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ESMAP
Energy Sector Management Assistance Program

June 2021

LEARNING FROM POWER SECTOR REFORM EXPERIENCES

THE CASE OF COLOMBIA

This report has been authored by Hugh Rudnick and Constantin Velásquez. The authors are very grateful for financial support from the Energy Sector Management Assistance Program (ESMAP) and the Public Private Infrastructure Advisory Facility (PPIAF). Special thanks to Isaac Dyner, who provided most of the source information, data and analysis used to develop this paper. Thanks are also due to Claudia Ines Vasquez Suarez who acted as peer reviewers. Any shortcomings are the sole responsibility of the authors.

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Learning from Power Sector Reform: The Case of Colombia[1]

Hugh Rudnick and Constantin Velásquez[2]

Abstract

In the early 1990s, Colombia's publicly-owned power sector was financially distressed and poorly managed, becoming a risk for the country's macroeconomic stability. The sector reached a tipping point during extensive demand rationing episodes in 1992. Amidst the paradigm transformation promoted by the 1991 Constitution, Colombia launched an ambitious power sector reform package in 1994, introducing private sector participation, independent regulation of distribution and transmission, and competition in power generation and retailing. Aversion of demand rationing meant that early regulation and privatization efforts focused on the generation segment. Distribution privatization and unbundling proved more difficult and stalled shortly thereafter, preventing Colombia from fully implementing the announced reform package. As progress was slow, in the 2000 decade a new *firm-energy* market was introduced to ensure security of supply, and distribution regulation revamped. Reforms have been successful in many aspects such as the absence of demand rationing, improving efficiency and financial viability of the sector, attracting investment in power generation, and improving average quality of service for final customers. However, disappointment emerged again due to weaknesses of the firm-energy market unveiled during the 2016 El Niño event, slow adoption of non-hydro renewables, steady tariff increases and poor performance of several distribution utilities.

[1] This paper is a product of the "Rethinking Power Sector Reform" knowledge program of the Energy & Extractives Global Practice of the World Bank. Any views presented here are the authors alone and should not be attributed to the World Bank or any other person or institution. The authors are very grateful for financial support from the Energy Sector Management Assistance Program (ESMAP) and the Public Private Infrastructure Advisory Facility (PPIAF). Special thanks to Isaac Dyner, who provided most of the source information, data and analysis used to develop this paper. Thanks are also due to Claudia Ines Vasquez Suarez who acted as peer reviewers. Any shortcomings are the sole responsibility of the authors.

[2] Department of Electrical Engineering, Pontificia Universidad Católica de Chile and Systep Ingeniería y Diseños.

Foreword

Rethinking Power Sector Reform, a multi-year global initiative of the World Bank's Energy and Extractives Global Practice, provides an updated assessment of experiences with power sector reform across the developing world. Its goal is to refresh our thinking on power sector reform by analyzing lessons learned over the past 25 years in countries that have undertaken various types of reforms, and by articulating a new vision based on that analysis. Critically, the initiative examines how the recent technological trends and business models that are disrupting the sector may call for new reform strategies.

Since the 1990s, a standard set of policy prescriptions for power sector reform has been widely used. Those prescriptions include vertical and horizontal unbundling of power utilities; private sector participation; creation of an independent regulator; and competition in power generation (with associated cost-recovery pricing). Although this package of reforms was adopted, at least partially, by several developing countries, momentum and uptake slowed considerably in the 2000s, and it is past time to revise our approaches in the light of experience, evidence, and technological advances.

It is our hope and intention that the revision will provide practitioners with a flexible frame of reference that can help them identify the types of reforms most likely to improve the performance of the power sector in a given country context.

With support from the World Bank's Energy Sector Management Assistance Program (ESMAP) and the Public–Private Infrastructure Advisory Facility (PPIAF), Rethinking Power Sector Reform works with partners and experts across the World Bank Group and beyond to generate evidence, analysis, and insights on key themes of interest to power sector reform practitioners and decision makers. Findings and recommendations will be published in a forthcoming report.

The research undertaken by the initiative is grounded in an in-depth exploration of the 25-year reform journey of 15 World Bank Group client countries that represent a wide variety of geographies, income levels, and approaches to reform. The countries are Colombia, Dominican Republic, Arab Republic of Egypt, India, Kenya, Morocco, Pakistan, Peru, Philippines, Senegal, Tajikistan, Tanzania, Uganda, Ukraine, and Vietnam.

An important output of the project is a series of case studies—of which this is one—that provide a narrative of the reform dynamics in each country and evaluate the impact of reforms on key dimensions of sector performance, including security of supply, operational efficiency, cost recovery and energy access. With respect to a subset of countries that pursued deeper reforms—Colombia, India, Peru and the Philippines—the project also includes a series of free-standing case studies that evaluate experience with wholesale power markets. The purpose of all the case studies is to reflect upon the experiences of individual countries, with a view to extracting lessons of broader interest to the global community. It is not the role of these papers to recommend, let alone prescribe, any particular approach in any particular country or context.

These case studies, which constitute companions to an eventual flagship report, are being published in the World Bank's Policy Research Working Paper series. As such, they represent the views of the authors alone and should not be attributed to the World Bank Group or to any other person or institution.

Contents

Abbreviations and Acronyms

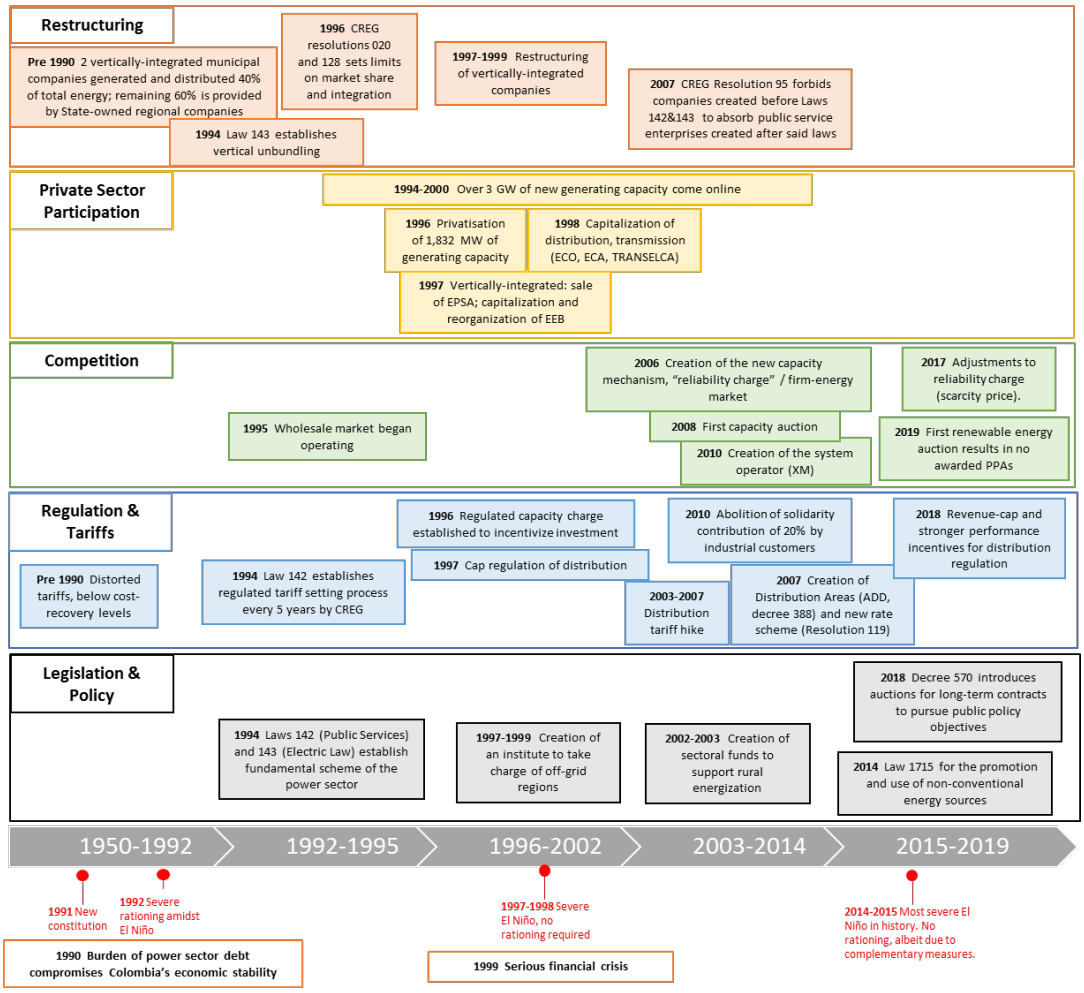
ADD	Distribution Areas
ACOLGEN	Colombian Association of Hydropower Generators (*Asociación Colombiana de Generadores*)
ANDEG	Association of Thermal Generating Companies (*Asociación Nacional de Empresas Generadoras*)
ASIC	Trading System Administrator (pool market operator, currently XM)
ASOCODIS	Colombian Association of Distributors (*Asociación Colombiana de Distribuidores*)
BCOP	Billion Colombian Pesos
CND	National Dispatch Center (system operator, currently XM)
COP	Colombian Pesos (nominal values unless otherwise stated)
CREG	Commission for the Regulation of Energy and Gas
CSMEM	Committee for Monitoring the Wholesale Energy Market
DES	Equivalent Duration of Service Interruptions
FES	Equivalent Frequency of Service Interruptions
IRAD	Referential Grouped Index of Discontinuity
ISA	Interconexión Eléctrica SA, major transmission company
ITAD	Quarterly Grouped Index of Discontinuity
LTSO	Legally unbundled Transmission System Operator
MEM	Wholesale Energy Market
OEF	Firm Energy Obligation
PLF	Plant Load Factor
PPA	Power Purchase Agreement
PSP	Private Sector Participation
QfD	Quasi-fiscal Deficit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SSPD	Superintendence of Public and Domiciliary (household) Services
TIE	International Electricity Transactions
UPME	Mining and Energy Planning Unit
XM	System and market operation company (a subsidiary of Interconexión Eléctrica SA or ISA)

1 Introduction

Colombia's power sector was heavily distressed in the early 1990's. Financially unsustainable utilities placed an enormous burden on the country's fiscal gap. Efficiency was very low overall, particularly in areas with high electricity theft and fraud. Furthermore, two major blackout periods, first in 1983 and then in 1992-1993, pushed power sector reform to the top of the country's agenda in 1993 (Larsen, Dyner, Bedoya, & Franco, 2004).

To tackle these challenges, a comprehensive reform package was launched with enactment of Laws 142 and 143 of 1994. These laws established the framework for vertical unbundling and private sector participation, a new regulatory framework and rate-system governed by principles such as efficiency and financial sufficiency, and introduction of wholesale competition, among other measures. After 2008, a second period began for the Colombian power sector, following the introduction of a new capacity market (the firm-energy market) and an update of distribution regulation (see Figure 1).

Figure 1: Colombia power sector reform timeline.



Source: Rethinking Power Sector Reform project.

This case study analyses Colombia's experience with power sector reforms and is structured as follows. Section 2 provides a chronological account of reforms. Section 3 assesses performance of the Colombian power sector, and analyzes institutional factors for such performance outcomes, under the following four areas: (1) investment and security of supply; (2) access and affordability; (3) utility efficiency and financial sustainability; and (4) tariffs and cost-recovery. Section 4 concludes this case study by summarizing performance outcomes of reforms and drawing lessons that may be relevant for other developing countries.

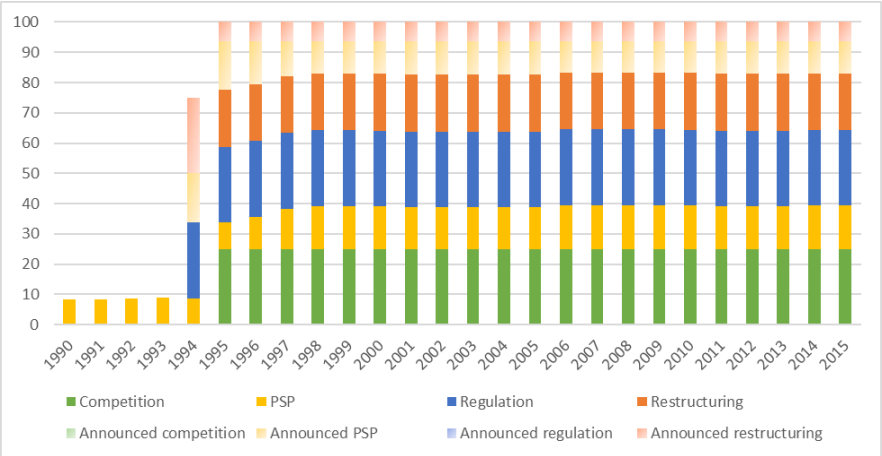
2 Evolution of Colombia's power sector reforms

In the early 1990s, the Colombian electricity sector incorporated exclusively public companies in all components of the supply chain. However, unlike many countries in the region, the Colombian power sector before reforms was rather decentralized, with two vertically-integrated municipal companies generating and distributing about 40% of total energy, and the remaining 60% provided by State-owned regional companies (Millán et al., 2003). As most companies were largely subsidized and poorly managed, their operating costs and production losses were extremely high. This distorted the financial performance of companies and tariffs charged to consumers. The sector was increasingly dependent on the national budget, which compromised the country's macroeconomic stability.

Delays in the generation expansion plan as well as poor maintenance of thermal power plants did not help to confront the droughts caused by El Niño phenomenon during the period 1991-1992. Under these circumstances, the system collapsed, and electricity rationing was imposed for 14 months (9 hours a day), which was the catalyst for reform.

Laws 142 and 143 of 1994 laid the foundations of Colombia's power sector reform. Key components of the reform process were swiftly implemented in just a couple of years. Indeed, by 1996 Colombia had already implemented wholesale market competition, one of the most cumbersome reform steps, and the less frequently implemented across developing countries. However, even today Colombia's reform process falls short of achieving announced reforms in full (see Figure 2). Indeed, restructuring and private sector participation (PSP) were only partially addressed, as further discussed below.

Figure 2: Announced and actual power sector reforms in Colombia.



Source: Rethinking Power Sector Reform Project, see further details in Annex A.

A chronological account of reforms is provided below. After describing the background crisis (section 2.1) and reform elements (section 2.2), the privatization process and initial success in generation investment between 1996-2002 is discussed (section 2.3). The following period (2003-2014) was characterized by introduction of the firm-energy market -to ensure security of supply- and distribution regulation reforms (section 2.4). However, weaknesses unveiled during the 2015-2016 El Niño event recently motivated adjustments to the firm-energy market and the adoption of new policy instruments such as long-term

auctions (section 2.5). Finally, given the relevance of security of supply for key stakeholders, a discussion from the political economy perspective is provided (section 2.6).

2.1 1950-1992: Crisis background and the need for a reform

Colombia experienced deep institutional transformation in the late 1980s and early 1990s as a result of an economic, political and social paradigm change. There was a gradual shift from a state-supported industrialization model, to a model of economic openness between 1990 and 1994, under Cesar Gaviria's presidential term. Following execution of a new Constitution in 1991, pro-market reforms were implemented to increase efficiency through competition (see Annex B for further details). In this context, electricity supply is one of the economic sectors that underwent deeper transformations, seeking to achieve a more modern, sustainable and efficient structure.

