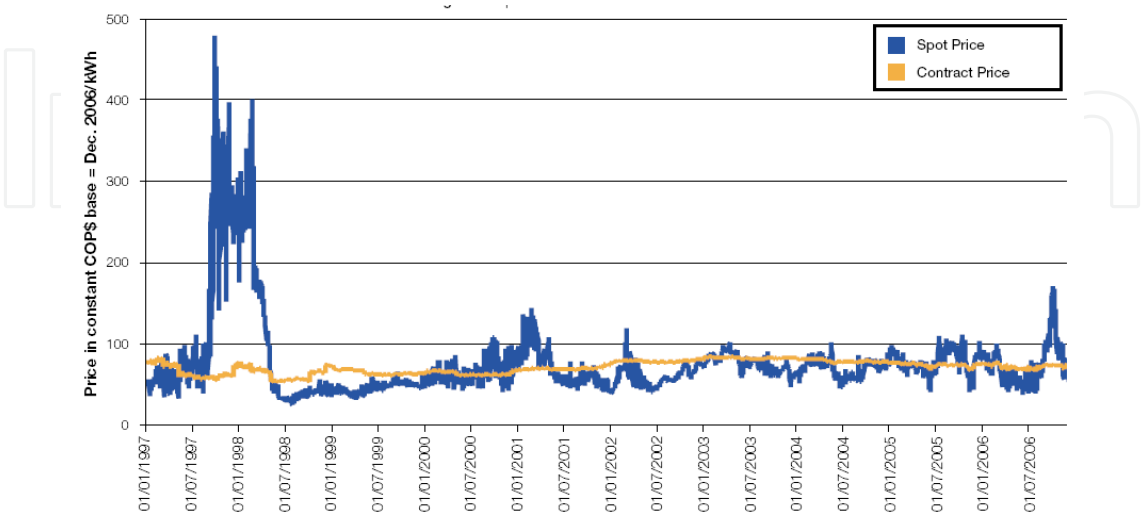
resources makes it necessary for the electric sector to have enough generation plants with firm energy to replace hydro-generated energy in dry periods that occur during climate phenomena such as El Niño. Without these alternative resources, demand would have to be rationed, implying high costs on the national economy.



Source: EIA and XM, 2007.

Figure 17.18. Colombia

Following the pattern of the electricity markets in the region, the price volatility in the energy Spot Market (see Figure 17.19), largely explained by the huge hydraulic component of supply and the periodic occurrence of El Niño phenomenon in Colombia, poses a considerable risk for generation companies that need financing for their projects. This situation calls for the implementation of hedging mechanisms to mitigate the risks for generation companies and new investors.



Source: XM and CREG, 2007.

Figure 17.19. Energy spot and contract prices in Colombia

### 17.7.1 The Previous Scheme: Capacity Charge

During 1992, Colombia experienced the most serious electrical rationing that the country has known. Direct costs were estimated of the order of three billion US dollars that the Colombian society paid in various ways. Rationing was mainly due to shortages of water resources brought by an El Niño event. This event precipitated the formation of the electric market (July 1995) and therefore, from its origins, the regulation of the Colombian electrical market is mainly focus on the potential consequences that may derive from a new rationing. Consequently, the regulation of the market has been determined by the interpretation that was made of the main cause of the rationing: shortage of hydro resources. Then, the efforts have been centered in preserving the resources and replacing them with more expensive resources that are complementary and more reliable.

Implementing a remuneration scheme that promotes income stabilization is considered as a fundamental issue by the regulatory body (CREG). Therefore, making investment in generation resources viable to efficiently cover the demand requirements, particularly during critical periods of low hydraulic supply [11,12], arises as an important task for the regulator. The first mechanism adopted was the administratively settled capacity charge: in general terms, it is a regulated income oriented to guarantee the reliability of the system, based on the remuneration of the plants established from the requirements of generation during the summer season estimated by an economic dispatch model with transmission, having as reference a critical hydrologic scenario and a demand projected for the year in reference. Initially the hydrologic scenario was associated to the critical biennium 91-92, later, this scenario was changed to an artificial “hyper dry” hydrologic event.

The capacity charge scheme in Colombia has always faced several challenges and implementation difficulties such as the administratively setting of the payment and the calculation of the firm energy, among others. With the intention of correcting these distortions and centrally replacing established procedures by market mechanisms, changes were introduced in 2006. They will be described next.

