Lessons from deregulation in Colombia: successes, failures and the way ahead

Erik R. Larsen, Isaac Dyner, Leonardo Bedoya V., Carlos Jaime Franco

Faculty of Management, Cass Business School, 106 Bunhill Row, London EC1Y 0HB, UK
Energy Institute, Universidad Nacional de Colombia, AA 1027, Medellín, Colombia

Abstract

We analyze and evaluate the evolution of the deregulated market for electricity in Colombia in the period from 1995, when deregulation took place, to 2002. The case of Colombia is of particular interest as it is one of the most open markets in the developing world as well as being predominantly based on hydroelectrical technology. Furthermore, Colombia has had no blackouts since deregulation, in contrast to a number of neighboring countries, even though Colombia has had periods with severe adverse weather conditions. Colombia has so far managed to adjust the regulatory environment to keep investment at a reasonable level. Finally, we discuss the prospects for the Colombian system over the next 5 years.

Keywords: Deregulation; Colombia; Hydro-systems; Regulation

Introduction

Through the nineties we have observed an increasing number of countries that have deregulated their electricity industries or are in the process of doing so (Bacon and Besant-Jones, 2001; Jaskow, 2000; Patterson, 1999; Green and Newberry, 1998; Midttun, 1997; Gilbert and Khan, 1996). The starting point for deregulation has been very varied across different countries. This is the result of the differences in evolution of the various national electricity industries, based on access to natural resources, existing and new choices of technology, political aims, past availability of capital, etc. We have also observed very different results in the outcome of different countries’ “experiments” with deregulation, depending on the organization of the markets, the pricing mechanism, the behaviors of the players in the market and the degree of public/private ownership, as well as the “initial conditions” mentioned above (Sweeney, 2002; Bacon and Besant-Jones, 2001; Midttun, 2000; Littlechild, 1998). It is therefore increasingly important to understand how the interdependence of the “initial conditions” with respect to technology, infrastructure, capitalization and the chosen market structure with respect to regulatory regime, pricing and contracts influence together the evolution of the electricity markets after deregulation.

It is necessary that governments and regulators understand more than just the initial conditions and their influences. The implementation of the deregulation process has to be monitored very carefully and most likely there will be a need to “fine-tune” the initial framework one or (many) more times during the first decade after deregulation. The way in which these adjustments are made to the system is very important, both in terms of style (how it is done) as well as content (what is changed). Too many changes made too often could lead the companies in the market to lose faith in the regulator/government and probably limit or stop future investment; in particular, investments from abroad might quickly dry up if there is a perception of too much regulatory risk. On the other hand, no change might drive the system toward an unsustainable situation with an eventual “breakdown” of the deregulated system.

There is a need to build a set of “cases” to create a broader understanding of the effect of deregulation on a wider scale. Some cases of “failure” of deregulation have been highly publicized over the last few years, e.g. the blackouts in California and the subsequent...
discussion of whom to blame for the problems (Sweeney, 2002). Other cases have been extensively analyzed and by most considered relatively successful, e.g. the case of England & Wales (Surrey, 1996) and Norway (Midttun, 1997). However, cases which were initially hailed as being very successful have since shown some problems, e.g. Chile. The Chileans, which at first were seen as the very model of a successful deregulation, did not make refinements to take account of gaps in their legislation, which created the wrong incentives for investments, leading to blackouts in 1998 (Fisher and Galetoviz, 2000).

It is also important to understand whether the problems are only in the transitional period or if they are inherent in the design of markets, to what extent governments and regulatory bodies should intervene and when they should do so, and how much political intervention is desirable. Transitional problems might be due to the time it takes for companies to get used to a deregulated market, and an initial phase of trying to explore the boundaries of the system (Dyner and Larsen, 2001). This type of problem can in many cases be solved by the market, while imperfections in the structure of the market will need, in most cases, to be solved by intervention from the regulator or the government.

Against this background, we examine the Colombian case to assess whether the deregulation process has been and will be on the right track, and if that is not the case then what might need to be done to get the sector back onto a sustainable course. This paper describes and analyzes the situation in Colombia 7 years after the deregulation took place. The Colombian model was adapted from the model used in England and Wales, even though the situation in Colombia in many ways looks more like the situation in Norway, before the creation of Nordpool, with regards to the generation technology, e.g. the dependence on hydroelectricity.

The paper is organized in the following way. We start with a short description of the Colombian electricity system and discuss what created the impetus for deregulation. We then briefly review the Colombian system and how it has performed over the last 7 years. Finally, we discuss some of the problems the system faces and what actions might be necessary, followed by a discussion of the positive and negative effects that have been observed up to the time of writing.

### The Colombian electricity system

The basic statistics regarding population and electricity for Colombia are provided in Table 1. The population has grown by almost 20% over the last decade while GDP growth only increased by about 4% per annum during the first part of the nineties, while the economy fell sharply in 1999. However, there has been an increase in the installed electricity capacity, from 8.3 GW in 1990 to 12.3 GW in 2000. We will discuss this increase later in the paper. Colombia was drawn into an economic recession in 1999, where GDP decreased by 5%, and has yet to emerge from it. The recession caused a fall in demand for electricity of about 4.6% in 1999. It is still uncertain when the economic climate will change, as GDP increased less than the population in 2002.