By that time, the power sector had become nearly bankrupt and ended up being a heavy burden for the Colombian state. Between 1950 and 1990, the state took over the responsibility of supplying the fast-growing electricity demand and expanding coverage beyond the most profitable markets. As a result, 78% of population had been electrified by 1990. To accomplish this task, the state relied on multilateral bank loans to finance investments. Indeed, the proportion of the national budget destined to the electricity sector grew from 4.8% in 1970 to a peak 19.1% in 1980. Public debt deteriorated further due to high inflation -averaging 19% between 1968 and 1984- and Colombian peso devaluation against the dollar -averaging 18% per annum until 1990 (Méndez, 2014). The power sector ended up accounting for 30% of total foreign debt and 33% of nonfinancial public deficit (Millán et al., 2003).

In this context, the expansion model that was once financially supported by multilateral banks would not be feasible over time as new restrictions were imposed on credit to Colombian state (Méndez, 2014). General uncertainty created in the region as a result of the 1980's economic crisis contributed to deteriorate sectoral sustainability. Severe operation and design deficiencies resulted in significant pressure from multilateral banks, main contributors to the initial national-level interconnection and expansion. Pressure motivated a series of policy initiatives that paved the way for 1994's reform.

Summarizing, reform of the Colombian power sector occurred as a response to a set of factors that compromised sectoral sustainability, including the following:

1. **Serious financial crisis** associated to sector management, which deepened further due to the macroeconomic environment.
2. **Inefficient utilities and distorted tariffs**: integrated companies had inefficient and costly operating structures; system electricity losses were very high (about 22%, well above what is considered to be efficient); prices did not reflect average long-term costs; and tariffs were distorted both in structure and average level (Romero, 2006).
3. **Political interference**: in some regions, utilities were used as political means to appoint officials and assign contracts.
4. **Planning inefficiencies and coordination failures**: inefficiencies in project planning and structuring, as well as coordination failures between sectoral entities, leading to development of

large generation projects with excess costs and delays.[3] A significant burden was imposed on national budget, since it was necessary to allocate recurrent central government fiscal resources to cover financial shortfalls (Romero, 2006).

In this context, there was a clear necessity to promote a different sectoral structure and design, to ensure long term sustainability.

2.2 1992-1995: Blackouts and comprehensive power sector reform

The state led expansion plan for supplying fast growing electricity demand in Colombia relied heavily in hydro generation, which accounted for about 80% of supply in 1992. Despite being abundant on average, hydrological inflows in Colombia fall considerably during El Niño events[4], which occurs every 2 to 7 years (with no clear and regular time pattern). Aggregated hydro inflows have historically shown high variability (ranging from 55.5 TWh in 1971 to 31.8 TWh in 1997), especially during El Niño and La Niña climate phases. Furthermore, the Colombian system was different to other hydro-dominated countries which pursued electricity reforms, in at least two aspects. First, Colombia lacked strong interconnectors and regional energy market integration, which have proven important for electricity markets in Nordic countries.[5] Second, hydro storage capacity was relatively low and just enough for the summer, with only one dam having inter-year regulation capabilities, contrasting with large dams in Brazil, for example (Gómez, Pérez, & Fernández, 2005). Thus, Colombia's power system is heavily dependent on hydrological conditions. Prolonged and profound El Niño events lead to scarcity conditions during which thermal generation must supply the deficit power.

A profound El Niño event hit the Colombian power system in 1992. By the time, thermal infrastructure was under-used, under-maintained, and gas supply was insufficient. Out of an effective installed thermal capacity of 1835 MW, 635 MW were unavailable for backup, mostly due to maintenance problems which can be traced back to the financial crisis of the sector and poor centralized management (Pombo, 2001). There was no choice but to declare a power rationing that lasted almost a year. This event made explicit a series of shortcomings in a sector that, for a long time, was considered oversized.

The Colombian power sector thus reached a critical point and the need for intervention was evident. The government declared a state of social and economic emergency (Decree 680/1992) and initiated elaboration of technical and political proposals to prevent the extension of crisis effects (Decree 700/1992). A modernization process that began in the Political Constitution of 1991 was continued, where competition (where possible) and free entry had been established as key principles for achieving efficiency in public services. In December 1992, the national government restructured the Ministry of Mines and Energy, the country's top energy authority, and dissolved the National Energy Commission, created in 1989 to regulate rational and integral use of different energy sources. Three special administrative units were created: the Energy Regulatory Commission (CRE) - which would later become the current Energy

[3] A notable example is the six-year delay of 1000 MW Guavio hydroelectric, which influenced the 1992 shortage, and the development of the Chinu gas-based plant without enough fuel availability (Pombo, 2001).

[4] According to US National Oceanic and Atmospheric Administration (NOAA), El Niño Southern Oscillation (ENSO) is a climate pattern with two opposite phases, known as El Niño and La Niña. During El Niño phases, the east-central tropical Pacific is significantly warmer than usual.

[5] International electricity trade increased substantially since 2003 due to a coordinated regulatory framework developed with neighboring country Ecuador (International Electricity Transactions, TIEs).

and Gas Regulatory Commission (CREG)-, Energy Mining Information Unit (UIME) and the Mining and Energy Planning Unit (UPME).

Power sector reforms were consolidated with the issuance of two laws in 1994: Public Services Law 142 and Electric Law 143. These created the legal framework for more efficient sectoral business management, allowed effective entry of private capital investment, and defined schemes for sustainable expansion, freeing the State as guarantor for electricity debts. These laws induced profound reforms in the electricity sector which importantly improved the performance of the industry in less than a decade; particularly regarding security of supply, service quality and service coverage.

Explicitly, Law 143 specified the following objectives (ECSIM, 2013):

- A unified legal and regulatory regime for all businesses, regardless of the property nature.
- A rate-system governed by principles of economic efficiency, which requires the correct allocation and use of resources in a way that guarantees the provision of the service at the lowest economic cost, financial sufficiency and social solidarity.
- A unique and sustainable system of cross-subsidies, applicable to customers of all companies, regardless of their nature and ownership.
- Vertical disintegration of the electricity supply chain.
- Separation of monopolistic activities (transmission and distribution) from the ones where competition was desirable (generation and commercialization). To prevent anticompetitive behavior, surveillance authorities were created.
- Suppression of regional electricity supply monopolies seeking free access to transmission and distribution networks.
- Creation of specialized State agencies according to functions: policy, regulation, monitoring and control.
- Contractual freedom for consumers whose consumption levels exceed the thresholds stablished by the regulator.
- Indicative planning for the generation activity and freedom of investment in generation assets. Mandatory planning for the transmission activity.
- Creation of a wholesale electricity market with the participation of generators, traders and large electricity consumers.

Reforms entailed important institutional developments (see Box 1). UPME centralized the national system planning function, by coordinating sectoral information with agents and stakeholders to elaborate an integrated generation and transmission expansion plan. CREG, as an independent and autonomous commission of experts, was now in charge of *"regulating the provision of public utilities for electric energy, fuel gas and public liquid fuel services"* at the national level, issuing technical resolutions on system operation and design. Currently, the regulator (CREG) has the functions of establishing conditions to ensure an efficient energy supply; approve charges for the use and access to networks; define tariffs and related formulas for regulated users (residential market); establish national interconnected system codes

and rules, as well as Rationing Statute and Network Code. Control and monitoring of companies and free competition, would be carried out by the SSPD (later, Superintendence of Industry and Commerce –SIC– would centralize part of these functions). Besides regulation and oversight institutions, participation of sectoral agents is organized through strong sectoral associations, including distributors (ASOCODIS), hydro power (ACOLGEN) and thermal power (ANDEG) associations. These organized and resourceful associations exert high level influence on regulation and policy making of the Colombian sector (Valencia, 2005).

Box 1. Colombia's power sector institutions

Ministry of Energy and Mines. Responsible of power sector policy-making and planning through UPME.

Commission for the Regulation of Energy and Gas (CREG). Regulator of the electricity sector, responsible of tariff setting for regulated activities (including distribution, transmission and supply of regulated customers), pursuing the improvement of service and its quality, as well as competition, efficiency, and sustainability in energy markets.

Mining and Energy Planning Unit (UPME). Administrative and technical unit under the Ministry of Mines and Energy. Its mission is to "plan holistically energy/mining development, support the formulation of public policy and coordinate sectoral information with agents and stakeholders". Develops indicate generation expansion plans and mandatory transmission expansion plans.

Superintendence of Domestic Public Services (SSPD). In charge of enforcing and supervising regulations for the provision of public services in Colombia. It has the Delegated Superintendence for Energy and Fuel Gas as the area responsible for the analysis, direction, evaluation, formulation and orientation of policies and plans concerning action, development and implementation of the technical, legal and financial aspects of the companies providing energy services.

Interconexión Eléctrica SA (ISA). Largest high-voltage transmission company in Colombia, with 60% of government ownership. Vertically-integrated utility before reforms, its generation business has since been unbundled to private ISAGEN, but ISA has retained system and market operations through XM. Currently invests across Latin American countries.

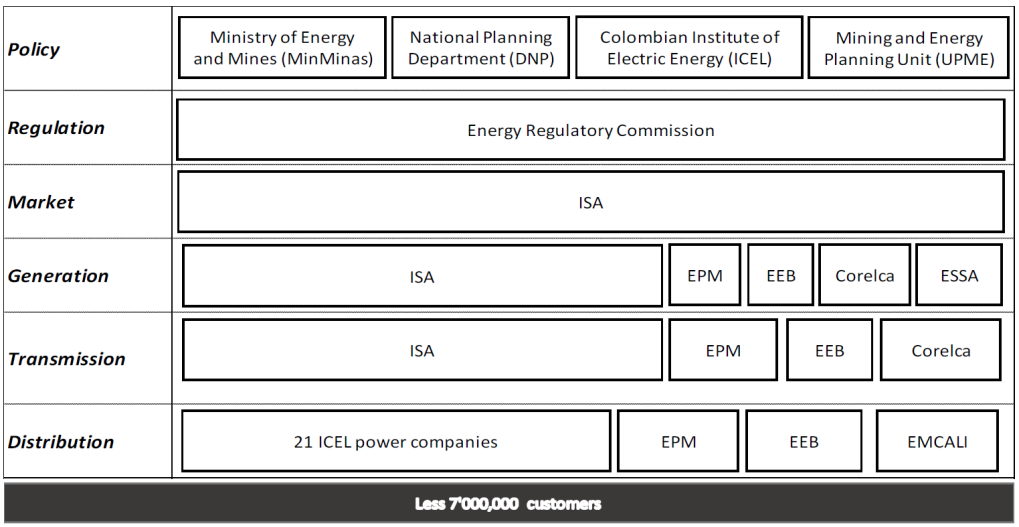
Expertos del Mercado (XM). The Colombian system and market operator, subsidiary of ISA, schedules plant dispatch to meet demand with economic, security and reliability criteria, and calculates economic settlements in the wholesale market.

In the new regulatory framework, a Wholesale Electricity Market (MEM) began operating in 1995, regulated by CREG and administered by a newly created system operator (currently XM), who clears short-term prices and determines electricity dispatch. Colombia's experience with wholesale competition is analyzed in a dedicated case study of the Rethinking Power Sector Reform project (Rudnick & Velasquez, 2019).

Despite the completeness of the envisioned reform package with regards to the textbook model, in practice the reform fell short of full vertical unbundling and privatization (see Figure 3 and Figure 4).

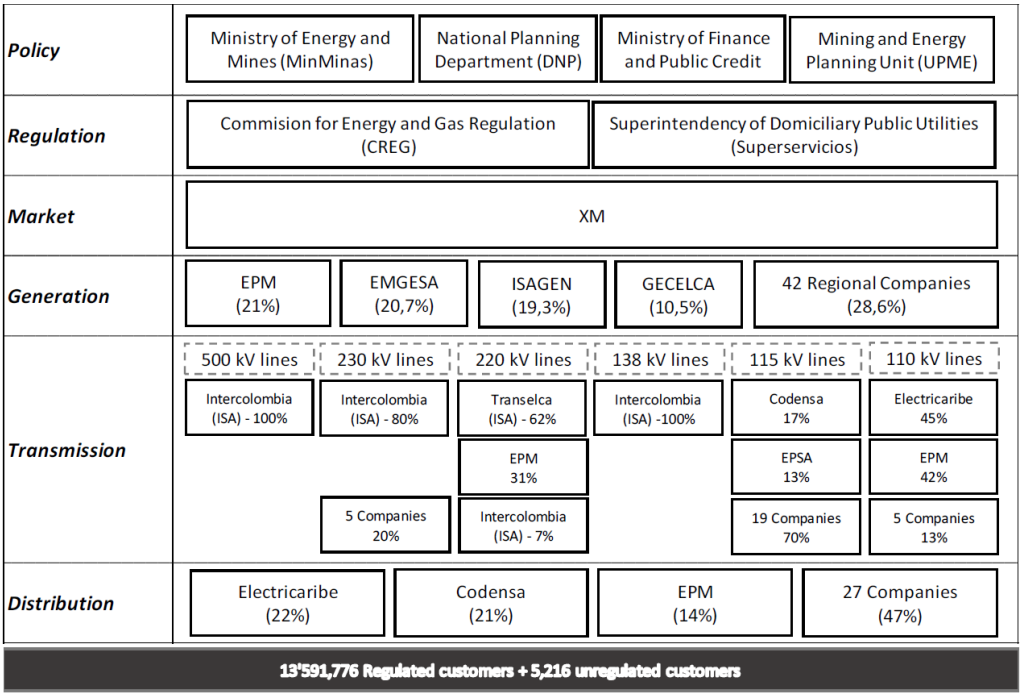
Private sector participation was allowed by the law and spurred by privatization processes further discussed below. Article 74 of Law 143 prohibited vertical integration for public services companies constituted after the enactment of Laws 142 and 143, with an exception for commercialization segment, which could develop its activity in conjunction with generation or distribution. However, existing vertically integrated companies –like EPM– were able to continue as such, provided certain conditions were fulfilled (independent accounting by segment and limits to market quota). Current regulation considers generation-transmission, generation-distribution, transmission-distribution and transmission-commercialization as exclusive activities. Despite rules to curb concentration and efforts in increasing competition, the Colombian power still exhibits relatively high levels of vertical and horizontal concentration, periodically raising concerns regarding market efficiency.

Figure 3: Taxonomy of Colombian power sector before reform (1994)



Source: Rethinking Power Sector Reform Project

Figure 4: Taxonomy of Colombian power sector after reform (2015)



Source: Rethinking Power Sector Reform Project

2.3 1996-2002: Privatization and generation capacity expansion

Although the aforementioned crisis forced the State to assume a more direct presence (through shareholding, especially in some thermal companies), there was now a clear intention of advancing towards a new agenda in which the role of private sector was central. Private agents could now assume responsibility for providing public services according to the competences established by law, plus responsibilities related to provision, coverage, quality, financing and a tariff system that must take into account cost criteria, solidarity and redistribution of income for regulated customers.

The process of linking private capital to power sector had two main objectives: increase efficiency in operations and promote sustainable expansion and operations in public utilities. Accordingly, the government started with the disposal and transference of some of its assets, through auctions and direct sales. Although privatization wasn't exempt from detractors, there was a general perception that it was a necessary step to balance the "delicate" situation of some companies in the sector.