### 17.7.2. The New Scheme: Reliability Charge

Following ten years of uninterrupted application of the Capacity Charge scheme, CREG considered it beneficial to replace it with a market scheme, which conveys a long term signal that promotes new investments in generation resources in Colombia, to guarantee the availability of electric energy at efficient prices in periods of scarcity. A new method was designed, based on a market mechanism denominated Reliability Charge, which has been in place since December 2006. This new mechanism preserves the essential factors of settlement, billing and collection that guaranteed the successful payment to generation companies in the previous scheme. It is fully described in [12,13].

One of the essential features of this new scheme is the existence of the Firm Energy Obligation (OEF), which is a commitment on the part of generation companies backed by a physical resource capable of producing firm energy during scarcity periods. This new scheme aims to ensure the reliability in the supply of energy in the long run at efficient prices. To achieve this purpose, the OEFs needed to cover the demand auctioned among generation companies and investors. The generator who wins the OEF allocation receives a



stable compensation during a specific time period, and in exchange commits to deliver a determined quantity of energy when the energy spot price is higher than the pre-determined level, the Scarcity Price. Such compensation is settled and collected by the system and is paid by all the end-users of the interconnected system, through the fees charged by commercialization companies.

#### **17.7.2.1 Firm Energy Obligation, commitment and scarcity price**

The Firm Energy Obligation is an option product designed to guarantee the reliability in the supply of energy in the long run at efficient prices. When the spot price surpasses in at least one hour during the day the value previously established by CREG, which is known as the Scarcity Price, it reflects a critical electric energy supply situation. When this occurs, it serves as a trigger factor for generation companies with OEF allocations to produce, as required in the ideal dispatch, a determined daily quantity of energy. The OEF can be acquired through centralized transactions in the wholesale energy market. The OEFs are auctioned and allocated uniquely among generators or investors that have or are planning to own generation resources. Only those generators with their corresponding firm energy at a determined time can participate in the OEF auction.

The firm Energy for the Reliability Charge (or ENFICC) refers to the maximum electric energy that a generation plant is able to deliver on a continual basis during a year, in extreme conditions of hydro inflows. The Scarcity Price, which is established by the CREG and updated monthly based on the variation of the Fuel Price Index, has a double purpose. On the one hand, it indicates the time when the different generation units or plants will be required to fulfill their OEFs, which happens when the spot price exceeds the scarcity price, and on the other hand, it is the price at which this energy will be paid. The commitment period of the OEF is decided by the owner or the commercial representative of the generation resource that backs up the OEF. If the generation plant is new, meaning at the time of the auction its construction has not started, the obligation to generate energy can be between a minimum of one year and a maximum of twenty years. If it is a special resource or at the time of the auction the generation plant or unit is in the process of construction, the obligation to generate energy is between one and ten years. Finally, if it is an existing resource, which implies that it is ready to operate (or it is already operating) in the wholesale energy market at the time of the auction, the commitment period of the OEF is one year.

During the commitment period of the OEF, the generator receives the Reliability Charge remuneration, a value that is determined in the auction where the generating company participated to obtain its OEF. The owner of the OEF commits to generate daily, as required in the ideal dispatch, a certain quantity of energy up to the amount specified in the OEF. When the Spot Price exceeds the Scarcity Price, in order to verify that each generator has fulfilled its commitment, all the energy generated from all its plants at each hour of the ideal dispatch are added up.

The generator who acquires an OEF will receive a fixed remuneration during the commitment period of the OEF, whether the fulfillment of this obligation is required or not. The price for each kilowatt-hour of the OEF corresponds to the clearing price in the auction in which the generator sold its firm energy. This price is denominated as Reliability Charge.



When this firm energy is required, which happens when the Spot Price surpasses the Scarcity Price, aside from the Reliability Charge the generator also receives the Scarcity Price for each kilowatt-hour generated associated with its OEF. In case the energy generated is more than the obligation specified in the OEF, this additional energy will be paid or rewarded at the Spot Price.

In summary, the “Reliability Charge” acts like an option with an exercise price equal to the “Scarcity Price”: a generator with a given firm energy allocation, should make this energy available to the spot market at the scarcity price, whenever the value of the spot market is equal or above the scarcity price. Plants can generate above their firm energy commitment, selling this spare energy at the prevailing spot market price.