It is useful to compare Colombia with Norway (another country that relies on hydroelectricity) and England, whose “deregulation model” was implemented in Colombia. Table 2 shows this basic comparison.

Table 2 sets the scene for the remainder of the paper. It shows that Colombia is still far behind in terms of per capita capacity. Colombia might have excess electricity capacity at present, but it is reasonable to expect that there will be an increasing demand for electricity when the current recession ends and the system will then need the flexibility to cope with a surge in demand.

### Background for deregulation

There were a number of reasons why the Colombian government decided to deregulate the electricity system.

### Table 1

<table>
<thead>
<tr>
<th>Basic statistics for Colombia</th>
<th>1990</th>
<th>1995</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>35 mil</td>
<td>38 mil</td>
<td>41.3 mil</td>
</tr>
<tr>
<td>GNP growth (% average variation on 5 years)</td>
<td>4.4*</td>
<td>4.6**</td>
<td>0.9**</td>
</tr>
<tr>
<td>Installed generation capacity</td>
<td>8.3 GW</td>
<td>10.8 GW</td>
<td>12.3 GW</td>
</tr>
<tr>
<td>Hydro (%)</td>
<td>0.79</td>
<td>0.76</td>
<td>0.65</td>
</tr>
<tr>
<td>Oil/coal (%)</td>
<td>0.21</td>
<td>0.26</td>
<td>0.35</td>
</tr>
</tbody>
</table>

(www.banrep.gov.co/estad/dsbb/ctanal1sr.htm#consumo (26 de agosto de 2002).

*Baseline 1975.

**Baseline 1994.

### Table 2

Comparison between Colombia, Norway and England (2000 data)

<table>
<thead>
<tr>
<th>Area (1000 km²)</th>
<th>Population (mil)</th>
<th>Annual elect. production (TWh)</th>
<th>Production capacity (MW)</th>
<th>% Hydro of production capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombia</td>
<td>1200</td>
<td>41</td>
<td>45</td>
<td>12,000</td>
</tr>
<tr>
<td>Norway</td>
<td>300</td>
<td>4</td>
<td>120</td>
<td>27,000</td>
</tr>
<tr>
<td>England</td>
<td>245</td>
<td>58</td>
<td>300</td>
<td>65,000</td>
</tr>
</tbody>
</table>
industry. The feasibility of deregulation was established in 1993, as deregulation seemed to have been working in England and Wales as well as in the neighboring country of Chile. However, the three main (and in many ways related) reasons why deregulation was coming to the top of the agenda in 1993 were:

- **Two major blackout periods:** the first one in 1983 and the second during 1992–1993. These blackouts were seen as being (politically) unacceptable within Colombia and the government needed to find a way of avoiding any further major blackouts, or risk its political life (García and Dyner, 2000).
- One way of decreasing the probability of a blackout was to increase the amount of capacity in the Colombian system. However, the government was not able to finance this expansion of capacity, due to a need for concentrating economic efforts in other areas related mainly to the eradication of poverty. This created the need to allow for non-government, i.e. private, financing of the electricity sector.
- The second way of improving the system was to increase the efficiency of the existing capacity, again something which was most likely to happen through a deregulation and the creation of incentives for the private sector.

This last point is partly related to what was a very high fraction of non-technical losses in the system, especially around the large cities, which the monopolistic system had not been able to tackle. The total losses were over 22% in some cases. In Chile, however, privatized companies seemed to have been able, at least partly, to solve this problem (Fisher and Galetoviz, 2000).

The initial design of the Colombian deregulation

Passing laws number 142 and 143 in 1994 (Congreso de la Republica, 1994a, b) created the legal framework for deregulation. This was followed by the creation of the legal framework for the electricity Pool in 1995, enabling deregulation to take place and the market to operate from the summer of 1995 (CREG, 1995).

Colombia chose the same general framework that had been developed in the late eighties and implemented since 1990 in England (Amstrong et al., 1994). The framework used in England was then adapted to the Colombian situation with a few important changes, taking into consideration the structure and technology differences in the Colombian electricity system as compared to England. Where in England there was a deregulation as well as a privatization, the Colombian government only deregulated the market, allowing a mixed ownership structure (private as well as public—public in the context of central and regional governments). We will later discuss the mix of private–public ownership in more detail. Secondly, provisions were made for subsidizing low-income consumers in Colombia, as had been the case before deregulation (CREG, 1997a, b). This is financed by slightly increased prices (in the form of cross subsidies) to consumers with a higher income and to industrial customers, as well as state subsidies.

In the new system a regulatory institution (CREG—Regulatory Commission for Electricity and Gas) was set up, with responsibility for overseeing both the electricity and the gas sector, recognizing the increasing interdependence of the two industries. CREG is an independent office, but is organized as part of the Ministry of Energy and Mines. The President appoints the regulators (normally five) for a fixed period of time (normally 5 years). At the same time, the government-owned company that was in charge of the high-voltage grid, ISA, was divested from its generation capacity which became the independent government-owned generator, ISAGEN. ISA was also the system operator responsible for scheduling, dispatch and for the operation of the Pool.