Privatization efforts focused first on generation plants with great initial success. Many generation plants were fully privatized in 1996, among which were hydro plants Chivor and Betania, and thermal plants Termocartagena and Termotasajero (see Table 2). Privatization continued in 1997 with the sale of vertically integrated EPSA-Pacific Energy Company and capitalization of vertically integrated EEB - Bogotá Energy Company. EEB was reorganized with transmission under publicly-owned EEB, separated from distribution and generation businesses (Codensa and Emgesa, respectively). EEB's distribution and generation businesses are currently managed by the Italian Enel group.

Distribution companies were secondary in the privatization process, largely due to opposition from regional politicians and the lack of strong political leadership to implement privatization when the opportunity emerged (Millán et al., 2003). Besides Codensa's capitalization, a large proportion of government shares in distribution companies Electrocosta and Electricaribe were sold in 1998. However, the privatization process stagnated that year and has since shown no major advances. ISA's generation assets were transferred to ISAGEN in 1995, but privatization efforts failed, and privatization was only realized during 2015 with the sale of 58% of the government's shares. Despite relatively low state participation in generation (excluding EPM, which has a special municipal character), public ownership (both from the state and municipalities) remains important across the electricity supply chain, particularly so in distribution utilities and transmission company ISA.

Table 1: Privatization timetable.

			Capacity		Value	
Year	**Process**	**Asset**	**MW**	**Customers (thousands)**	**US$ millions**	**%**
1996	Sale of shares in four generation plants	Chivor (H)	1,000	na	647	100
		Betania (H)	500	na	506	100
		Tasajero (T)	153	na	19	100
		Cartagena (T)	179	na	18	100
1997	Sale of shares in Integrated Company					
	Capitalization:	EPSA (96% H)	869	270	537	65
	generation	EMGESA	2,453	na	952	48.5
	distribution	CODENSA	na	1,500	1,226	48.5
	transmission	EEB	na	na	na	11
1998	Capitalization of distribution, transmission	ECO	na	490	530*	65
		ECA	na	627		65
		TRANSELCA	na	na	–	65
2000	Sale of IPO shares, transmission company	ISA	na	na	–	25

* Includes ECO and ECA.
na – not applicable.

Source: (Millán et al., 2003)

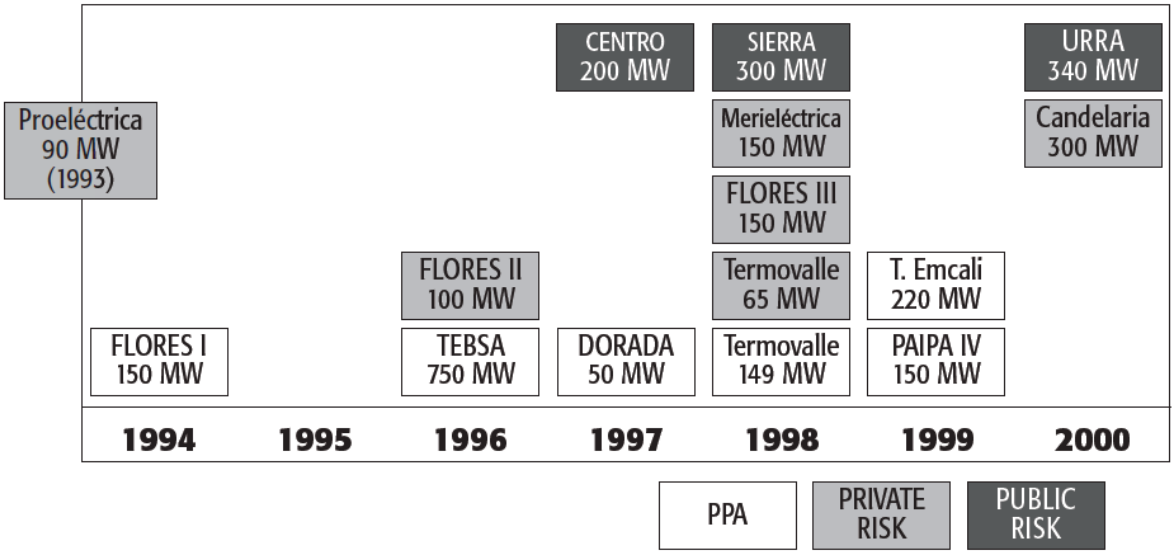
Generation capacity soared between 1994 and 2000 with over 3 GW of additional capacity due to a mix of market-driven private investments and legacy projects from the centralized expansion regime (see Figure 5). Most of these projects were gas-fired power plants, much needed during low hydro availability periods. Some of these thermal plants were developed as a response to high expected wholesale prices as well as the newly established market with capacity payments. The initial 1995 wholesale market comprised a power and backup payment based on the costs of a gas turbine. The regulated backup payment was replaced by regulated capacity payments established by CREG resolution 116 of 1996.

Capacity payments, which came into force in 1997, were conceived as a transitional measure to ensure thermal capacity expansion until the market is *"mature and stable enough to make this price intervention unnecessary"* (CREG Document 024 of 1996). The capacity charge established an annual fixed income per

installed megawatt, at a price defined by CREG, which promoted *"income stabilization, making investment in generation resources viable to efficiently cover demand requirements"*[6]. The payment was based on (1) power plant availability; (2) UPME's indicative expansion plan which determines the optimal system capacity; and (3) a price based on fixed costs of the efficient capacity expansion technology (open-cycle gas turbine). The charge was set to expire in December 2006 to ensure a regulatory review of the mechanism 10 years after its launch (Gómez et al., 2005).

However, many thermal plants commissioned in this period were developed in direct response to 1992 blackouts and were backed by PPAs signed by distribution companies between 1992 and 1995, either before or shortly after enactment of reform laws. Moreover, all commissioned hydro power plants were previously being developed under the centralized regime. PPAs signed by distribution companies have been the subject of much criticism due to poor management and even corruption accusations, resulting in high-priced long-lived PPAs (Millán et al., 2003).

Figure 5: Generation projects commissioning after reforms.

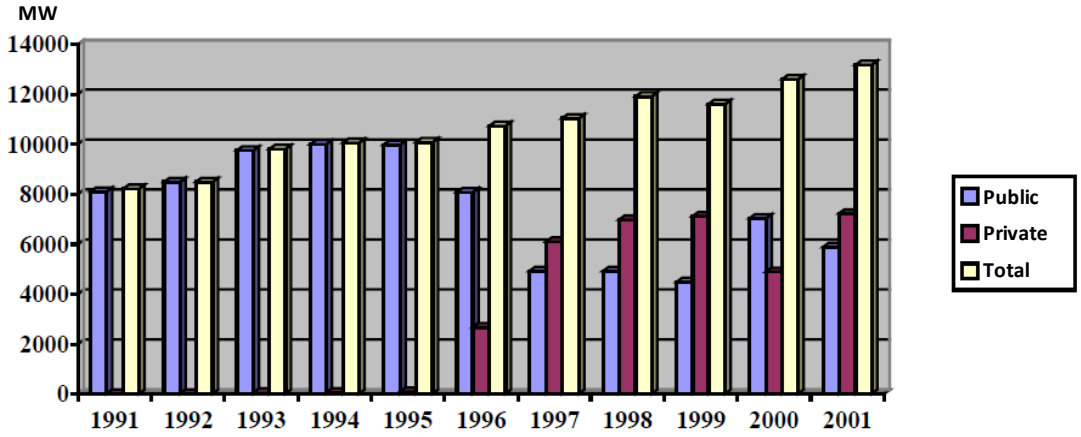


Source: (Millán et al., 2003)

The evolution of Colombia's generation segment between 1991 and 2001 highlights significant capacity expansion and the partial participation of private investors, owing to both extensive privatization efforts focused on generation plants, and a mix of legacy PPAs with market-driven investments (see Figure 6). However, state ownership remained important especially in distribution companies. Furthermore, significant vertical integration also remained for existing utilities such as EPM.

[6] CREG. What is reliability charge? Available on: **http://www.creg.gov.co/cxc/english/que_es/que_es.htm**

Figure 6: Private and public participation in Colombia's generating capacity.



Source: (Sandoval, 2004)

Positive outcomes of reforms became evident during the 1997-1998 El Niño event. Hydro inflows during this event were even lower than those of the 1992 blackouts period. Generation capacity additions and diversification through gas-fired plants allowed the country to successfully withstand the episode without resorting to demand rationing. However, as further discussed below the episode also raised concerns due to (1) large spot price volatility; (2) the regulator's imposition of price caps to avoid further spot price spikes; (3) lack of guaranteed capacity payment to resources that effectively contributed to security of supply; and (4) the operational and financial impact of minimum reservoir levels, perceived as an instrument of regulatory intervention in the market (Larsen et al., 2004; Millán et al., 2003).

Privatization was accompanied by the vertical unbundling process which, falling short of full ownership separation, focused on regulatory rules to prevent the harms of integration. In 1996, CREG issued Resolutions 020 and 128, seeking to ensure free competition in the purchases of electricity made in the newly constituted wholesale market, regulate the market share in the different segments of energy sector and setting limits to shareholding between companies with complementary activities. Resolution 128, particularly, establishes:

- No company may have more than 25% of the effective installed capacity in electricity generation.
- No company may have more than 25% of total commercialization.
- No company may have more than 25% of distribution activity.
- No generation company may have shares, quotas or parts on social interest that exceed 25% of a distribution company social capital.

Seeking to limit the advantage of companies founded prior to Laws 142 and 143 (which could therefore remain vertically integrated), on 2007 CREG issued resolution 95. With this regulation, the former companies will not be able to absorb public services enterprises created after the validity of said laws. This resolution put to a halt EPM's sustained efforts to absorb ISAGEN, in an effort to integrate operations of cascading hydro power plants in the Nare-Guatapé system.

For the monopolistic distribution segment, law 142 establishes a regulated tariff setting process for distribution to be undertaken by CREG every 5 years, resulting in a formula that distributors must apply to calculate tariffs. Remuneration was based in a price-cap mechanism for medium to low voltage level networks. For the first tariff period (1997-2002), CREG considered average asset values at the beginning of the period (valued at their reposition cost, i.e. based on regulated unit costs and other parameters) and 4% O&M costs (Resolution 099 of 1997). Quality of product and service, which received little attention before reforms, was regulated by key distribution bylaws enacted in 1998 (CREG Resolution 070 of 1998). The regulation bylaw introduced quantitative indicators and minimum standards for quality of product (e.g. voltage flicker) and service (e.g. interruption frequency).

2.4 2003-2014: Stalled progress motivates regulatory push to security of supply and quality of service

After initial success of reforms in enticing private sector participation and generation investment, progress stalled in the early 2000's. During the first ten years of reforms, energy losses and electricity interruptions did not present significant reductions and varied enormously across distributors. Electricaribe's electricity losses stood at 35% in 2000, comparing poorly to a 20% country average, EPM and Codensa's average at about 13%, and regulation which recognized only 14.75% losses in tariffs (Millán et al., 2003). Despite some improvements after 2005, by 2007 CREG considered progress on efficiency and quality of service to be too small and slow in the distribution segment (Galán & Pollitt, 2014a).

In the generation segment, aggressive capacity expansion in the previous period essentially stalled between 2002 and 2009. Several factors may have driven the interruption of capital inflows to generation expansion. Spot prices had proven very volatile during the 1997-1998 El Niño, but then plunged back to very low levels due to (1) surplus capacity due to aggressive expansion and the unforeseen economic crisis of 1999, during which electricity demand fell by 5%; and (2) high hydro inflows during La Niña period after the 1997-1998 El Niño. Most of the time, spot prices were well below long-term average incremental costs, thus proving insufficient for new generation investments (Perez, 2004).

The financial impact of low and volatile spot prices was alleviated by the regulated capacity payment. These additional incomes would be key for thermal power plants that were not dispatched during long periods of time. By way of the capacity charge, an average annual payment of US$ 490 million was provided to power plants between 1997 and 2003, and the equivalent capacity price was equal to 41% of the spot price over the same period. Nonetheless, there were concerns regarding the market's ability to sustain adequate returns for investors and incentivize optimal capital investments even after accounting for this additional income. Furthermore, some perceived the regulator to be excessively intervening through ex-post adjustments of the capacity mechanism and dispatch rules. Given that capacity payments were not guaranteed for thermal generators, CREG issued a number of resolutions that ended up redistributing hydro capacity payments to thermal generators in 2001, resulting in hydro generators suing CREG (Millán et al., 2003).[7]

Overall, sustainability of reforms was repeatedly being called into question during this period (Larsen et al., 2004; Millán et al., 2003). Stagnation of privatization, the economic recession of 1999 and the escalation of terrorist attacks on transmission facilities since 2000 eroded the electricity sector business

[7] While total capacity payments changed only slightly between 1997 and 2003, payments to thermal generators doubled between 2000 and 2001, wand payment to hydro generators fell.

climate. In fact, a 2002 World Bank survey found a broad loss of investor confidence in Colombia (Lamech & Saeed, 2003). Moreover, several estimations found plunging financial returns for power sector investors in the early 2000s. Larsen et. al. (2004) pointed at negative returns for generation and distribution during 2000. Urbiztondo and Rojas (2005) estimated returns on equity for generators to have fallen from 70% in 1998 to -5% in 2002 (averaging 2% in 2000-2003), and a more dramatic plunge for fully integrated companies, from 36% in 1998 to -26% in 2003 (averaging -28% in 2000-2003). A joint ASOCODIS – UPME report (2011) also estimates negative returns for 24 distribution companies, with an average -5% net income and -1% return on assets between 2000 and 2003. These estimations vary widely among companies, depending on their coverage area, size and level of vertical integration.

As progress was poor, CREG created the so-called firm-energy market to replace the former regulated capacity payment. The firm-energy mechanism aimed at ensuring enough generation is available to supply demand at all times, through a stable payment specifically linked to the obligation of supplying energy during scarcity periods (particularly during El Niño events).[8] Providing a stable income for new power plants, the firm-energy market gave a renewed push to generation investment in hydro and thermal power plants. Although a profound El Niño event was successfully withstood by the system in 2009-2010, the mechanism was criticized at the time due to possibly uncompetitive auction results, and meddling by the regulator in the mechanism during scarcity conditions (Barrera & García, 2010; ECSIM, 2013).