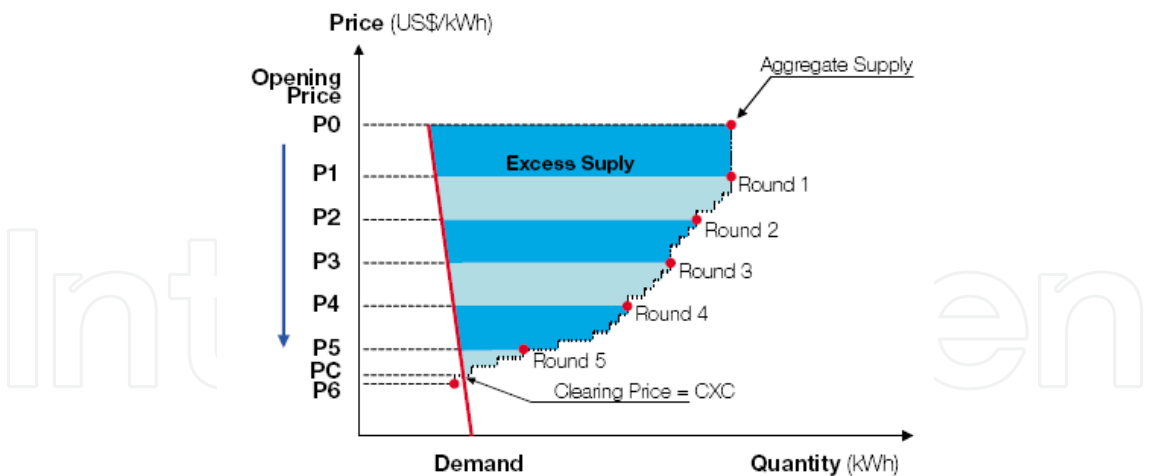
#### **17.7.2.2 Allocation of the firm energy options: auctions**

The allocation of the OEF among different generators and investors is done through a dynamic auction. In this transaction in the wholesale energy market, generators and investors participate actively, while the electricity demand of end-users connected to the system is represented by a price-quantity function previously established by the CREG. For this purpose, an auction to allocate the OEFs is undertaken three years before the firm energy obligation can be called. The Auction for the allocation of OEF is a one sided process. This means that the generators and potential investors, who have complied with all the requirements necessary to participate in the auction, can actively bid. The demand of end-users connected to the system is represented by an aggregate demand curve that is previously established by the CREG and made known to the public before the auction is conducted.

The mechanism employed is a descending clock auction and is carried out as follows:

- The auctioneer opens the auction at a price equivalent to two times the Cost of Entrant; a value calculated by the CREG and made known to the bidders (generators and investors) before the auction. Likewise, the auctioneer announces the floor price at which this first round will close.
- Between these two prices the bidders build their firm energy supply curve and this information is sent to the auction administrator. Figure 17.20 describes the auction methodology.
- 

Taking into account that the purpose of conducting auctions is to acquire firm energy, these auctions only take place when it is estimated that the demand for energy three years from now cannot be covered during scarcity periods of power supply by the firm energy production of existing generation resources and new resources that will enter into operation during the next three years. Annually, the CREG evaluates the balance between the supply and demand of firm energy and if the CREG deems it necessary to convene an auction, it communicates this decision through a Resolution, and indicates the timetable of the activities required before and after the auction to enable bidders to participate in the process and to formalize the allocation of the OEFs.



Source: CREG, 2007.

Figure 17.20. Descending price-clock auction with intra-round bids in Colombia

In summary, the unit price (\$/kWh) paid for each kWh of firm energy allocated, as well as the firm energy allocated to each generator, are the result of a “descending clock auction” with an elastic demand curve (Figure 17.20), that takes place three years before the regulator estimates that the firm energy will be required, or when the Regulator so decides. The price obtained as a result of this auction is guaranteed to new investors for a period of up to 20 years, to help them in firming up their cash flow and thus to facilitate project finance. For existing plants, the price is valid only for the following year.