The Colombian system was only partly unbundled. The incumbents were allowed to remain both generators and distributors (as was not initially allowed in the English system). Companies were, however, required to create separate subsidiaries with “Chinese walls” between them in order to be allowed to retain both functions. At the same time, some restrictions were introduced on how much electricity a distribution company can buy from a generation company within the same group. This is 60% at present, the remaining 40% having to be bought from other suppliers whether they are cheaper or not. Another pre-condition in the Colombian system is that no generator or supplier can have a market share greater than 25% of the total.

Similar to the original system in England and Wales, a 24-hour-ahead Pool was put in place in Colombia, through which all electricity is dispatched, regardless of any short-, medium- or long-term bilateral agreements between agents. However, there were also important differences between the English and Colombian Pools, the most significant being that the Colombian Pool did not have fixed capacity payment. Instead, CREG introduced capacity payments (CREG, 1998) based on an indicative plan, developed and executed by the Ministry of Energy and Mines, that runs a set of scenarios mainly focused on worst case scenarios, to determine the annual “optimal” capacity payment (see, e.g. UPME, 2000). Initially, consumers, with demand below 1 MW, had to buy electricity through distribution companies, but this threshold has since been gradually reduced to 0.1 MW.

Perhaps one of the most important differences between the English and Colombian systems, apart from those related to the technology and the
maintenance of subsidies to households with low incomes, was the creation of a planning unit (UPME) within the Ministry of Mines and Energy. UPME is responsible for undertaking the indicative capacity expansion plan, the actual transmission expansion plan, and policies on rational energy use.

**The development of the Colombian electricity sector 1995–2002**

In this section we will review in more detail the evolution of the Colombian system during its first 7 years of existence. We will focus on four main areas: prices, regulatory challenges, structural changes and the system’s performance.

**The evolution and volatility of prices**

Electricity prices are relatively low in Colombia, compared to other South American countries; see Table 3 for comparisons. This is not a new phenomenon, but rather a function of technology, fuel and the date of the comparisons (Fig. 1 shows prices might vary significantly over time in Colombia).

If we compare electricity prices across some of the countries that have undertaken deregulation of their electricity sectors in Latin America (Rufin, 2001) in Table 3, we can observe that Colombia is well below the average in the residential sector (where the end-user price is determined by the government) and the commercial sector. However, it is just below the average price in the industrial sector. As the industrial sector is completely deregulated, in contrast to the two other sectors, it might raise some questions with respect to this discrepancy, i.e. is cross-subsidization too high or is the market not sufficiently efficient? It is also interesting to note that in England the deregulated price was below that in the non-deregulated sectors (Surrey, 1996).

To get a real understanding of how prices in Colombia have changed following deregulation we need to take a longitudinal view on the price of electricity shown in Fig. 1. The average price of contracts, in US dollars, has not increased since liberalization took place (see Fig. 1) but, if anything, has fallen slightly. This relatively stable price has had a stabilizing effect on the market, as will be discussed later. However, Pool prices (the short-term price) have varied mainly according to weather conditions, providing mixed signals for capacity expansion and showing the inherent problems of having a predominantly hydro-based system.

During the period from 1992 to mid-1995 (when deregulation took place), we can observe an almost linear increase in prices. Under the centrally planned scheme that was operating in Colombia during this period, prices were fixed according to a long-term incremental plan. This plan was developed as an optimal expansion plan for the Colombian system, where cheaper plants (normally hydroelectric) were to be built first. Fig. 1 shows that this price evolution was increasing steadily as could be expected in an optimal planning system. However, the underlying assumptions did not account well for technology improvements, the potential change of technology from hydro to gas-fired plants and the possibility for increasing the efficiency of the system. The sharp rise of Pool prices by the end of 1995 (6 months after deregulation), was mainly due to a false alarm and general uncertainty about what could be expected from the Pool during a major drought, the first “dry” season after deregulation. To protect the system from “running out of” water, the regulator imposed limits on how much water the generators could take from the reservoirs. This in turn increased the already-worried industry, and the uncertainty created a surge in Pool prices leading to the spike that can be observed in Fig. 1, where, for a short period, the prices went up very sharply—a leap of over 500%. In retrospect, it turned out that the dry season at the beginning of 1996 was not that dry. This fact led to the Pool prices dropping equally rapidly bringing prices back to a level below those at the time of deregulation. This experience shows

![Fig. 1. The evolution of Pool and contract electricity prices in Colombia from 1990 to 2002.](image-url)
how the regulatory institution can, if not very careful, in fact make a situation much worse by intervening in the market. It is conceivable that had there not been water limits imposed on the reservoirs, the Pool would have seen a peak that was considerably lower. This first increase in prices in the Pool can, given the explanation above, be seen as a learning experience for all the actors involved in the market.