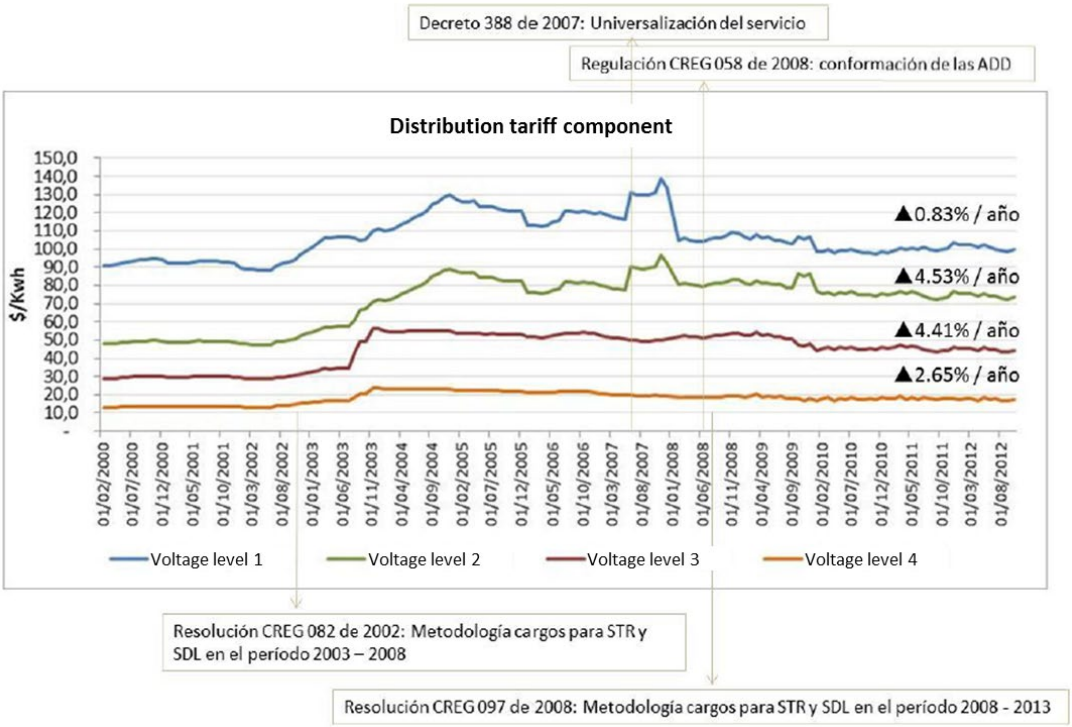
Distribution financial sufficiency and quality of service was also addressed by CREG between 2003 and 2008. Financial distress of distribution utilities such as Electricaribe and Electrocosta stressed the need for further regulatory efforts in bringing tariffs closer to cost-recovery levels. For the third tariff period (2003-2007) CREG introduced important updates including an upward revision of the rate of return from 9%, to a WACC-based rate between 14%-16% (Resolution 082 of 2002). Considering the slightly downward 2008-2013 revision as well, an ECSIM study (2013) determines that the regulated distribution tariff grew by 31% in real terms between 2000 and 2012 for low-voltage levels, at a rate of 2.65% per annum (see Figure 7). Therefore, financial sufficiency of the distribution segment improved, pushing average returns of the industry to positive grounds.

Innovations on quality of service regulation were introduced for the 2008-2013 period. The previous framework was based on a compensation mechanism to penalize non-compliance with minimum standards, promoting an average level of quality. In the 2007 revision, CREG established compensations for the most affected users to ensure a minimum level of quality. Moreover, incentives for quality of service improvements were introduced to the pricing formula (Galán & Pollitt, 2014a). Indeed, the distribution charge was to be updated on a quarterly basis depending on the quality of the provided service, as measured by an interruption duration indicator (ITAD). Upper and lower limits referential ITAD limits are established for each distributor. If ITAD is above the upper limit, quality of service is deemed too low and the distribution charge is reduced. Conversely, if ITAD is below the lower limit, the distribution

[8] Core financial products of the mechanism are Firm Energy Obligations (OEFs), which, according to CREG, are *"commitments on the part of generation companies backed by a physical resource capable of producing firm energy during scarcity periods. OEFs need to cover demand [and] are auctioned among generation companies and investors. The generator who wins the OEF allocation receives a 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"*. The resources associated with the reliability charge are collected by the system operator and are paid by all end-users in the system.

charge increases. As further discussed later, the new regulatory framework brought about some quality of service improvements.

Figure 7: Distribution tariff evolution 2000-2012, in constant 2012 Colombian pesos per kWh.



Source: (ECSIM, 2013)

2.5 2015-2019: Revisiting generation expansion and revamping distribution regulation

The most dramatic El Niño event recorded in history hit Colombia's power system between 2014-2016. The situation, analyzed in further detail by Harbord (2016), became critical in the 2016 summer due to unforeseen facilities outage that added to low hydro reservoir levels. In scarcity conditions, thermal generators who had collected the reliability charge for years were being called into operation to avoid demand curtailment. However, the regulated scarcity price had fallen below variable fuel costs of the most expensive generators, whom refused to operate at a loss (since they would receive the scarcity price for the power they supply to the grid). A variety of measures were implemented to avoid rationing, including a temporal intervention of the scarcity price to favor thermal power plants; SSPD intervention of Termocandelaria thermal plant; and voluntary programs for demand curtailment.

Absence of demand rationing has been somewhat overshadowed by criticism of the firm-energy market and the wider institutional setting. Users had to pay for regulatory inefficiencies relating to the scarcity price and market operation during the 2015-2016 El Niño, as it was documented by The General Controller of the Nation in July 2016. Criticism of the firm-energy mechanism, along with discussions of mechanisms

to effectively incentivize generation with alternative renewable sources, put the firm-energy market at the center of sectoral debate after 2016.

As further discussed below, this situation conveyed mixed perceptions from different agents. As a result, an array of proposals emerged for revamping Colombia's power market, ranging from modest adjustments to the scarcity price, to full replacement of the firm-energy market by an organized futures and day-ahead market. Following a series of technical debates and workshops, CREG issued resolution 140 of 2017 redefining the scarcity price to prevent thermal generators from running at an operating loss in future scarcity conditions. Furthermore, adjustments were introduced in 2018 to the OEF auction and audit mechanisms (CREG Resolution 103), and a floating regasification Liquified Natural Gas unit was commissioned in 2017 to ensure natural gas availability for thermal generators.

The 2015-2019 period has also been characterized by the push for alternative renewable generation resources, such as wind, solar and biomass. Law 1715 of 2014 established the legal and instrumental framework for the promotion and use of non-conventional renewable energy (NCRE) sources -. The law includes a series of funds and taxes, tariffs and accounting incentives, and defines responsibilities for administrative entities such as the Ministry, the regulator (CREG) and UPME. Despite the adoption of this law, the progress in the implementation of NCRE projects lagged and there were discussions in different instances about the slow progress of its regulation. More recently, Colombia embarked an ambitious effort to decarbonize and diversify its energy mix through the implementation of NCRE projects. A successful NCRE auction in 2019 put the country on track to meet its target to increase NCRE to 1,500 MW by 2022 set in its Nationally Determined Contribution (NDC) 2018-22 (see box 1).

Box 2. Colombia's ongoing energy transition

As mentioned above, the country had a very low penetration of NCRE technologies (only 1 percent of the installed capacity by 2018) despite its abundant resources -mostly wind and solar in the north of the country. In this context, the expansion of NCRE was identified as an important mean to supply, at lower-cost, its steadily growing demand and without increasing the power's sector GHG emissions. The diversification of the supply mix is also expected to increase the power system's resilience to climate events such as el Nino y la Nina, affecting its hydropower generation.

To implement this vision, Colombia adopted the **National Energy Plan 2050**[9] and the **National Development Plan (NDP) 2018-2022.**[10] The Energy Plan 2050, aims to diversify the country's energy resources and ensure a reliable and sophisticated energy supply. The plan includes implementation of wind power plants, solar photovoltaic (PV), and geothermal energy generation into the country's electric mix. The NDP 2018-2022 established a goal to increase NCRE generation from 22.4 MW in 2018 to 1,500 MW in 2022.

Since 2018, the country designed tailor-made public interventions, incentives, and policies, including electricity auction schemes. In February and October 2019, Colombia held power auctions. The first auction was cancelled because the results were not in compliance with the strict concentration and dominance indexes predefined by the CREG. Building on the lessons learned in the first auction, the October 2019 auction was the culmination of a two-year effort championed by two successive

[9]Unidad de Planeación Minero-Energética (UPME). Plan Energético Nacional (National Energy Plan). Bogotá Colombia. See: **http://www1.upme.gov.co/Documents/PEN_IdearioEnergetico2050.pdf**

[10] Plan Nacional de Desarrollo. Plan Nacional de Desarrollo 2018-2022 Pacto por Colombia, pacto por la equidad. See: **https://colaboracion.dnp.gov.co/CDT/Prensa/Resumen-PND2018-2022-final.pdf**

government administrations to introduce competition in the award of long-term PPAs for renewable energy. It was a decisive step that paved the road for expanding NCRE, attracting new players, and creating appetite for more investments. A total of 4.4 TWh/year of energy were awarded to be delivered starting in January 2022, backed by nine renewable projects totaling 1,374 MW of capacity. The process resulted in historic-low average prices of approximately US$28 per MWh for energy, very close to the lowest price observed in international auctions held in 2018.

CREG also introduced major changes in distribution regulation in 2018 (Resolutions 015 and 016). Distribution remuneration for the five-year tariff period 2018-2022 is determined as a revenue-cap based on utility assets with depreciation. This is different from all previous tariff periods, which considered a price-cap based on reposition costs. Moreover, performance incentives introduced in 2008 are enhanced by the introduction of explicit targets for quality of service improvements, along with the adoption of standard international indicators SAIDI and SAIFI.

2.6 Political economy perspective on Colombia's security of supply

Traumatic demand rationing episodes in 1992 have placed security of supply at the core of Colombia's power sector reforms. Security of supply has been the main driver of decision-making processes and the cornerstone of a market architecture where shortage risk management is central. Other elements such as tariff level and energy matrix diversification have moved to a secondary level in discussions and regulation. Thus, a political economy analysis of Colombia's security of supply is outlined next. The analysis is based on structured interviews with generating companies, members of regulatory bodies and sectoral experts.

Given hydric resource endowments in the country, important investments in hydroelectric plants have been made to meet national demand and ensure continuity of energy supply. This has led to significant dependence and market concentration, which in turn has given a privileged position to the group of hydropower generators, distribution agents and, to a lesser extent, thermal generators as well (since thermal plants are back-up sources, key to withstand periods of low hydro-inflows). Nonetheless, the regulator's (CREG) independence has not been compromised. Although in this context results of the Colombian model are successful, particularly if measured by the absence of rationing since 1992, a market development such as the Colombian one can have several effects.

On the one hand, fear of rationing during El Niño events has caused the Ministry to be a passive agent in a dynamic world of innovative technologies and new needs from the demand side. The Ministry has sought to maintain the *status quo* of a model considered successful. There hasn't been timely introduction of instruments for new advances in energy policy. As a result, the regulator has taken the role of a policy-maker who has emphasized design of mechanisms to ensure enough investment to meet consumer demand (i.e. the original regulated capacity payment, later replaced by the reliability charge or firm-energy market). Reliability mechanisms have even become the primary mechanism for generation capacity expansion in the national electricity sector.

On the other hand, internal risk perception remains high among sectoral agents despite substantial progress made after reforms. Reforms and the reliability mechanism have successfully brought about capacity additions, prominent hydro developments, efficient sector maintenance and operations and an utter absence of rationing. Nonetheless, excluding hydraulic generators, many stakeholders currently perceive that effective supply security has not increased compared to pre-reform levels. The perception

can be anchored in the recent 2016 event when looming rationing risks became a possibility once again, after thermal generators refused to fulfill their firm-energy obligations.

Additionally, development of the power market has been substantial but unbalanced. Interaction with other sectors that complement energy supply has not been fully considered, particularly natural gas which doesn't have competitive supply and displays considerably high costs. Modernization of the business structure –necessary for the introduction of new technologies– has been delayed and the possibility for demand participation (open and feasible by law) is still a pending issue.

Among the factors that could explain disappointment with the sector's security of supply, are several flaws on energy policy formulation, implementation and regulation. Indeed, the great majority of agents observe flaws on energy policy implementation associated to three fundamental reasons: (1) lack of a clear long-term objective, (2) lags in execution and monitoring and (3) coordination failures between the ministry and regulatory commission. Moreover, coordination problems also extend to a lack of alignment with sectoral dynamics, both current and planned, particularly in the generating industry.

Moreover, many agents point at the role played by the regulator, whose action is perceived as lagging behind necessary market developments. Regulatory stability *per se* can be perceived as an achievement but, at the same time, it can become a limitation for sectoral transformation to the extent that it hinders the introduction of innovations and new elements of market design that can improve its performance. It can even be perceived as a *"symptom"* of the influence level of incumbent agents, although this doesn't seem to be the case according to the interviews conducted for the Rethinking Power Sector Reform project. While it can be said that Colombian model hasn't been sensitive to the influence of political power in office (at least when it is compared to other cases) and its post-reform evolution has responded to predominantly technical issues, the perception that sector policy has lagged behind in its response to technological, environmental and interconnection challenges with industrial dynamics and other energy (specifically natural gas) prevails.

In spite all of this, it is generally recognized that recent progress has been made in the form of industrial dynamic considerations being integrated into sectoral planning. There are also remarkable efforts from planning agencies and ministries to speed up non-conventional renewable sources regulation, incorporate different perspectives into planning criteria as well as different types of prospective elements that contribute to consolidate a clear long-term vision for the power market and its associated sectors (natural gas, in particular). In this sense, the first long-term supply auction held in 2019 is a key milestone for sectoral policy. Unfortunately, the first auction culminated with no awarded contracts despite interest from renewable developers, highlighting difficulties that must be overcome in future processes. Expectations from the auction mechanism are reasonably high given plunging prices observed in the region[11]. However, country-specific conditions such as renewable resource quality, access to financing, the wider institutional framework and political economy dynamics are certain to determine the extent to which auctions are successful in improving Colombia's power sector performance.

[11] According to the IEA, average prices for 2022 delivery across Latin American countries are 35 US$/MWh for solar photovoltaic and 20 US$/MWh for onshore wind. See **https://www.iea.org/newsroom/news/2019/february/have-the-prices-from-competitive-auctions-become-the-new-normal-prices-for-.html**

3 Sector Performance

Reforms are a means to improve performance of the power sector. As previously described, Colombian reforms aimed primarily at improving security of supply, financial sustainability and efficiency of the power sector. Colombia implemented both standard textbook reforms (such as unbundling and independent regulation), and tailored mechanisms for ensuring security of supply.

This section analyzes performance of the Colombian power sector, and the relevance of specific institutional factors in determining these outcomes. Performance and institutions are analyzed under the following four dimensions:

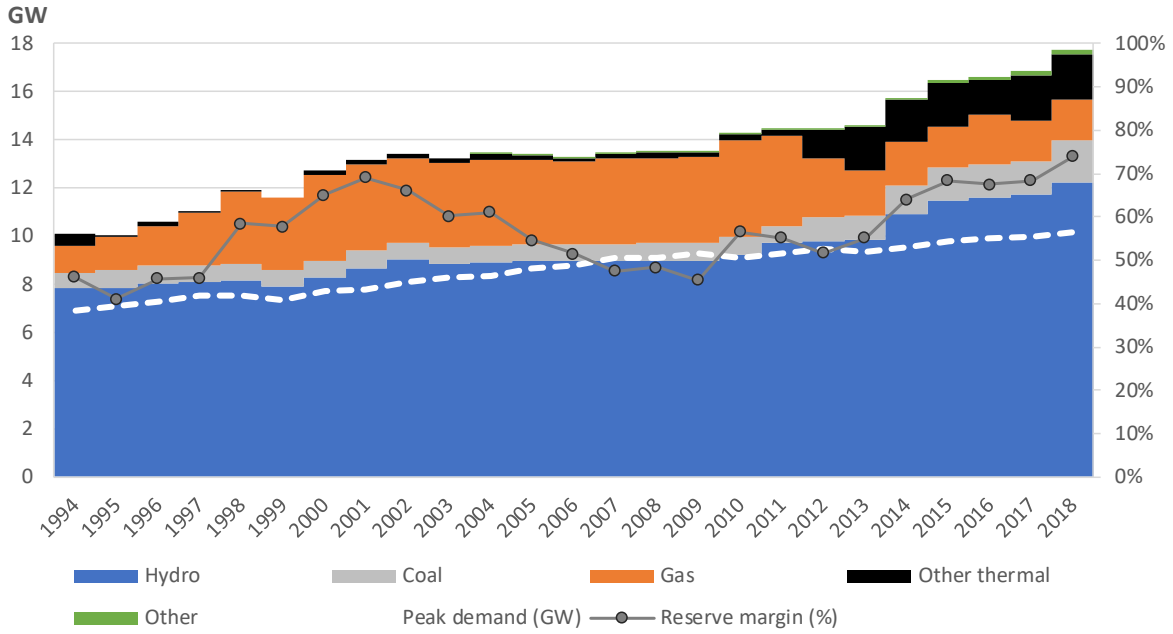
1. Investment and security of supply.
2. Access and affordability.
3. Utility efficiency and financial sustainability.
4. Tariffs and cost-recovery.