17.7.2.3 Results

The first auction under the reliability charge scheme was carried out in May 2008 with a successful result, guaranteeing a capacity coverage to Colombia until 2018. In parallel with the new “Reliability Charge”, the regulator is replacing bilateral contracts by short term (up to three years) energy contracts in which all the demand will be auctioned in concurrent auctions for regulated and unregulated clients. In order to reduce risks, these auctions will be rolling, periodic with a certain percentage of the demand being auctioned each time.

17.8 Peru and Central America: Towards Energy Auctions

17.8.1 Peru

In 2007, Peru had 7.0 GW of installed generating capacity. In the same year, the country generated 25.0 TWh of electricity, while consuming 22.6 TWh. Even though installed capacity is evenly divided between hydroelectricity and conventional thermal, 80 percent of Peru’s total electricity generation comes from hydroelectric facilities: conventional thermal plants generally operate only during peak load periods or when weather factors dampen hydroelectric output. The power sector underwent vertical and, to a lesser degree, horizontal restructuring initiated in 1994, following enactment of a new Electricity Concessions Law in 1992. The country first market design followed the principles adopted in Colombia and Chile: capacity payments assigned by the regulator and the energy spot market as the marketplace for energy trading and provider of signals for new investment.

As in the Brazilian, Chilean and Colombian cases, Peru has undergone a drought and several difficulties with the current scheme came up. Therefore, as described in [17], a proposal of reform has been elaborated in 2006 to ensure generation adequacy and to reduce the exposition of the Peruvian electric system to the risks of excessive prices and a prolonged deficit of energy by introducing competition “for the market”. These reforms are mainly based on the implementation of energy contract auctions mechanisms.

An energy Law passed in 2006 defines that distribution companies must be 100% contracted for the next three years and that auctions should be called to ensure the entrance of new generation. The contracts to supply electricity for the medium or long arranged under the terms of the tender process, i.e. employing regulated electricity rates fixed as a result of the best bid received, will reduce the levels of risk as much for the consumers as for the producers and will make more feasible the new investments, possibly increasing with new agents the generation supply and as a consequence the competition in and for the market in Peru.. Figure 17.21 next describes the transition process:

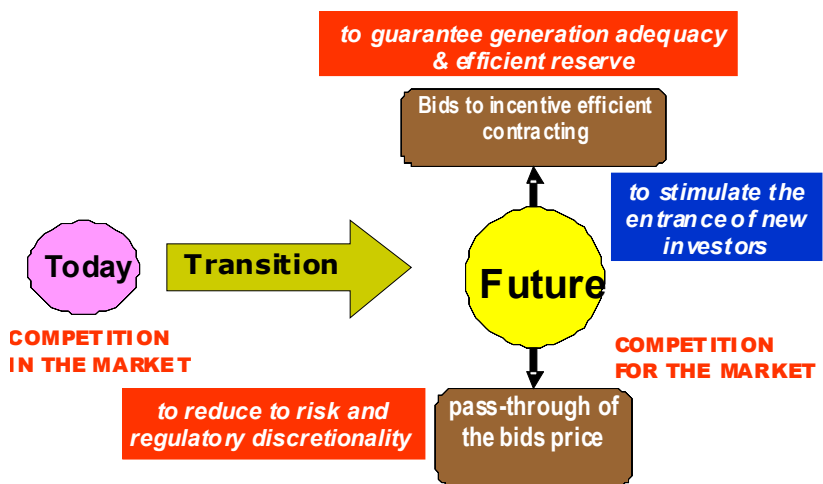


Figure 17.21. Peru: Competition for the market.