After the initial peak, prices stayed low for the remainder of 1996 and the first half of 1997. The main reason for this was an abundance of water in the reservoirs as well as enough hydroelectric capacity to cope with demand. The hydroelectric capacity had grown at a rate close to 5% yearly during the previous 10 years because the monopoly system was expanding more slowly than indicated by the expansion plan. As the market was liberalized, some 2.5 GW of new gas-fired capacity was built; this helped the system to operate more efficiently and with less volatility. However, this only lasted until the second half of 1997 where the worst Niño in Colombian history proved that the prices in the Pool were far from stable. El Niño, a Pacific weather system that is unpredictable, has the effect of creating droughts in Colombia. During the year of El Niño, the average river inflow was 2127 GWh/month compared to the annual average of 2962 GWh/month (ISA, 2002). This situation of comparatively limited rainfall drove the electricity prices to highs never registered in Colombia before. As can be observed in Fig. 1, the monthly average prices reached almost 0.125$/kWh, while during some hourly periods the Pool price reached 0.25$/kWh. The regulator created an indirect cap scheme for electricity prices in the Pool, preventing it from going even higher (which in all likelihood it would have done—the introduction of rationing prices is equivalent to capping prices). However, it is worth noting that when the Pool price increased significantly, the contract price did not move much during this period, providing an “insurance” for those distribution companies which were fully contracted. As we will discuss later, there were also companies in this period that were not fully contracted and this situation created serious problems for them.

Following El Niño, a combination of two main factors created a very low price in the next couple of years; first Colombia had the worst recession in 80 years (the economy grew −5% in 1999), which reduced demand for electricity. This coincided with a very heavy La Niña period, which is another Pacific weather system that exhibits heavy rainfalls in Colombia (i.e. the opposite of El Niño). Due to the periodically overflowing reservoirs and generally high quantity of water, prices reached low levels not seen since the early nineties—this state led to conditions where electricity was sold at the absolute minimum price (the lowest bidding price being equivalent to the capital cost of an open cycle gas-fired plant). This created large problems for the non-hydroelectric capacity that was not able to compete with a water price of zero and therefore not scheduled to run. We will discuss this in more detail in the last section of the paper.

The last surge in prices, which can be observed in Fig. 1, is a consequence of the on-going conflict in Colombia, as a new tactic from some of the guerrilla groups is to bomb electricity pylons. Hundreds of electricity pylons were brought down by these attacks, isolating some “cheap plants” from the main grid, making it necessary to schedule more “expensive plants”, as well as creating restrictions in the system which yielded market power for some regional generators.

As could be deduced, based on the discussion above, the electricity price has been very volatile over the life of the Pool. Intra-day, seasonal and inter-natural phenomena (between Niños and Niñas) volatility have all been high. Fig. 2 shows the yearly volatility of daily prices. As can be observed and should be expected, volatility has been considerably higher when there are droughts compared to situations of excess water. During the period of Niños, volatility was almost twice as high as the following period of the Niñas, emphasizing the discussion above about the minimal bidding price during the Niñas. We can also see that the price volatility was relatively constant during this period from 1998 to 2000. The problem of constraints in the grid due to the bombing of the pylons can also be seen in Fig. 2, as volatility increases during the year 2000 although there was plenty of water. As a comparison the intra-year volatility in Colombia is higher than the Norwegian volatility, which to a large extent has a similar technology but not quite as severe weather variations. However, the volatility is much higher than the volatility often registered in England during the period when England had the same system as Colombia (i.e. before NETA).

![](image.png) Fig. 2. The yearly volatility of daily prices
The volatility due to the weather systems has created particular difficulties for the reliability of the system, although no blackouts have occurred since deregulation. Furthermore, the strong inter-natural-phenomena volatility has made things appear much worse in terms of over and under-capacity cycles. Because of the potential long periods of excess water, the economics of gas-fired capacity, such as CCGT, will look very uncertain and not encourage investment in thermo-electricity, at least not in very efficient gas-fired plants, but perhaps in alternative peak-time technologies.

**Regulatory challenges**

One of the main problems, which has been frequently observed in connection with deregulation, is how the regulator should deal with potential market power. Most if not all of the implementation of deregulation over have last decade has, at least in some periods, allowed for some players in the market to gain market power. It has become one of the main areas for regulators to monitor and stop any company abusing possible market power (Bunn and Day, 2001). For example, under extreme weather conditions or in some countries at peak times during the summer, the system calls for the most inefficient plants in reserve to be able to supply electricity. These units are only called for operation very rarely, and regardless of the industry structure, these may exercise market power. However, a more worrying case occurs when there are only two or three major companies in an auction market or short-term market (Bunn et al., 1997). These companies may exercise market power, but the exact way in which this may be done depends on the details of the market in which they operate.

Market power is often measured in terms of the Herfindahl Index (HHI).1 This is a measure of market concentration; a value of around 1000 is seen as the lowest possible value for a highly fragmented market. Markets are considered weakly dispersed if the value reaches a maximum of 1800, and is highly concentrated above this number. In Colombia, the overall HHI index in terms of capacity market share composition is 1382, indicating a market where market power should not be problematic. This compares to England and Wales where the HHI has come down from 1800 in 1990 to 1200 in 1996 (Littlechild, 1998). However, if one examines the peak hours these values are much higher, as shown in Table 4, indicating that generators might be able to exercise considerable market power during these periods.

Furthermore, if one only accounts reservoir capacity (which may be a proxy of market power during the rainy season, where it is not economical to run thermo-capacity) the index is 2168, which indicates a persistent market power during these periods. However, due to the weather systems which affect Colombia, the market power during Niño periods can be even greater. Therefore, market power may be exercised in a number of frequently occurring situations, putting customers at a disadvantage. This is one of the major challenges for the regulatory institutions in Colombia and can be changed if the technology mix is changed.