3.1 Investment and security of supply

3.1.1 Performance

Colombia's power system has historically been highly dominated by hydro generation capacity (see Figure 8). Hydro accounts for 69% of effective generating capacity during 2018, down from 78% in 1994. Market-oriented reforms have incentivized entry of thermal generating capacity besides hydro. Thus, thermal generation reached 30% of effective generating capacity during 2018, up from 22% in 1994. Figure 8 depicts generating capacity, peak demand and reserve margin as a referential indicator for security of supply. However, assessing Colombia's security of supply requires analyzing hydro inflows and scarcity conditions beyond this simple reserve margin indicator, as will be further discussed below.

Figure 8: Effective generating capacity, peak demand (GW) and reserve margin

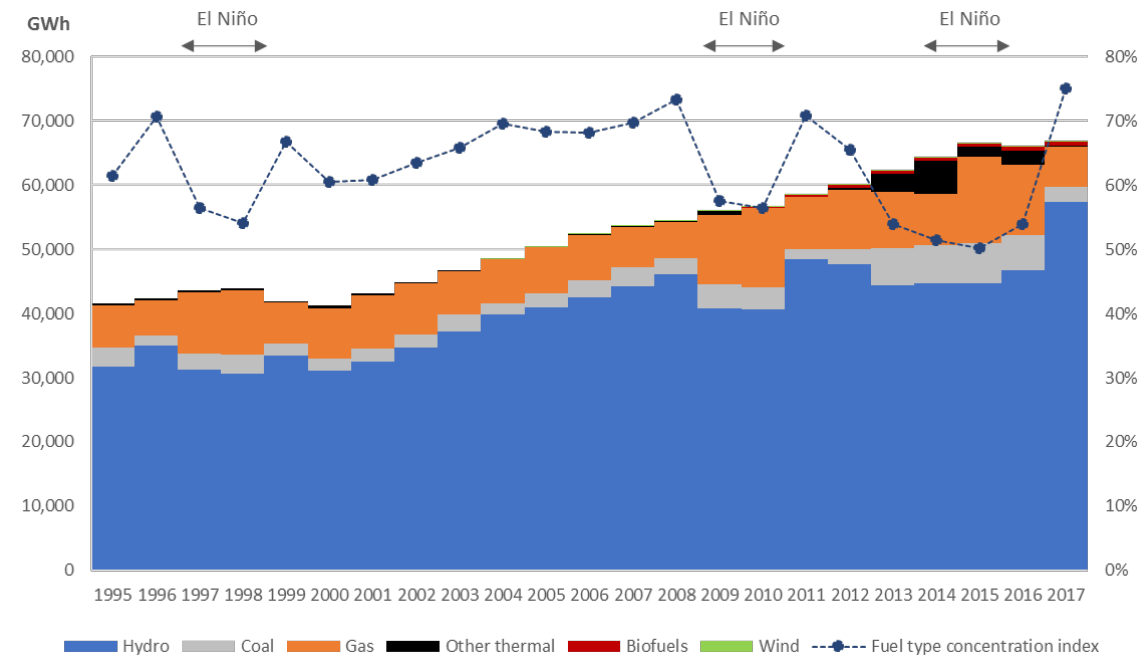


Source: UPME, XM

Despite thermal capacity additions, after two decades of reforms the Colombian electricity generation fleet is still heavily reliant on hydro generation, highlighting the system's exposure to variable hydrological availability (see Figure 9). In years of normal hydrological conditions, the share of hydro-power generation has been roughly 80%. However, hydrological availability in Colombia falls significantly during El Niño events. Lacking multi-year hydro storage capacity and strong regional market integration, long El Niño events lead to scarcity conditions during which thermal generation supply the deficit power. Figure 9 highlights severe El Niño events with marked impacts in power generation. Figure 10 depicts the Oceanic Niño Index (ONI), an indicator to monitor El Niño and La Niña events.[12]

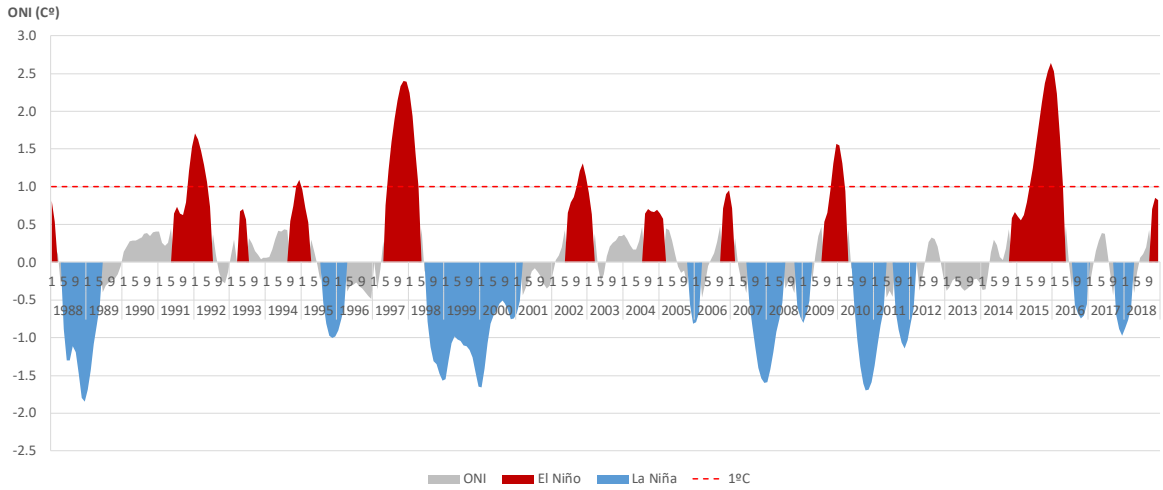
[12] When the ONI indicator surpasses 0.5 ºC, El Niño conditions are considered to be present, leading to low hydro inflows in Colombia's generation fleet. If the indicator falls below -0.5 ºC, La Niña conditions are considered to be present, leading to heavy rainfalls in Colombia.

Figure 9: Colombia electricity generation by fuel type.



Source: UPME, XM

Figure 10: Oceanic Niño Index (ONI), highlighting El Niño and La Niña events.



Source: National Oceanic and Atmospheric Administration, US Department of Commerce

Severe El Niño events led to electricity rationing in the early 1990's, highlighting the risks of hydro-dependency in a region where hydro inflows vary significantly due to unpredictable weather conditions. Efforts to manage demand rationing risks have therefore included an important push for diversification of the energy-mix, primarily through thermal generation and, more recently, non-hydro renewables.

Market-oriented reforms introduced by Law 142/1994 drove the initial wave of capacity additions in the late 1990's, increasing the system's reserve margin to 69% in 2001, up from 46% in 1994. Gas-fired effective generating capacity increased by about 2.4 GW between 1994 and 2000, reducing to some extent Colombia's reliance on hydro-power.[13] During 1997-98 the Colombian power system successfully withstood the most severe El Niño event recorded at the time (more intense than the 1991-92 event, and surpassed only by the 2014-16 event), without requiring demand rationing. This historic El Niño event was followed by a prolonged La Niña event which increased hydro availability. Furthermore, Colombia's deep 1999 economic crisis resulted in depressed demand and prices. This situation drove thermal power plants out of the economic dispatch, putting them under financial pressure.

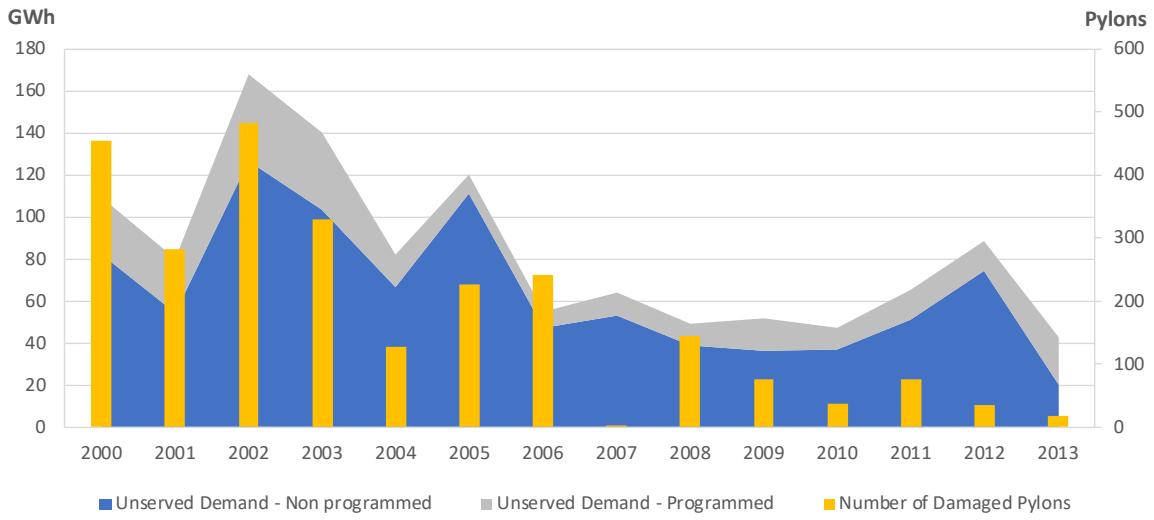
The reserve margin dipped back to 45% in 2009 after generation investment stalled in the early 2000's. Another relatively severe El Niño condition took place in 2009-2010. No demand rationing was required during the event, albeit given numerous temporal regulations issued to avoid rationing, including a decree of gas rationing. Some have catalogued these temporal regulations as market interventions (Barrera & García, 2010), thus potentially undermining confidence in the Colombian power market.

Following the 2006 firm-energy market reform, new hydro and thermal generation investment has materialized and the reserve margin reached 74% in 2018. However, the system faced numerous difficulties in 2014-2016, during an extremely severe El Niño. Again, no demand rationing was required, albeit supported by a number of temporal regulations and market interventions. Regulatory measures included a program to incentivize voluntary demand reductions, modification of the firm-energy market (additional costs were passed-through to final customers), and even intervention of a thermal power plant.

Supply security has also been affected in the past due to attacks to transmission facilities, including terrorist attacks (Figure 11). Although attacks on transmission infrastructure required special regulatory measures during the early 2000's, attacks and their impacts in the electricity market have fallen in recent years.

[13] Besides capacity additions, decommissioning of 890 MW generating capacity took place between 1997 and 2022, comprising old and inefficient power plants undercut by modern market-driven plants (Perez, 2004).

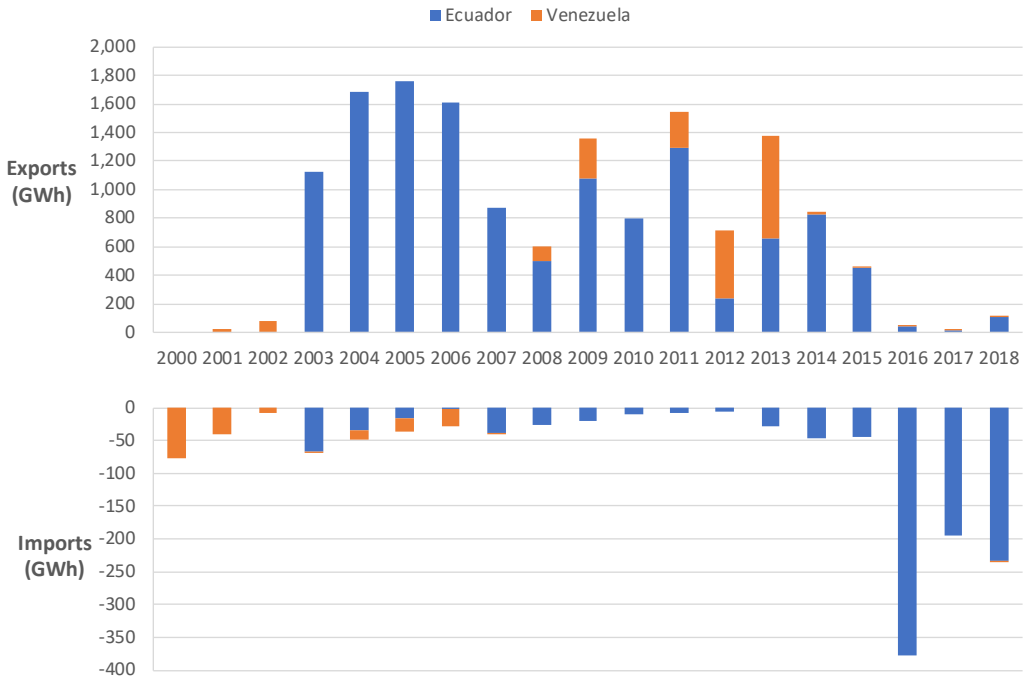
Figure 11: Unserved energy demand (GWh) and number of damaged pylons in the transmission system