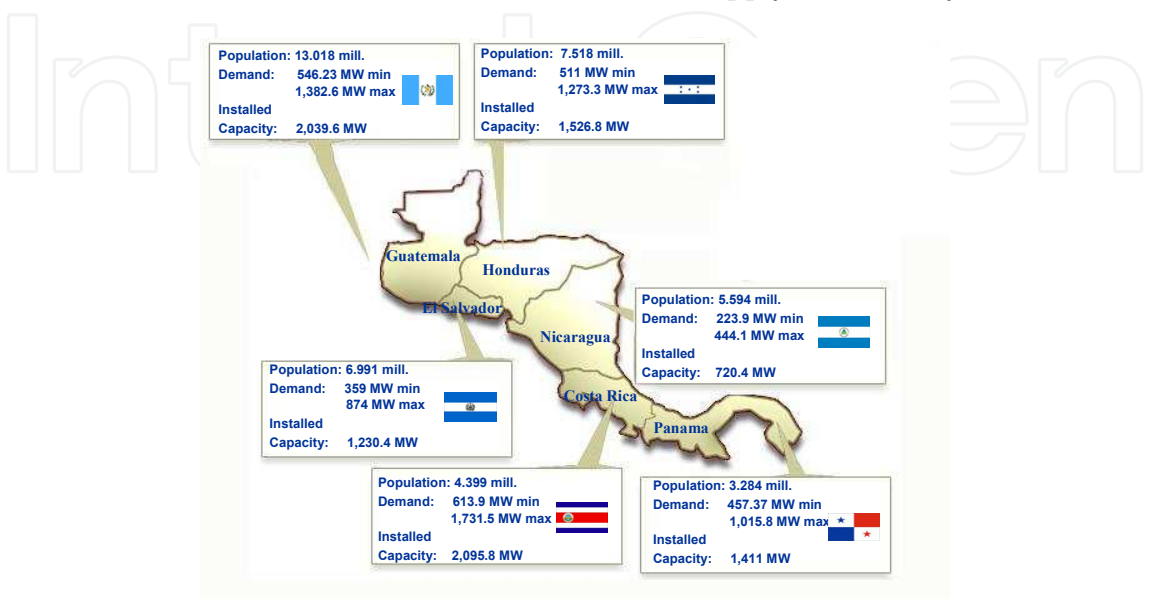
By the time of this writing (October 2008), the regulations that specify the guidelines of the Law are still being prepared and the first auctions to contract new energy are expected to be called in 2008. However, the principles that will guide the Peruvian auctions are similar to the ones contained in the Brazilian and Chilean frameworks.

17.8.2 Central America: Towards Regional Energy Auctions

Central American nations have a population of 41 million inhabitants, a GDP of some US\$ 90 billion and installed generation capacity of about 9000 MW.

During the early 1990s the Power Sector in Central America (CA) was basically managed by vertically integrated state-owned utilities that concentrated the production and supply of electric power. As in the vast majority of Latin-American countries, the main characteristics of the power industry before the restructuring were electric power shortages, vertically integrated state-owned utilities, lack of fresh funds, poorly maintained power plants and unavailability of public financing resources. As a consequence, the reform of the power

sector took place in many Central American countries, even though with distinctive features in each case, following the basis of the model applied in other South American countries such as Chile, Argentina and Brazil. The aim of the Reform was to provide a new institutional and regulatory framework based on private investments, competition in the generation segment, and adequate regulation of monopoly services (transmission and distribution) that could ensure a reliable and economic supply of electricity.



Source: EOR, CEPAL

Figure 17.22. Central America.

17.8.2.1 Supply adequacy schemes

The region is a net importer of liquid fuels. Therefore, international fuel prices directly affect the electricity market. This fuel price increase has introduced tariff problems and has put pressure to modify the rules of competitive markets. Electricity tariffs vary across the region (with variations up to 70 %), showing different energy policies between countries.

There are several models of organization of the electricity sectors in CA. Countries in the early stages of liberalization in CA (Honduras, Costa Rica) have primarily used PPAs to support generation expansion. El Salvador, initially with an energy-only market, did not include in its original market design any capacity support mechanisms. The other three countries (Guatemala, Nicaragua and Panama) have taken a market approach for energy trading, but with obligations to distributors and large users to buy in advance their expected demand through forward contracts. The electricity markets in these countries has been designed based on (i) energy prices related to variable (regulated) generation costs (cost-based pool) with a relatively low (capped) value during shortage conditions, (ii) a generation capacity obligation for loads to cover in advance through contracts their participation in the system peak load, (iii) auctions to cover reserves for the next year (only in Panama), (iv) a daily capacity market to settle imbalances (deficiencies and excesses) in generation capacity due to differences between expected peak load and actual peak load and, finally, (v) differences between committed generation capacity and actual availability.

In Guatemala, El Salvador, Nicaragua and Panama, at the time of market opening, distribution companies were allocated existing PPAs as a form of "vesting" contracts, however, additional new capacity is secured through supply contracts with shorter periods and without recourse to sovereign guarantees.