Another aspect of the regulatory regime is the regulatory risk that investors have been confronting, especially during recent years. The Colombian system was revised in 1999 with respect to the capacity payment to generators. The reason for this was that it was felt that the initial system of “ad hoc” capacity payments was not transparent enough and had not, it was believed, rewarded the plants that should have been rewarded (TERA, 2001). Fig. 3 shows how capacity payments have evolved from 1997 to 2000. As we can observe, the total amount has stayed more or less constant during this period. The interesting point is, however, to compare the split between the different technologies over time. The gas and coal part of the payment has increased from around 20% in 1997 to close to 35% in 2000, a considerable increase which could indicate a shift of supporting thermoelectric capacity from the regulatory institution. However, it is not clear if this is enough to create incentives for a more balanced technology mix. We will return to this point in the next part of the paper. So far recommendations have

---

1HHI is given by the sum of squares of the market shares of the companies in an industry (normally the 10 biggest companies).

**Table 4**

<table>
<thead>
<tr>
<th>Time</th>
<th>HHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00–13:00</td>
<td>2125</td>
</tr>
<tr>
<td>19:00–20:00</td>
<td>2926</td>
</tr>
</tbody>
</table>

---

**Fig. 3.** Capacity payment in total and by technology.
been made for major changes to the capacity payment mechanism but only minor adjustments have been made, creating a major uncertainty for new potential investors.

There is a similar issue of perceived unfairness, or regulatory risk, concerning the minimum operation rules established for running reservoirs (CREG, 1996). For example, EPM, the second largest electricity generator, complained that CREG changed the rules about the minimum water levels at reservoirs. Some have calculated that its loss during the last Niño, due to the changing of the rules with respect to minimum water levels, amounts to several tens of millions of US dollars monthly during a period of 6 months (Martinez, 1998).

Structural, technical and ownership changes

The technology mix of generation in Colombia has moved from an initial value of 87% hydroelectric power in 1995 to less than 70% in 2002. This change in technology mix was achieved as almost all new generation plants in the period were gas fired plants. Fig. 4 shows this development. In the 1990s, private investors spent over US$6 billion, which places Colombia as the third country for inward investments in the electricity sector in Latin America (US$77 billion) and among the top ten in the developing World (US$193 billion) (Millan et al., 2001).

The two main drivers for the interest in thermal capacity were first that during the Niño period, limited amounts of water were available for production from hydroelectric plants, reducing the output for hydroelectric plants, which made it extremely profitable to run gas and coal fired power stations. The second factor that favored thermal plants was the extra capacity payments which CREG, the regulator, made in an attempt to reduce dependence on the weather. However, during the last year, a number of issues have brought a stop to this development of increasing share of thermoelectric plants. First, the slowdown in demand—or rather decrease in demand—due to the economic situation. See Fig. 5 for the evolution in demand and economic growth. Demand actually fell by 5% in 2001, and demand in 2002 is only expected to have reached the level of demand in 1998, in a country where population grows at about 1.7% per year. After the heavy rainfalls caused by La Niña, which drove prices to a level where it was uneconomic to actually turn on the thermoelectric plants even during peak hours, it resulted in CCGT plants rarely operating during their first years of existence. Even though the capacity payment to
thermoelectricity plants has gone up over the last couple of years, they are not economic unless they can run for at least part of the year. This makes it difficult to believe that investors in the Colombian system will build new CCGT plants or any other gas-fired plants, although there is a significant amount of gas available in Colombia.

The instability of the system at the present time is not giving a clear signal for the short- or long-term technology mix. It is not quite clear if the current market mechanism will be able to provide this signal. Given the market-based investment strategies that companies necessarily will take, it is not possible to predict what an equilibrium technology mix might look like and when it will be reached. It is relatively clear that the generation companies’ short-term strategic objectives will be dominant and the most likely response is that they may decide to complete some of the ongoing projects with relaxed schedules, i.e. delay them. Secondly, instead of initiating new power plants, companies might decide to build an extra turbine, fitting a second cycle to one of their existing units or even by completing a chain of plants along a river stream and possibly by upgrading existing hydro-turbines. However, if the regulator or government aim is to dampen volatility resulting from weather conditions, this is probably not enough to have any impact on the reliance on hydroelectricity, and therefore not on the amplitude and duration of the cycles resulting from the constantly changing weather systems.

Before deregulation all parts of the system from generation through transmission to distribution were publicly owned, either directly by the central government or by municipalities. Fig. 6 shows the development in the four main areas from 1995 to 2000. There are a number of interesting observations which can be made from Fig. 6.

We can see that the number of generators has increased significantly over the period, from 17 in 1995 to 30 in 2000, almost a doubling of the number of generators, and more than 40% of the generators are now privately owned. However, what cannot be seen from Fig. 6 is that while there might be more public than private-owned companies the private companies are larger; in terms of capacity the private sector owns or has control over 59% of the generation capacity against the 41% owned by public companies. The new companies are mainly multinationals. We cannot see a similar trend in transmission, where the number of companies has stayed constant (as could be expected), but there is now a significant private ownership of the transmission. The pattern is repeated in distribution. While, on the one hand, the companies that bought distribution facilities are also mainly foreign, on the other hand, the high-voltage transmission lines are being concentrated in a semi-public Colombian company.

Finally, as should be expected, there has been a sharp increase in the number of companies that have received a license to trade electricity. At the moment this is the only sector, along with generation, in which the private ownership is larger than the public.