Source: UPME, XM

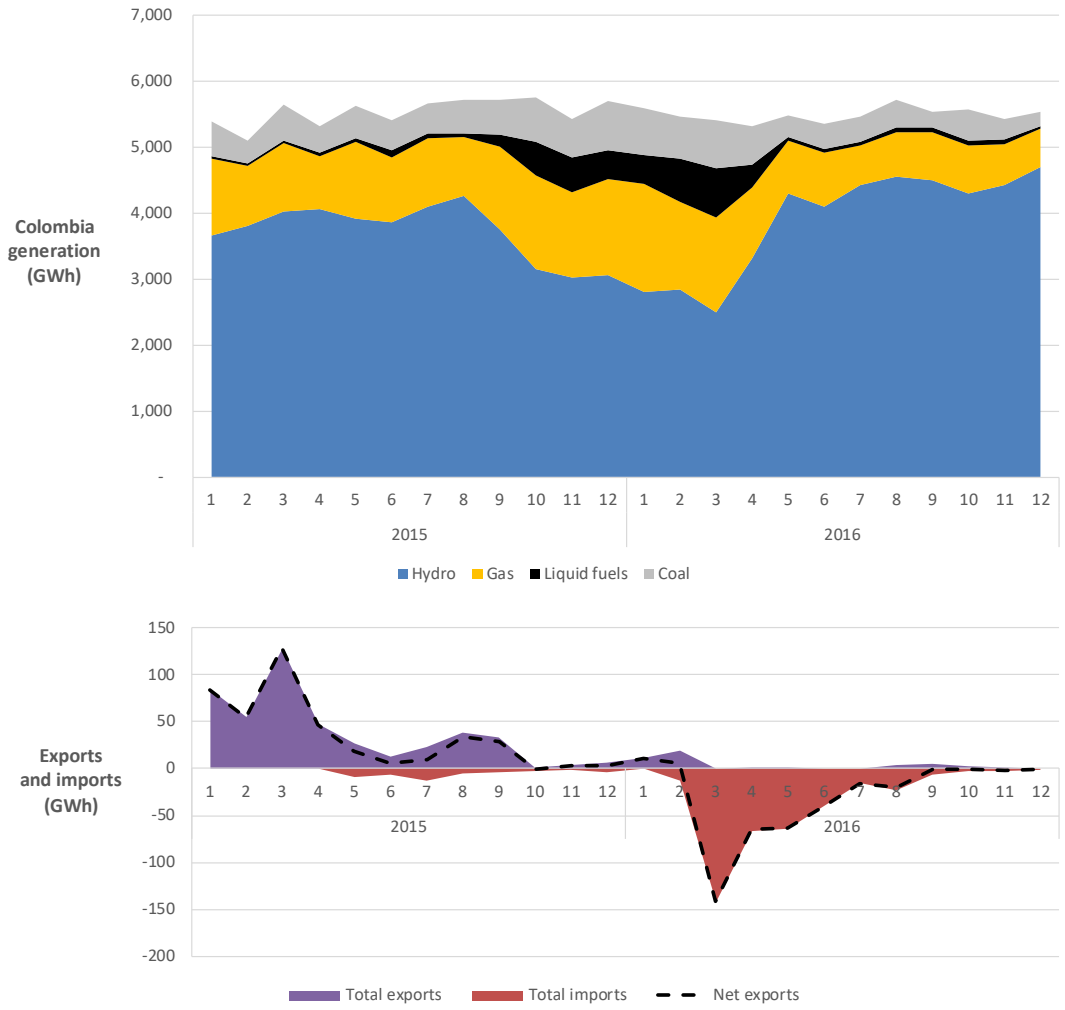
Besides domestic generation resources, interconnectors with neighbor countries have also been used to manage security of supply in Colombia (Figure 12). Colombia exported an average of 1,100 GWh per year between 2003 and 2014, primarily to Ecuador. In turn, total imports never surpassed 80 GWh until 2016, when imports from Ecuador increased significantly due to capacity additions in the neighboring country. Although imports may seem low overall, the system operator recurs to imports specially during tight supply conditions, such as those following terrorist attacks on transmission facilities, or during severe El Niño events. This was the case of the 2016 El Niño, when maximizing imports from Ecuador where among emergency actions taken by the System Operator to avoid rationing between March and May 2016 (Figure 13).

Figure 12: Electricity exports and imports (GWh, vertical axis different for imports and exports)



Source: UPME, XM

Figure 13: Colombia power generation and international exports and imports during 2015-2016 El Niño event.



Source: UPME, XM

3.1.2 Institutions

The institutional framework for security of supply in Colombia is a mixture of both market-based mechanisms (the *firm-energy market*) and centralized planning by a unit within the Ministry of Mines and Energy (UPME).

Regarding generation competition (further discussed by (Rudnick & Velasquez, 2019)), the Colombian reform of 1994 created a spot market and a regulated capacity payment (based on the centralized generation plan developed by UPME). The market was initially successful in attracting hydro and thermal generation, allowing the country to withstand a severe El Niño event during 1997-98. The market was adapted in 2006 by replacing the regulated capacity payment by a firm-energy market, designed to ensure enough generating capacity is available during tight supply conditions (particularly during El Niño events). Despite having attracted new generating capacity, the firm-energy market faced serious difficulties during the 2014-2016 El Niño event. Lessons from these events led to another adaptation of the firm-energy market in 2017 (resolution Nº 140/2017) by re-defining the scarcity price (which was previously set

administratively), which now considers the variable costs of the most expensive generators to avoid serious operating losses for thermal generators required to run under tight supply conditions.

Complementary to market-based forces for security of supply, Colombia has a special administrative and technical unit of the National order, the Mining and Energy Planning Unit – UPME, under the Ministry of Mines and Energy. It is governed by Law 143 of 1994 and Decree No. 1258 of June 17, 2013 and its mission is to *"plan holistically energy/mining development, support the formulation of public policy and coordinate sectoral information with agents and stakeholders"*. For this purpose, UPME has a technical team grouped in 4 sub-directions -demand, electric power, hydrocarbons and mining-, and requests national and international consultancy for support in specific research projects.

UPME formulates plans to promote adequate use of mining resources and ensure optimal and timely supply of energy resources. Likewise, it issues technical and financial concept to electrification and gasification project requests. The main objective of said entity is the formulation of:

(i) National Energy Plan, to visualize the most favorable options to power sector development, alternative energies, gas and hydrocarbons.

(ii) Expansion plans for generation (indicative) and transmission (mandatory).

This entity is responsible for public calls to expand National Transmission System in all its phases, with reliability and optimization of cost criteria. Other products made by this planning unit are:

- Supply and transportation plan for natural gas.
- Energy Balances, through which supply structure, resource transformation and energy demand by sector and use are consolidated.
- National Mining Development Plan.

In addition to UPME's planning work, XM (Colombian market operator) performs electric and energy analyzes on expected system behavior and provides information on the main variables of the power market.

It can be said that Colombia has strong referents which provide information as an input for energy policy and sustainable system expansion. UPME is an entity with high technical capabilities that carries out transversal planning to all the components of the electricity production chain. This strong institutional framework is reflected on Colombia's very high score on the Planning and Procurement index (see Table 3), compared to countries with or in the transition to wholesale power markets (Peru, Philippines and Vietnam).

Table 2: Institutional arrangements for power sector planning and procurement in Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International Benchmark
Planning and Procurement	**95%**	**77%**	**59%**	**59%**	**70%**
Generation Planning	86%	43%	71%	71%	56%
Procurement of Generation	95%	90%	100%	50%	85%
Transmission Planning	100%	75%	50%	100%	72%
Transmission Procurement	100%	100%	17%	17%	64%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details refer to the Annex and the project website at http://www.esmap.org/rethinking_power_sector_reform

Although social and political issues have caused delays in generation and transmission projects entry, it can also be said that clear signals have been provided to meet demand expansion and energetic needs. Generation planning in Colombia, however, is not exempt from criticism. While it is clear that generation planning is indicative, some agents affirm much remains to be integrated to the planning agenda, regarding the mix of generation technologies and the use of alternative resources such as gas, wind and solar PV. Recent efforts such as long-term auctions and resiliency criteria for planning aim at addressing these shortcomings.

3.1.3 Summary

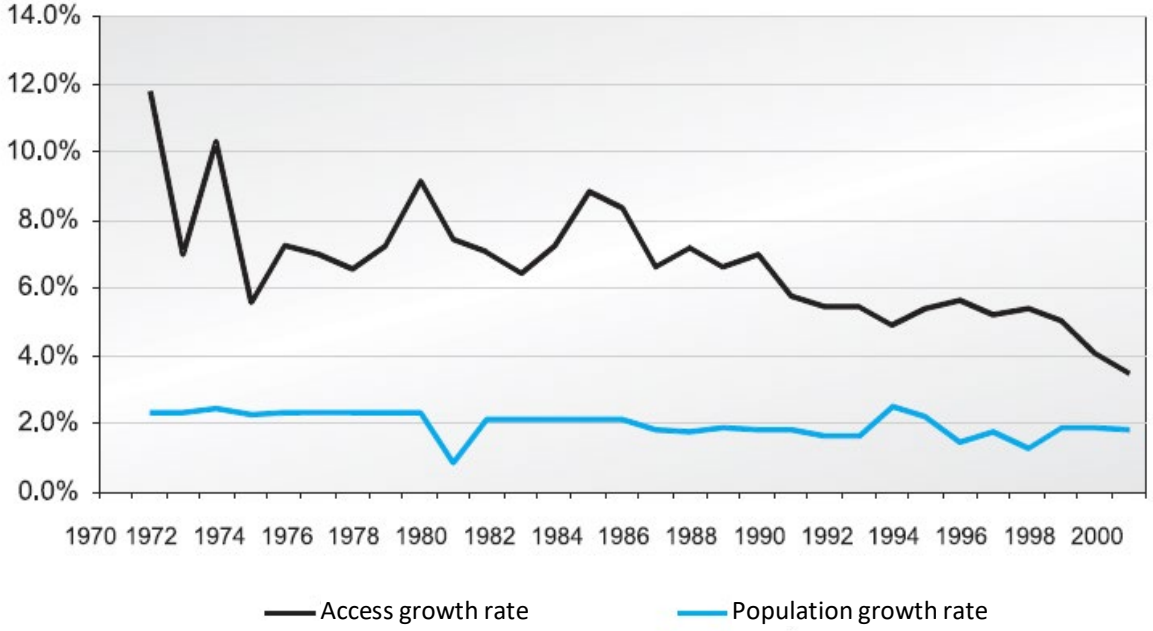
Risks of hydro scarcity and demand rationing during El Niño events have been among key persisting challenges for the Colombian power sector. Avoiding rationing was one of the major drivers for the Colombian power sector reform. A complement of centralized indicative planning and market-oriented reforms have successfully enabled private sector participation and investment in the generation segment. Moreover, thermal generation has also come online besides hydro generation. However, even with a firm-energy market specifically tailored to reduce rationing risks during hydro scarcity conditions, El Niño events continue to challenge the highly hydro-dependent Colombian power system.

3.2 Access and affordability

3.2.1 Performance

Colombia was highly successful in expanding electricity access between 1970 and 1990. According to government data (Figure 14), national electrification policies in the 1970's and 1980's decades resulted in high annual growth rates of electricity access (above 8%), far surpassing the 2% population growth rates, albeit at high costs and resulting in large outstanding debts. Coverage expansion slowed down progressively during the 1990's, arguably because high coverage was achieved in urban sectors (Distco's primary markets), while rural electrification remained low due to the high associated costs (UPME, 2003).

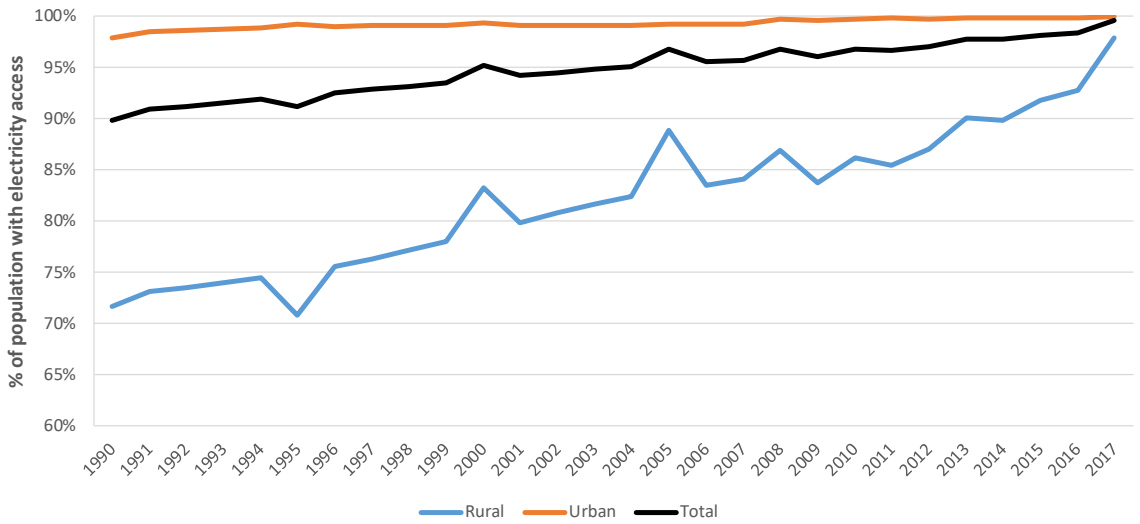
Figure 14: Population and electricity access growth rates in Colombia, 1970-2000



Source: (UPME, 2003)

Electricity access has increased steadily since 1990 (Figure 15). Indeed, access grew from a relatively high 90% in 1990 to practically 100% in 2017 for total population. Tremendous progress was made for rural customers, increasing electricity access from 72% in 1990 to 98% in 2017, albeit partly thanks to a downward trend in rural population. Nonetheless, almost 200.000 people remain without electricity access, and access remains very low in some regions such as Vichada, with less than 60% electricity coverage in 2018 (UPME, 2018). Electrification is particularly challenging for areas that cannot be economically interconnected to the existing national system (SIN), which accounted for 30% of people without electricity access by 2015 according to UPME. Moreover, service quality is very low in some of the locations which have electricity service. In the period 2015-2017, the two zones defined as Special Service Areas averaged 23.97 hours of electricity service, while the Amazon Zone averaged 14.81 hours of electricity service.

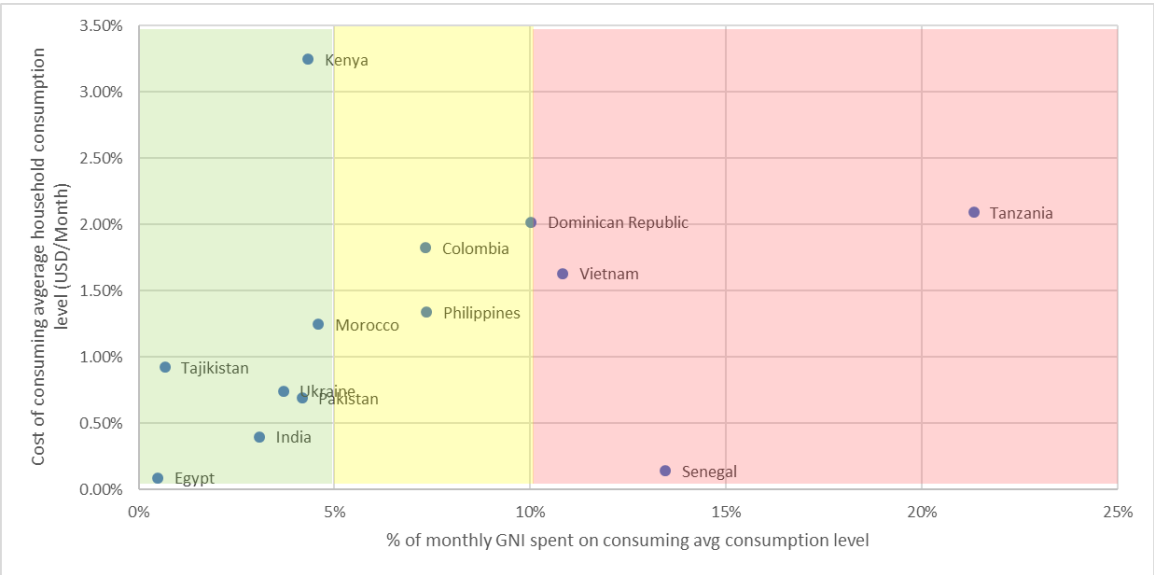
Figure 15: Electricity access in Colombia, 1990-2014



Source: Tracking SDG 7, 2018

Electricity service affordability in Colombia is among the lowest compared to other developing countries considered for this study (see Figure 16 and Figure 17). Considering an average household consumption of 136 kWh/month, the annual cost of electricity in Colombia was US$ 208 during 2016, representing 7% of annual income for households in the bottom 40% of Gross National Income. In turn, the cost of subsistence consumption (30 kWh/month, equal to 22% of average household consumption) represents 1.8% of the annual income for the poorest 40% households. Therefore, Colombia ranks 10th out of 13 countries regarding affordability of subsistence consumption.