In summary, the electricity market reform panorama is:

- Guatemala, Nicaragua and Panama have organized competitive markets with a high level of regulatory intervention to ensure adequacy, through mandatory requirements to distribution companies and large users (final users authorized to find their own source of supply in the market) for contracting forward their expected peak demand plus some defined security reserve margin.
- El Salvador organized initially an energy-only market, with little regulatory intervention to ensure adequacy, although in 2002, as a result of decreasing reserve margins during several years, it introduced amendments to the law to incorporate some level of intervention on this and other topics.
- Costa Rica and Honduras created single buyer competitive markets, maintaining a centrally planned system, and allowing private participation in generation through Power Purchase Agreements (PPA) with Independent Power Producers (IPPs). In Honduras a new plant is basically built through PPAs which in December 2004 represented 64% of the total system installed capacity. On the other hand, in Costa Rica private participation is limited to 30% of the country's total installed capacity.

#### **17.8.2.2 A full regional marketplace**

The most interesting part of Central America is the high degree of integration among the different countries. The Governments of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama, in the framework of the Central American Integration System (SICA), initiated in 1996 a gradual process of electrical integration by developing a competitive regional electricity market through transmission lines which interconnect their national grids and by promoting regional generation projects. They implemented the project known as the Central American Electrical Interconnection System (SIEPAC) and so the Framework Treaty for the Central American Electricity Market was agreed in 1996. Two regional agencies were created to better fulfill the purposes of the Treaty: the Regional Electrical Interconnection Commission (CRIE) and the Regional Operating Agency (EOR). This regional market allows spot transactions and will allow regional firm contractual arrangements once the new Interconnection in 200 KV will be in service (expected for 2010).

One of the main objectives of the new Regional Electricity Market (MER), once implemented, is to enable the construction of regional generation projects, which will take advantage of economies of scale and provide cheaper electricity to consumers in the region. To support this type of projects -and in general the fulfillment of national capacity and energy obligations with sources originating in other countries, the MER market design provides for firm regional supply contracts that will be required to acquire firm transmission rights in order to be accepted by local regulators as a comparable source of supply to generation located within the country's borders. The MER will effectively allow an integrated approach to adequacy, through the concept of regional firm contracts. A second objective of the MER is to increase



effective competition. The possibility of distributors of CA to procure in the MER energy to fulfill their obligations, rather than in their national markets, increases substantially the level of competition. The main characteristics of the MER are:

- It constitutes a “seventh” market “superposed” on top of the national markets
- A regional regulatory agency (CRIE) and an independent system and market operator (EOR) are created
- Countries preserve national regulations and interact with the MER through “interfaces” (a feedback mechanism between the national markets and the MER)
- A short-term market is established, with ex-ante (day ahead) and ex-post (real time balance) hourly nodal prices (reflecting energy, congestion and losses prices), for each node of the regional transmission network (RTR – Red de Transmisión Regional)
- A contract market is established, with firm and non-firm contracts
- Transmission rights (financial and physical) are auctioned by EOR.

Since November 2002 the MER has been operating using a “transitory” code – an hourly day-ahead energy and transmission dispatch with hourly nodal prices at the tie-lines substations [18]. The “new” regulations have been recently approved by CRIE and a SCADA/EMS system and models (pre-dispatch, transmission rights auctions, settlement, etc.) are being developed.



Figure 17.23. SIEPAC line.

At the regional level, the augmentation of transmission capacity between countries, the existence of firm contracts and the associated transmission rights, opens up an opportunity for the coordination of the distribution companies procurement auctions (individually the distributors are very small) to incentivize efficient contracting (i.e. through the entrance of regional generators, which are too big for a single country, and even more so for a single distribution company).



MER firm contracts have priority of supply at the buyer's node; they must be approved by the national regulators involved (the seller's and the buyer's countries), and must hold the corresponding firm transmission rights. New transmission rights are created/acquired by either increasing (building new lines) the transmission capacity between the seller and buyer's locations, or through long and short-term auctions organized by the EOR.

### 17.8.2.3 Regional contracts and firm transmission rights

A firm regional contract means "iron on the ground" for both generation (capacity and energy) and transmission. In a firm regional contract the seller agrees to deliver firm energy at the RTR node declared by the buyer.