**System performance**

There have been significant efficiency improvements following deregulation. One measure is the number of employees for each GWh produced by the generators. This has fallen from 0.58 employees for each GWh produced in 1997, down to 0.49 2 years later in 1999, an improvement of 15% in 2 years, and it is likely that we will see further improvements. Another measure is system losses, which in Colombia have been notably high, compared to other countries in the developing world. However, this has also fallen significantly from a high of 22.5% in the year before deregulation to slightly over 15% in 2000. Fig. 7 shows the evolution during the period of deregulation. As we can observe, there was almost no change over the years before deregulation, but a sharp decrease in system losses afterwards.

Another important measure of industry performance consists in establishing what fraction of the bills issued is actually paid, i.e. how many of the customers are willing and able to pay their electricity bill when they receive it. As we can see in Table 5 this has also improved dramatically since deregulation. Not only has the fraction of bills paid increased by almost 20% over the four years shown in Table 5, the companies have become more efficient in issuing the bills to the customers. However, by far the largest improvement can be observed in how long people take to pay the bill when they have received it; the time has been cut from an average of 81 days in 1996 to only 34 days in 1999, an improvement of almost 60%. It is clear that such changes significantly improve the cash flows for the
distribution companies involved, and together with the increase in people actually paying their bills and the consequent reduction in losses, results in a much healthier economic situation for the whole industry.

Figures showing the overall performance of the Colombian system in comparison with other countries can be found in Table 6. It is clear that as late as 2000 there were still major problems for the Colombian system with the number of interruptions, up to three or four times the number found in neighboring countries.

This number is clearly related to the current political situation in Colombia, and although the aim is to significantly reduce interruptions in 2002, it will remain an open question whether it will prove possible.

This ends the review of the evolution of the electricity system after deregulation in Colombia. Appendix 1 provides a more detailed timeline with the major events during the first 7 years of deregulation.

The good, the bad and the way ahead: lessons from the first 7 years of deregulation and a view over the next 5 years

We will aim next to outline lessons that can be drawn from the first 7 years of deregulation in Colombia. The focus will be on the points that are important not only for Colombia but also could be informative in the broader context of deregulation in general.

The overall conclusion we draw is that in spite of the internal social, economic and political difficulties, Colombia has made important progress, but still has a long way to go before the deregulation process can be said to have been a success. Colombia has done well on price, reliability and quality but still has major problems trying to legitimize the whole system, implement a sustainable (and fair) price system, improve the wholesale market framework, and develop a proper market for household customers, i.e. fully develop retail competition. If no progress is made with respect to these and similar issues, Colombia might end up worse off than Chile, Brazil and California.

The first achievement to highlight, as a major accomplishment of the deregulated system, is that there has been no blackout in the period since deregulation in 1995. The previous occurrences of blackouts were, as discussed above, one of the main reasons why deregulation was accepted and had there been a major blackout in the early years after deregulation it is very unlikely that the deregulation process would have continued. The fact that no blackout has happened is in some way surprising, as there has been one major El Niño in the period since deregulation. Other countries or regions such as California, Brazil and Chile, also with liberalized wholesale markets, had suffered periods of major blackouts and problems with capacity additions. Why was there no blackout in Colombia when we could have expected it? We believe that the major factors for this were the introduction in Colombian of regulatory frameworks for both the capacity charged, and for reservoir intervention. The first consists of remunerating plants that are not necessarily being dispatched, but that have been available for generating electricity, and might be required during periods of drought. The second is basically a measure of intervention in the management of reservoirs, not allowing their owners to use all the

<table>
<thead>
<tr>
<th>Year</th>
<th>Fraction of bills paid (%)</th>
<th>Time to issue bills (average days)</th>
<th>Time before bills paid (average days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>80.10</td>
<td>109.70</td>
<td>81.60</td>
</tr>
<tr>
<td>1997</td>
<td>84.40</td>
<td>116.00</td>
<td>111.0</td>
</tr>
<tr>
<td>1998</td>
<td>88.20</td>
<td>62.10</td>
<td>19.00</td>
</tr>
<tr>
<td>1999</td>
<td>94.50</td>
<td>75.00</td>
<td>34.00</td>
</tr>
<tr>
<td>2000</td>
<td>87.74</td>
<td>67.80</td>
<td>20.90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Average number of interruptions per year</th>
<th>Hours of interruptions per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peru</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Argentina</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Spain</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Chile</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>Bolivia</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Colombia 2000</td>
<td>60</td>
<td>58</td>
</tr>
<tr>
<td>Aim 2002</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>England</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Ecuador</td>
<td>15.8</td>
<td>4.8</td>
</tr>
</tbody>
</table>
water that is available for electricity generation during the driest periods of the year. However, Colombia might not be able to avoid blackouts in the future. One of the reasons for this can be seen in Fig. 8, which shows the returns to the different parts of the electricity industry in 1999 and 2000. These numbers can, for example, be compared to the returns in the UK system 5 years after deregulation, where National Grid (the monopoly grid owner and operator) had returns of over 9%. Furthermore, profits for other parts of the industry in England rose by two digit numbers in the first 5-year period after deregulation (Mackerran and Watson, 1996).