Figure 16: Affordability of average consumption level in Colombia, 2016



Source: RISE, 2018

The largest contributors to Colombia's electricity tariffs are the generation and distribution components, accounting for about 75% of the final tariff for regulated customers (see an example in Table 4). The distribution component is regulated by CREG, thus it varies depending on the specific regulations enacted for the sector, as further explained later. The generation component is based on the competitive generation market, considering the average of bilateral contract purchases and spot purchases by suppliers (retailers). Both the distribution and generation components have followed a sustained upward trend in real terms since the 2000's (ECSIM, 2013). Furthermore, bilateral contracts to supply regulated customers have been consistently priced above contracts to supply non-regulated customers (those that negotiate supply prices and terms directly with retailers). Increasing competition in the generation and retail segments could thus put some downward pressure on final tariffs, improving electricity affordability in Colombia (Rudnick & Velasquez, 2019).

Table 3: Example of electricity tariff component disaggregation (Codensa, march-2019)

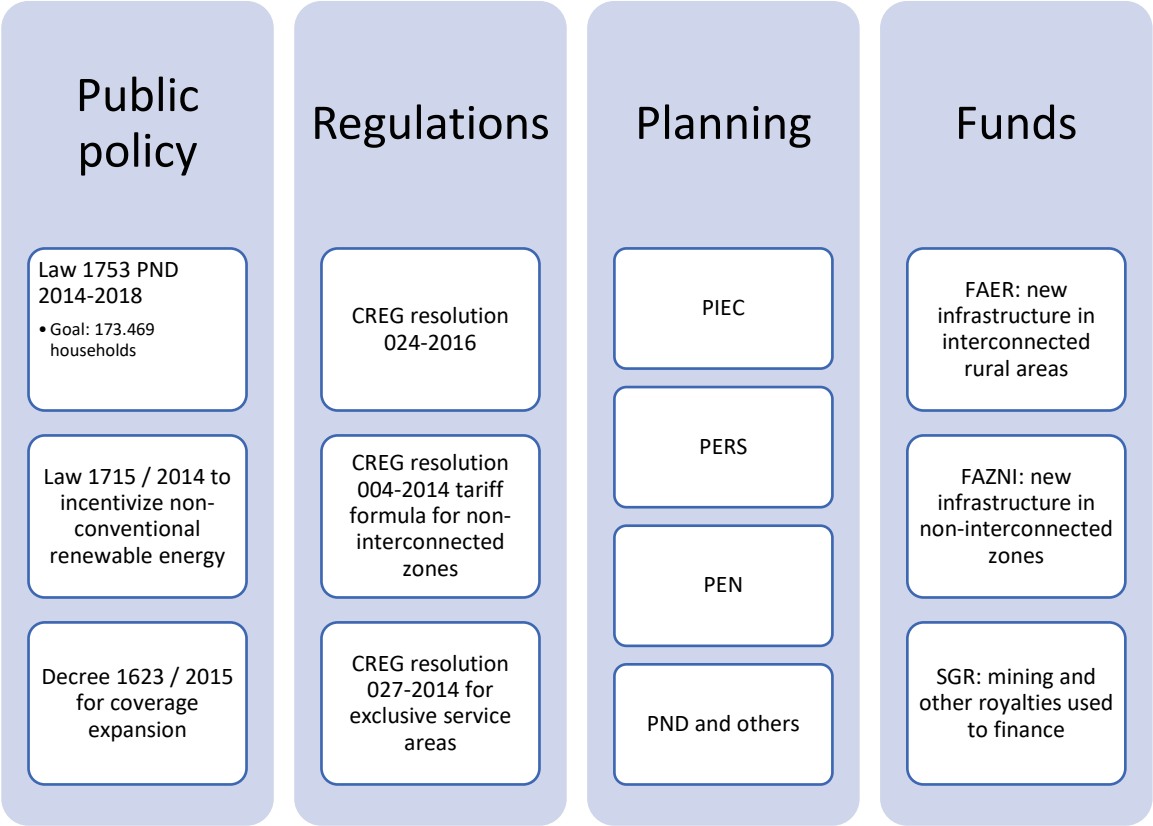
Item	Cost component (US$/kWh)	Cost component share (%)
Generation	72.4	43%
Transmission	11.1	7%
Distribution	52.8	32%
Commercialization (retailing)	14.7	9%
Losses	12.9	8%
Constraints	3.6	2%
Unit cost	**167.5**	**100%**

Source: Codensa march-2019 tariffs, available online at https://www.enel.com.co/content/dam/enel-co/espa%C3%B1ol/personas/1-17-1/2019/Tarifario-marzo-2019.pdf. Values for voltage level 1 (low voltage residential customers), property of Codensa. These values vary across customer types, voltage levels, distributors and time, and are only included here for illustration purposes.

3.2.2 Institutions

Instruments for electricity access in Colombia range from Public Policy to planning and specific funds (Figure 18).

Figure 17: Electricity access instruments in Colombia.



Source: UPME

The policy and regulation framework for electricity access establishes different strategies for coverage expansion in the following types of zones:

- Zones interconnected to the national system (SIN).
- Non-interconnected zones (about 51% of the national territory by 2018), defined as *"municipalities, boroughs, localities and hamlets not connected to the National Interconnected System (SIN)"*, and classified according to Decree 1073 of 2015 as:
    - Zones that can be economically interconnected to the SIN. For these zones, Law 855 of 2003 dictates that *"the geographical areas in which it becomes viable and sustainable to make an interconnection, will be excluded from the category of ZNI as soon as they begin to receive the electric power service"*.
    - Isolated zones those that cannot be economically interconnected to the SIN. For Isolated Areas, Decree MME 1623 of 2015 establishes that *"...expansion of the coverage of the electric energy service to users who are not economically efficient to connect to the SIN, will be carried out by isolated solutions -centralized or individual- and microgrids, which will be built and operated primarily by Network Operators (OR) -distributors- of the SIN, or through business schemes such as the Exclusive Service Areas -ASE or others"*.

Decree 1623 of 2015 redirected policies towards coverage expansion primarily through Network Operators of the SIN. Indeed, for interconnected zones and those that can be economically interconnected to the SIN, coverage expansion will be pursued by network operators and remunerated mainly through the distribution tariff. The distribution tariff associated to each network operator's coverage plan is approved by the regulator CREG. However, other financing sources are also available (further discussed below). In turn, coverage for isolated zones will be expanded also by network operators or through special business models, with both public and private investment (UPME, 2003).

Energy access regulation in Colombia is based on different strategic guidelines, such as the National Development Plan (PND), regional development plans, National Energy Plan (PEN), Sustainable Rural Energization Plans (PERS) and the Indicative Coverage Plan (PIEC). The Indicative Coverage Plan, established in Law 142 / 1994, is carried out every five years by the Mining and Energy Planning Unit (UPME) and is the basis for the Ministry of Mines and Energy to determine infrastructure needs and priorities of development to extend the coverage of electricity both in the Regional Transmission (STR) and Local Distribution (SDL) systems, as in Non-Interconnected Zones (ZNI). Additionally, the Institute for Planning and Promotion of Energy Solutions for Non-Interconnected Zones (IPSE), entity attached to Ministry of Mines and Energy, aims to *"identify, promote, develop, and implement energy solutions through efficient, financially viable and sustainable business schemes, seeking to meet the energy needs of Non-Interconnected Zones (ZNI)"*.

These plans are supported by different funds and subsidies aimed at increasing electrification of the national territory, namely:

- FAER: Financial Support Fund for the Energization of Rural Interconnected Zones, created by Law 788 of 2002, which allows local authorities together with network operators to develop priority investments in new electricity infrastructure in the SIN. This fund is collected from a surcharge applied to every kWh transported in the system.
- FAZNI: Financial Support Fund for the Energization of Non-Interconnected Zones, created by Law 633 of 2000, provides financing of energy infrastructure in non-interconnected zones. The fund is administered by the Ministry of Mines and Energy. This fund is also collected from a surcharge applied to every kWh dispatched in the spot market.
- PRONE: Standardization Program of Electrical Networks.
- FOES: Social Energy Fund, created by Law 812 of 2003, provides a subsidy of up to 46 LCU/kWh to low income customers in specific zones of the SIN.
- FSSRI: Solidarity Fund for Subsidies and Redistribution of Income.
- Others include resources from the National Royalties Fund (FNR) and other agreements.

On a final note, it is worth clarifying that, despite the regulatory advances in Colombia regarding wholesale market operation, energy access through minigrids, use of rooftop solar panels and behind-the-meter generation, are still in a "gray area" and lack a formal regulatory framework for tariffs, access conditions and connection to main grid, among other issues.

All in all, Colombia has a relatively high score regarding electricity access, when compared to Peru, Philippines and Vietnam (Table 5). Regulations are particularly weak for mini-grids, according to the previous comment.

Table 4: Regulatory framework for electricity access in Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International Benchmark
Energy Access Regulation	**67%**	**57%**	**74%**	**7%**	**58%**
Regulation of New Connections	68%	88%	57%	14%	65%
Regulation of solar home systems	100%	50%	100%	0%	66%
Regulation of mini-grids	33%	33%	67%	NAV	44%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details go to project website at http://www.esmap.org/rethinking_power_sector_reform

3.2.3 Summary

Overall, Colombia has achieved significant levels of electricity access through sustained public policy support and targeted funds for increasing coverage. However, serious gaps remain in electricity access for rural customers. The task is particularly challenging for isolated zones which require local solutions such as mini-grids. In this sense, an opportunity exists in increasing the rollout of renewable energy systems in the country to increase sustainable electricity access in remote locations. Regarding affordability, Colombia is close to the sample average of countries considered in this study when considering subsistence consumption, ranking 10th out of 15 countries with an indicator of 1.8% (slightly below the sample average of 2.1%, and slightly above the sample median of 1.3%). However, affordability varies widely across different Colombian distributors. Cross-subsidies targeted at the poorest households help them alleviate the burden of electricity costs.

3.3 Utility efficiency and financial viability

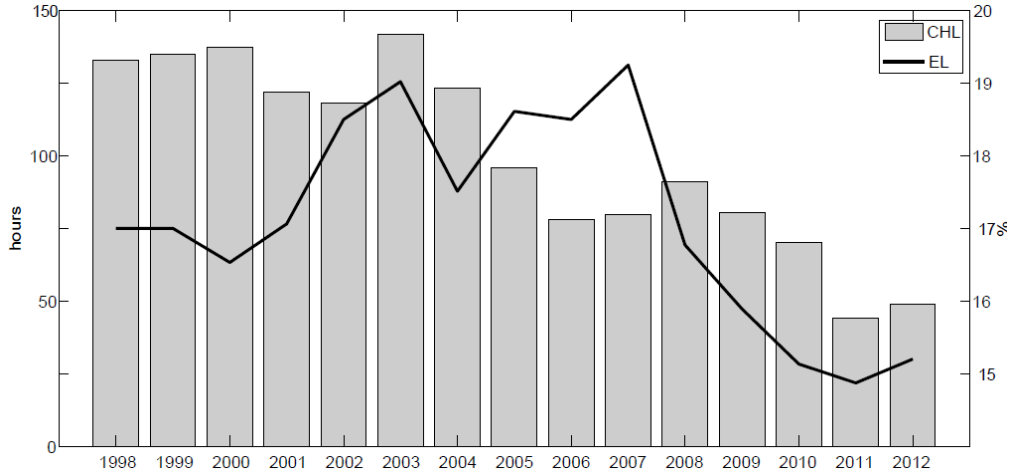
3.3.1 Performance

Colombia's distribution segment exhibited no significant performance improvements during the first decade of reforms. Pombo & Taborda (2004, 2006) found that despite positive outcomes on the generation segment, reforms had no evident impact on distribution-level efficiency: already inefficient distributors became less efficient after 1995, and larger utilities which were already efficient remained on the best practice frontier after reforms. Melo & Espinosa (2005) report similar results, finding no major technical efficiency improvements between 1999 and 2003, although environmental variables and customer density have an important impact on performance. Patiño, Gómez & Osorio (2010) also found that between 2004-2007 there was no technological shift, nor technical efficiency improvements.

Despite slow progress shortly after reforms, distribution-level performance has improved since the mid-2000s, possibly due to enhanced regulation (Galán & Pollitt, 2014b). Country-wide average customer hours lost have fallen from almost 150 hours in 2003 to less than 50 in 2012. Country-wide average losses also plunged to nearly 15% (see Figure 19). However, improvements have come at the expense of higher

residential electricity tariffs. Moreover, efficiency widely varies among distribution companies. Furthermore, rural distribution exhibits the highest efficiency gains in the 1998-2012 period, suggesting ineffective incentive regulation for urban distribution (Galán & Pollitt, 2014b). Unfortunately, distribution regulation in Colombia establishes a common charge for distributors in the same geographical area (i.e. those in the same ADD), despite density and other factors being more relevant to efficiency. Thus, ADDs may ineffectively distort distribution charges across locations (ECSIM, 2013).

Figure 18: Evolution of energy losses (EL) and customer-hours lost (CHL).



Source: (Galán & Pollitt, 2014a)

Utility-level performance is further analyzed for two sample Colombian distribution companies: Codensa, which supplies Bogotá, and EPM, which supplies Medellín. Performance is analyzed with respect to operational efficiency, financial management and service continuity.

Codensa is a private distribution company which serves 3.3 million customers in the capital and over 100 municipalities in Cundinamarca. Codensa was formed in 1997 after the unbundling and privatization of the government-owned utility Empresa de Energía de Bogotá (EEB). Prior to 1997, the government-owned vertically integrated utility EEB was representative of all that ailed the Colombian power sector before the reforms of 1994. Distribution losses were very high (27% in 1995) despite various attempts at reducing these losses with programs backed by Multilateral Financial Institutions (MFIs) in the late 80s and early 90s. EEB owed about $900mn to Financiera Eléctrica Nacional (FEN - a national entity set up to finance the energy sector), which represented 65% of FEN's assets. Therefore, FEN did not want to finance EEB anymore (EEB, 2000).

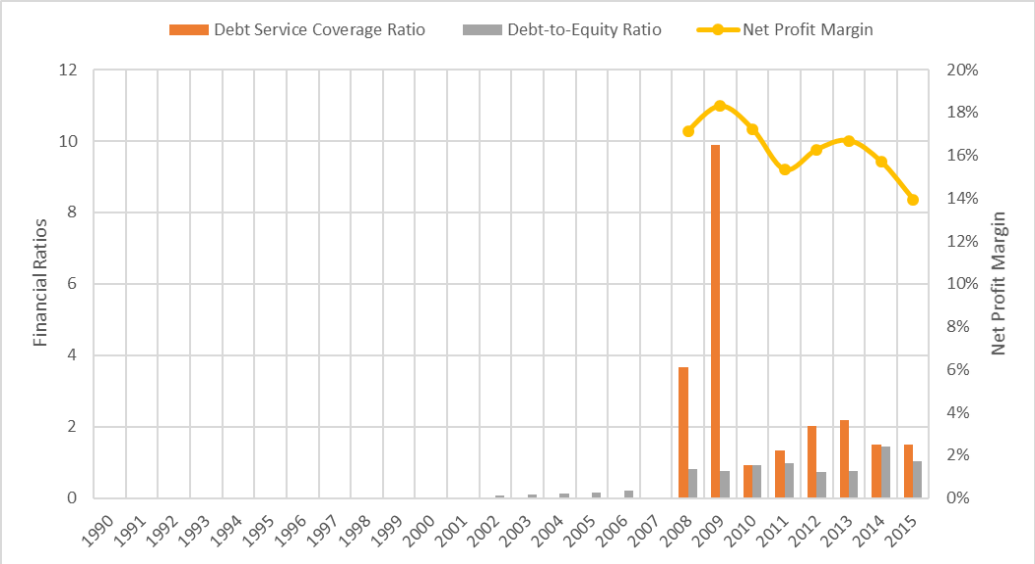
Given EEB's inability to reduce financially burdensome losses, and difficulty in securing further finance, the government decided to unbundle and privatize EEB in 1994. As a result, EEB became a joint stock company, debt was restructured, and in 1997 EEB was unbundled into a holding company EEB, a generating company EMGESA and a distribution company Codensa. Codensa was 48.5% private and 51.5% owned by EEB. EEB in turn was 81% owned by the national government, 7% by Bogota government and the rest by energy companies. Codensa and Emgesa are currently controlled by the Italian-based

multinational energy group Enel, with extensive presence in power generation, distribution and transmission across several Latin-American countries.