A firm regional contract offers the buyer security of delivery for the contracted energy, limiting the risk of energy provision, price and the associated variable transmission costs – except when, due to conditions on the RTR, it is technically impossible to deliver the energy. The objectives of firm regional contracts are:

- Give both, buyer and seller, greater security and obligations of fulfillment of the commitment;
- Assure the buyer the delivery of the contracted energy;
- Promote the development of regional generation plants;
- Promote interchanges of greater term and volume; and
- Promote the development of the RTR.

Due to their characteristics, firm contracts will be, in general, long term commitments. Nevertheless, their terms and duration are decisions of the parts and not subject to regional regulation. A firm regional contract establishes a priority of supply different to that which would "naturally" arise from the physical location of the generation committed. A firm regional contract "locates commercially" the contracted energy in the country where the retirement is committed (Figure 17.23). The contracted energy has priority for the supplying of the demand of the buyer at the RTR node declared for the energy retirement, instead of having priority of supplying for the demand of the country in which the seller (generator) is located.

The seller, or the agent whom the parts decide, must hold firm transmission rights (between the node of injection and the node of retirement) for the transmission capacity required by the contract. Firm transmission rights give not only financial protection against the variability in the difference of nodal prices between the agents' locations, but also guarantee that firm regional contracts can be physically accommodated by the RTR.

The energy committed in a firm regional contract cannot be offered (to sell) in a national contract to guarantee the supplying of the demand of the country in which the seller (generator) is physically located, i.e. the same energy cannot be committed simultaneously in a national and a firm regional contract. To avoid the risk of supplying or undue national dependency, the amount of energy that an agent qualified in the MER will be able to buy or to sell in this type of contracts will depend on:

- the energy authorized according to the regulation of the respective country, considering CRIE regional criteria for the firm energy estimation (that take into account generation

capacity, availability of energy resources, peak demand of each national system, exiting regional and national contracts and reserve requirements); and

- the associated firm transmission rights held.

The selling agent in a firm regional contract will be able to optimize the delivery of the energy to the buyer, from purchases in the regional opportunity market. Additionally, and as a reflection of the firmness, the selling agent must have injection offers to the regional opportunity market for, as a minimum, the totality of the firm commitments acquired in the MER. If the delivery of energy to the buyer is not possible due to the unavailability of the seller’s energy, the seller will assume the penalties that are derived from the breach of the contract. If firm energy cannot be delivered due to RTR constraints (security, quality) firm contracts will be reduced proportionally.

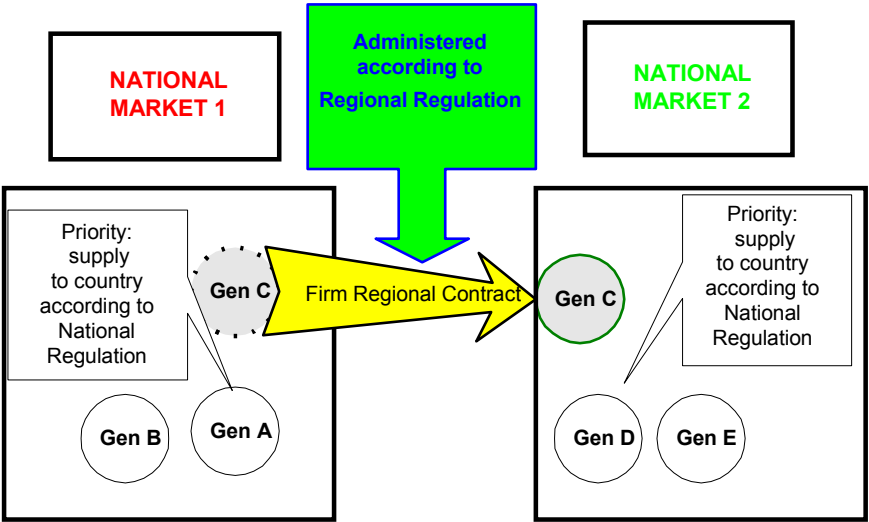


Figure 17.24. Priority of supply of firm regional contracts in MER.