This is clearly a situation that calls for some concern. If companies are on the way to becoming unprofitable, this might stop the future evolution of the industry. There are a number of reasons for this development worth mentioning. One reason is the current economic climate, where demand has been falling. This is a situation that few had foreseen; Colombia has a long history of stable economic growth, and it is not yet clear what the reaction of the different firms will be in the longer term given this experience of economic stagnation. To add to this, it is worth noticing that at the present stage the debts of the distribution companies are fairly large by Colombian standards. Though manageable, it takes about US$50 million per year to service the debt. However, the problem is not evenly distributed among the companies and is increasingly becoming a burden for the smaller distributors and generators. This problem of rising debt, especially for small companies, makes it much less attractive for new entrants into the industry. Fig. 9 shows the evolution of debts through the years since deregulation.

How severe the problems discussed above will become will partly depend on how long the current economic crisis continues. But it also depends on how the problem of payment difficulties, of parts of the population, can and will be solved. As for the majority of developing countries, Colombia has large portions of the population that have no means to pay for electricity at market prices. A viable and sustainable subsidy system has to be put in place, otherwise distribution companies will not survive, because of the losses they will incur due to the non-payment of bills. At the same time, distributors will not be able to pay generators, causing the whole system to collapse. One solution could be to create a system by which there was cross subsidy between different customer groups. It is conceivable that a temporary subsidy (partly by the government), in the area of US$50 million yearly, could help create lower electricity bills, which it would be possible for the economically disadvantaged segment of the population to pay. Implementing such a system could stop the emerging culture of non-payment.

The second point to consider is that investments have continued during the period, although the system still needs some time to prove that it works. Again, it is difficult to predict what the long-term implications of the current economic crisis will be. What might be more worrying is the issue of technology choice. With Colombia being mainly dependent on hydropower, it needs a more balanced portfolio of generation technologies. The main reason for this is the weather systems which play an important role in the amount of waterfall, resulting in the current dependency on water which makes the short-term price extremely volatile. In a situation where thermoelectric plants have not been used for 2 years or more (as is currently the case), it is hard to convince investors that this is a viable technology in the Colombian market. If this becomes the general belief, then the technology portfolio will become evermore skewed towards hydroelectricity, making electricity prices more volatile. However, it is unlikely that a large number of new hydro plants will be built in a deregulated system due to the time, cost, environmental...
concerns, etc. This could cause some concern in the future when demand picks up again. Price caps have operated during the Niño, and some plants are only required every 4 or 5 years; hence these (thermoelectric) plants clearly need some support to be financially viable (and they are at present clearly needed during the Niño periods). The solution to this might consist of changing the present regulatory regime to guarantees that a certain amount of thermolectric capacity runs at base or intermediate load (i.e. more intervention in the market) or, alternatively, by a more open solution (like NETA in the UK), where each generator decides how to run its portfolio of plants, seeking a balance between return and risk. This would allow for the system to increase the amount of non-hydro capacity and so damp some of the volatility in the system. This is also important as there is likely to be another Niño in the near future. It is not yet possible to predict the Niño in any scientific way, but it is conceivable that there will be another one occurring within the next 3–4 years. When the next Niño occurs, and in the case that no new fossil fuel capacity is made available, is it likely that there will be blackouts, as can be appreciated from Fig. 10. The figure illustrates what may happen if no further investment in capacity takes place during the near future in Colombia. Simulation conducted by Ochoa (2001) that indicates blackouts will occur, as electricity availability will be insufficient to satisfy demand if an intense Niño occurs by the year 2006, or any time later. Under those circumstances, blackouts will occur because hydroelectricity availability will be reduced by as much as 50%. Note that Scenarios 1, 2, and 3 correspond to growth rates in electricity demand of 2.5%, 3% and 4.5%, respectively, for the next 10 years.

It is still an open question as to what share of non-hydroelectric capacity will be required to reach a more balanced situation that will reduce price volatility. However, the regulatory institution should promote a solution for this in such a way that the markets find the appropriate balance between, on the one hand, the private initiative, and, on the other hand, the interest of the customers with respect to reasonably predictable prices. With the right regulation and incentives, this could be accomplished without destroying the market-based system.

Another way in which some of these problems could be at least partly solved in the longer term is with a much closer cooperation between the countries in the Andean region similar to NordPool. The Scandinavian solution has been to create a regional electricity market which has managed to develop a fairly balanced technology portfolio for generation. Norway (100% hydroelectric) has in this way not been forced to build any thermolectric capacity, but has been able to draw on capacity from Finland, Denmark and Sweden when needed, and sell electricity when there is excess water.

The third point to consider here is related to the trading activity. Companies and traders are learning to counter highly volatile prices by long-term contracting; so they tend not to be over-exposed to the Pool. The short-term market is mainly used for balancing purposes, which has prevented problems for most distribution companies. However, due to the current situation where competition is only taking place at the wholesale level and for large consumers, it has not been possible for the distribution companies to share risk with their customers, as domestic consumers have fixed tariffs (set by the government). This also means that domestic customers do not have the appropriate incentives to save

---

**Fig. 10.** Simulation of the consequence of an intense Niño on supply availability and electricity demand.
electricity during the periods with high prices, as the high wholesale prices have not been reflected in their bill. Some (small) distribution companies have been allowed to go bankrupt and have been taken over by larger distribution companies with a better understanding of the dynamics of the market as well as having better financial and risk management.