17.8.2.4 Perspectives

In summary, several electricity markets in Central America have implemented capacity obligations mechanism to support the prices of the energy markets, which by itself have shown limited success, at least in markets with a small participation of the demand, in maintaining an adequate level of supply adequacy through timely investments. In light of the experience in the region, it can be inferred that in small electricity markets, as is the case of each national market in the Central America region, competition is very difficult to achieve (individual competitors would need to be very small) and energy-only schemes do not seem to be able to guarantee supply adequacy. Even markets with “complementary” controls for supply adequacy (obligation to contract and capacity payments) have been somehow intervened (e.g. price caps). The Regional Electricity Market -being implemented- has been designed with features such as firm transmission rights that are expected to support the region-wide compatibilization and optimization of the supply adequacy objectives.

### 17.9 Further Reading

Further reading on Latin America market mechanisms and supply adequacy together with electricity resource adequacy planning is given in References [23-24].

### 17.10 Conclusions

The primary challenge for Latin American countries is to ensure sufficient capacity and investment to serve reliably their growing economies. Although converging in the need of a “second stage” of measures to ensure generation adequacy in the region, some countries (Brazil, Chile, Colombia, Central America and Peru) retained the market scheme and improved the rules to ensure the entrance of new capacity. Other important countries in the region, however, went back to the state-controlled scheme. This is the case of Argentina (already analyzed in this chapter), Bolivia, Ecuador, Paraguay and Venezuela. Therefore, an “ideological split” is observed in the region.

The reform processes, including these recent auction mechanisms, have aimed at creating conditions to respond to growing demand with economic investment and operation, but with key decisions made by private actors, with a limited role being played by central governments. The priorities of the private actors are essentially business oriented, responding to their strategies and their risk assumptions. Overall, the new capacity auctions in Brazil, Colombia and Chile have been of great interest to international investors looking to South America’s energy market: candidate suppliers include a wide variety of technologies, comprising new hydro projects, gas, coal and oil-fired plants, sugarcane biomass and international interconnections. Peru seems to be following the same path and Central America presents an innovative regional market with cross-border supply adequacy schemes. With these diverging approaches, this is how these countries are facing the challenges of electricity supply.

Among the issues that still need to be reviewed are the social and environmental constraints, which are an inherent part of electric markets and cannot be swept under the rug. As discussed in [20,21], the concern with the environment is absolute legitimate but in some cases has resulted in the construction of more expensive equipments this disrupting an efficient system expansion. The most fundamental challenge is to allow the society to know, through lively participation on the studies and licensing process of hydro and thermal plants, that there is no competitive energy without environmental impact. A policy of zero environmental impact has obviously a very high economic cost and the society must be aware about this tradeoff, so that the best choice to conciliate environment, economic growth and social justice can be chosen. The rapid and hardly predictable changes in the sector, including national and international interconnections of the power and gas networks, strategic considerations by firms, availability of fuels and increasing public participation, make this a complex task.

For further and updated details on the Latin American deregulation, we refer the reader to [22].

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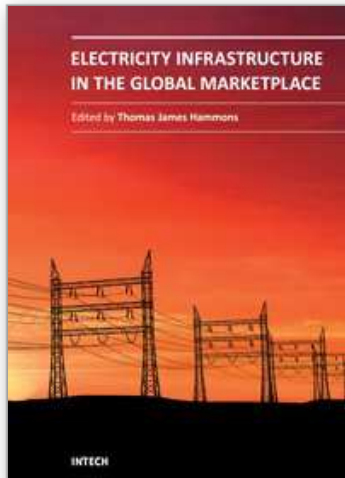
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## **Electricity Infrastructures in the Global Marketplace**

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This book discusses trends in the energy industries of emerging economies in all continents. It provides the forum for dissemination and exchange of scientific and engineering information on the theoretical generic and applied areas of scientific and engineering knowledge relating to electrical power infrastructure in the global marketplace. It is a timely reference to modern deregulated energy infrastructure: challenges of restructuring electricity markets in emerging economies. The topics deal with nuclear and hydropower worldwide; biomass; energy potential of the oceans; geothermal energy; reliability; wind power; integrating renewable and dispersed electricity into the grid; electricity markets in Africa, Asia, China, Europe, India, Russia, and in South America. In addition the merits of GHG programs and markets on the electrical power industry, market mechanisms and supply adequacy in hydro-dominated countries in Latin America, energy issues under deregulated environments (including insurance issues) and the African Union and new partnerships for Africa's development is considered.

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