The regulation of the industry has so far been a success; it has been perceived to be fair and relatively independent. This can be seen in the fact that so far there has been about US$6 billion in foreign investments. However, as more political intervention has taken place over the last few years, this has begun to reduce the trust in the system and there are some doubts that investment will continue at the same rate. The danger of this is not in the short term, due to the fall in consumption over recent years, but rather in the long term. When electricity consumption begins to pick up, this might be a major problem for the industry.

The development of a financial market for futures might also help stabilize the market. Colombia has taken the first steps in this, making it possible to hedge risk in a way which is not yet possible. These types of markets are often far from efficient in the initial phase, making the situation even worse as these immature markets can be manipulated to create even more uncertainty. Furthermore, these arrangements are less likely to operate properly in developing countries, given the intrinsically weak financial markets and commercial law in place, as well as the often-missing market depth and volume.

There is also some concern about the political will to continue to support the reforms. One of the negative outcomes might be a continuation of the non-payment culture, instead of the reforms needed to create the possibility of subsidizing the poor who can not afford to pay the full price in the short term. There have been a number of cases with especially bad distribution companies, some of which have not survived and have gone bankrupt, and others that have been taken over by the government or other bigger distribution companies. This policy of actually letting companies go down, as a consequence, has shown the political will to improve the sector, and made it clear to the management of the utilities that they have to perform, and cannot be expected to be bailed out by the government or the generators. However, it is not clear how long the current structure will have the resources to keep paying for bad management and non-paying customers.

We believe that the Colombian electricity industry has a sustainable future. However, this is under the assumption that the various stakeholders keep facing up to their responsibilities as they have been doing ever since the days of deregulation in 1994. There are some indications, described above, that this might not be the case, but the authors remain hopeful.

Acknowledgements

The Colombian authors acknowledge the kind financial support provided by COLCIENCIAS (The Colombian Science Council) that made this research possible. C.J. Franco acknowledges support from EULAFER. I. Dyner acknowledges support from the British Academy; this paper was finished while he was British Academy Visiting Professor at Imperial College.

Appendix 1. A time line of the main events since deregulation in Colombia

- Immediately after the Electricity Law was made public in 1994, investments in gas-fired plant took place in the north of Colombia, taking advantage of unsatisfied demand and system restrictions.
- In 1995 the Colombian regulator created the one-day-ahead Pool, similar to the one that was operating in the UK since 1990.
- In December 1995, the announcement of El Niño encouraged further investment in thermoelectricity plants.
- The initial 8 months of the Pool, a learning period, went fairly smoothly. Prices were slightly higher than expected and there was overreaction from both regulators and companies. The minimum operational levels for hydroelectricity plants, set by regulators, caused higher prices than indicated by above-average hydrology conditions for December 1995.
- 1996 went fairly well. No major events occurred, dominated by humid weather conditions.
- Big problems started to emerge in 1997. The build up of the worst Niño registered this century revealed a number of facts related to companies: (a) inefficiencies, (b) management problems, (c) lack of trading capabilities, (d) capacity payment inconsistencies.
- More than 10 small distribution companies plus an important regionally integrated utility proved non-viable. Losses were higher than book value. These companies were taken over by the government and sold (in the process). Corelca (an important regional utility) was separated into three different activities—generation, transmission and distribution—and sold by public tender.
- The most important multi-utility company of the country revealed weaknesses. As it owns the only multi-annual reservoir in Colombia, it had over-contracted power, not fully taking into account the reservoir intervention regulations (and its possible revision), before El Niño took place. As a result of a strong Niño and not being allowed to dispatch its hydro plant, EPM had to buy electricity at prices sometimes seven times as high as the price contracted.
for delivery to other companies. The losses amounted to about US$100 million in just a few months.

• Nevertheless, the system passed its more important test. No blackouts!

• La Niña period 1998–1999 has revealed how difficult it is for a purely thermoelectric company to survive within a system with a high hydroelectric component, strong weather variations and heavily regulated prices.

• Prices have been much lower than during the period prior to deregulation—Fig. 1.

• There is great satisfaction among generators and politicians in 1999 for some regulatory issues related to the capacity payment and also with respect to the minimum operation level of hydroelectricity plants.

• There is a threat that thermoelectric plants will disappear from the central region of Colombia because of the large number of hydroelectric units in this region and the slowdown of the economy. This has created temporary over-capacity, making it difficult for the gas units to compete with water turbines, as the former operate at zero fuel costs.

• It has been announced that the transportation (grid) utility company will go private. About 12% of it has already been sold to a number of small investors. The company manages to attract over 60,000 new owners in this way.

• Major attacks to the transmission infrastructure have isolated some important generator’s cheap generation capacity. As a consequence of this, some companies in the electricity system have to run with more expensive plants in operation and some companies have apparently managed to exercise market power.

• At the same time, it is now known that ISAGEN, the last generation company that belongs to the government, cannot be sold because of legal problems.

• Major political pressure has built up as prices increase dramatically during the time of attacks to the infrastructure. A new interventionist rule has been put in place by CREG (Resolution 034, 2001), intending to control the apparent market power exhibited by some generators.

• A second tranche of ISA shares (in excess of 10%) was sold in 2002.

References