In the very first year of operation Codensa's losses fell to 19%, from 25% the previous year (EEB, 2007). The decline continued reaching a low of 9% in 2006, but since then they have been hovering around the 10-11% mark. This is about 4% higher than what is generally considered an "efficient level" of loss for comparable utility in the region. Reliability was not measured before 1998 but the company has improved on all measured indicators of reliability such as SAIDI and SAIFI.

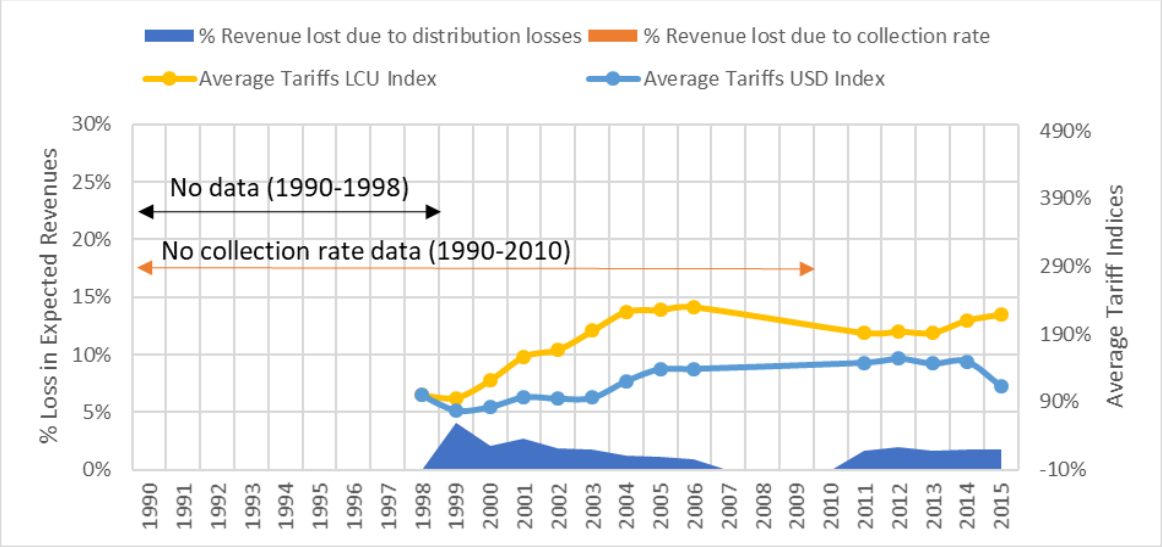
Since 2008 Codensa has consistently shown a healthy profit margin, debt service coverage ratio and debt equity ratio (Figure 20). Codensa's distribution losses seem to be stuck at 10-11% level and the utility has not been able to come down to the "efficient loss" level of 7%. However, the utility has clearly reduced its revenue loss from inefficiencies from about 4% of the expected revenue in 1999 to just under 2% of expected revenue in 2015 (see Figure 21).

Figure 19: Evolution of Codensa's profit margin and debt ratios, 2008-2015



Source: Rethinking Power Sector Reform Project

Figure 20: Evolution of Codensa's operational inefficiencies and average tariffs, 1998-2006 and 2011-2015



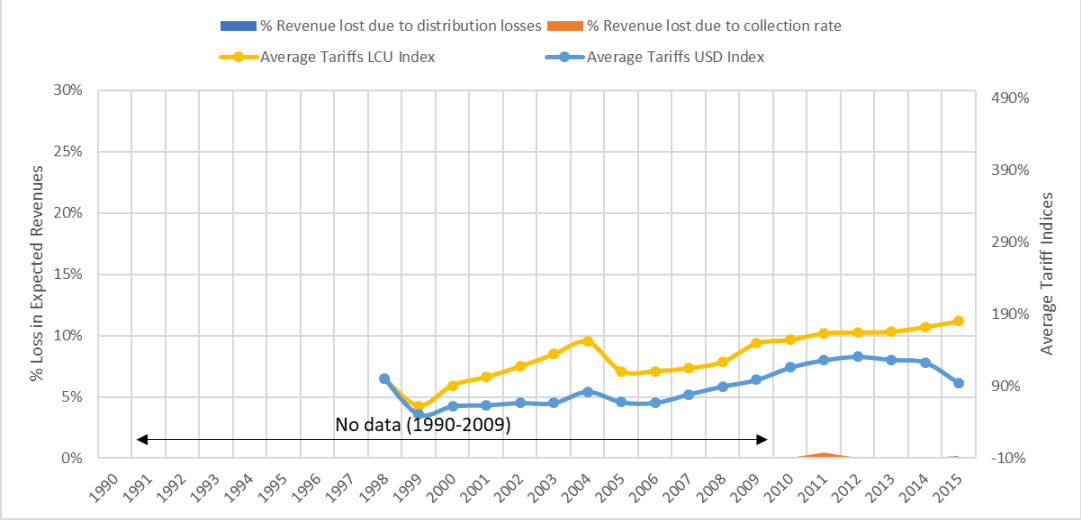
Source: Rethinking Power Sector Reform Project

EPM has historically been one of the best performing utility in Colombia and the region, with an extensive business across services (including electricity generation, transmission and distribution; telecommunications and water supply) and countries (present in Caribbean and other Latin-American countries). Before Colombia's 1994 reforms, EPM had already brought its losses down from 21% in 1993 to 15% in 1997. While reforms did not change EPM's structure directly[14], the formation of a power market and the involvement of the private sector did increase competition in the sector. EPM's losses kept declining post-1997, falling below the 10% threshold in 2001, a threshold that is considered the efficient loss level for a comparable utility in the region. Distribution losses reached a low of about 4% in 2007 after which they started increasing crossing the 10% threshold for the first time in 2015.

EPM's loss in expected revenues due to inefficiency in system losses was zero between 2001 and 2014, and it shows excellent collection rates from 2009-2015 (Figure 22). Throughout 2009-2015 the distribution losses and collection rate remain above the efficient loss threshold for a comparable utility in all but two years. In 2011 we see the collection rate fall marginally below 100% and in 2015 we see the distribution losses go above 10%. In both years the inefficiency loss in revenue is under 0.5% of expected revenues. Since 2006, EPM has maintained a very robust net profit margin but it has come down from around 40% in 2009 to about 25% in 2014 (Figure 23).

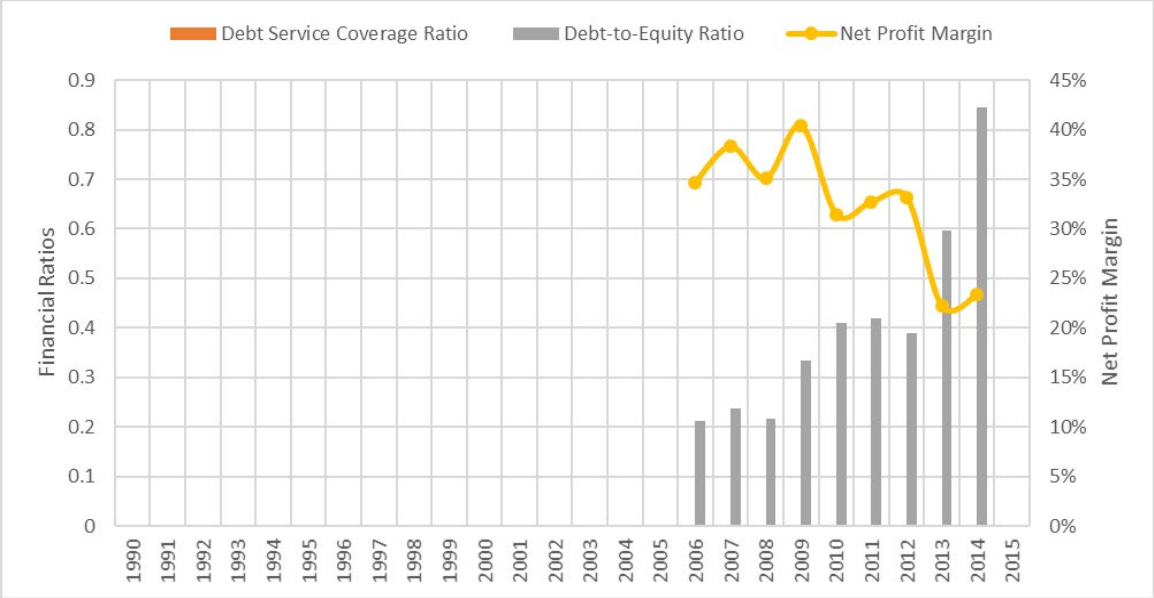
[14] EPM became in 1997 an Industrial and Commercial State company, with managerial and financial independence, although the Medellin municipality remained the sole owner of EPM.

Figure 21: Evolution of EPM's operational inefficiencies and average tariffs, 1998-2015



Source: Rethinking Power Sector Reform Project

Figure 22: Evolution of EPM's profit margin and debt ratios, 2006-2015



Source: Rethinking Power Sector Reform Project

Service quality is high on average but varies significantly across distribution companies, being relatively low in the Northern Caribbean zone. Firm-level data collected by the 2017 World Bank Enterprise Survey indicates that electricity outages experienced by firms operating in Colombia are below or near the average for LAC countries (see Table 6). However, outage indicators vary significantly across different locations within Colombia. For example, firms in Medellín report relatively few and short outages (below the LAC average), while firms in Barranquilla and Cartagena report many and more prolonged outages (above the LAC average).

Table 5: Firm-level indicators of supply reliability

Indicator	Colombia						Latin America & Caribbean
	Country average	Bogotá	Medellín	Cali	Barranquilla	Cartagena	
Percent of firms experiencing electrical outages	53.9	55.8	24.1	65.3	87.7	68.7	64.8
Number of electrical outages in a typical month	0.8	0.4	0.5	1.5	3.2	2.5	2.1
Average duration of outage (hours)	2.8	3.8	1.0	2.7	1.8	2.7	2.7
Average sales lost due to outages (% of annual sales)	1.9	2.3	0.5	0.7	2.6	3.0	1.7
Firms owning or sharing a generator (%)	17.7	19.2	8.3	15.1	20.0	45.5	26.0
Average proportion of electricity from own generator (%)	23.5	18.9	55.5	9.1	49.7	17.4	14.5

Source: 2017 World Bank Enterprise Survey.

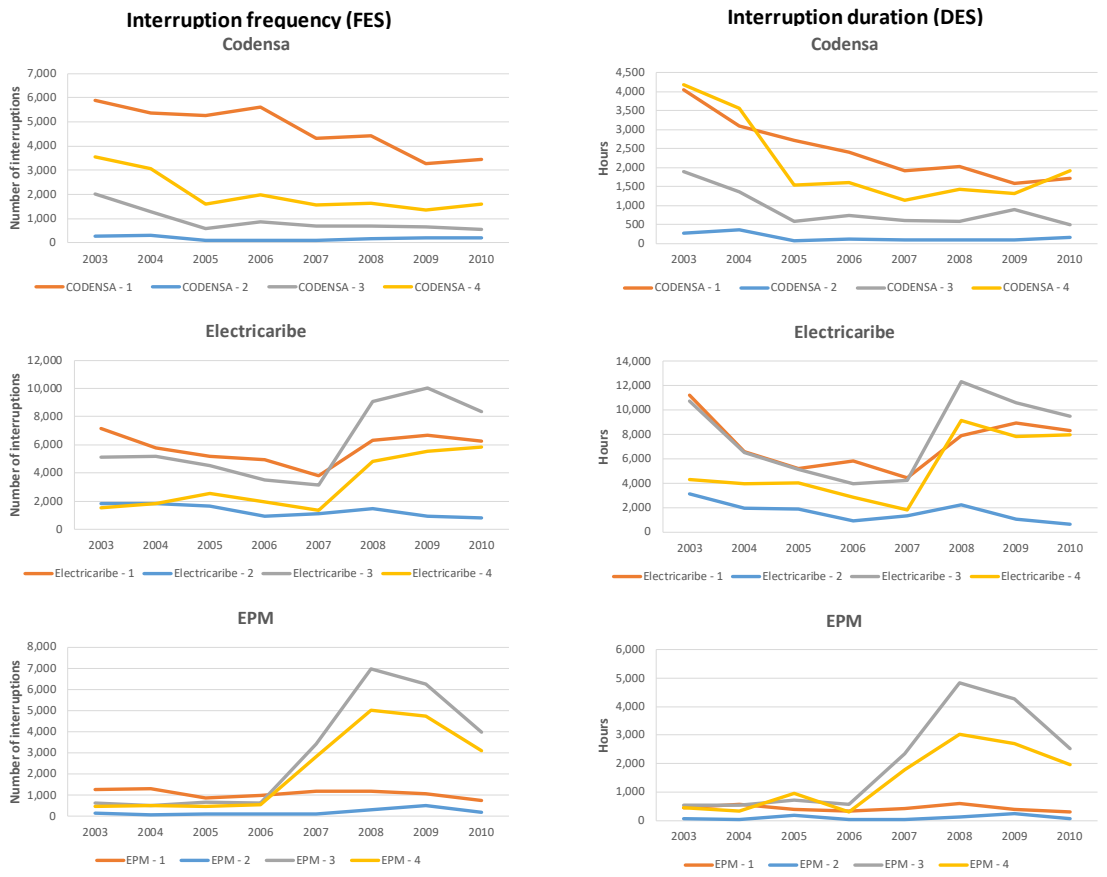
Cities with the worst indicator are highlighted with an orange background.

Colombian regulation establishes four different quality groups for service quality reporting purposes (see Annex C). Groups 1 through 3 comprise municipal electrical circuits with different number of inhabitants (where group 1 comprises zones with many inhabitants), while group 4 comprises rural electrical circuits. There are two publicly available distribution-level quality indicators between 2003 and 2010, one related to the frequency of interruptions (FES), and the other related to the duration of interruptions (DES).[15] FES and DES are presented for each quality group and for three distribution companies in Colombia: EPM which supplies Medellín; Codensa which supplies Bogotá; and Electricaribe which supplies Barranquilla (Figure 24).

Service quality indicators highlight Electricaribe's relatively poor service quality compared to EPM and Codensa. Moreover, indicators for Codensa exhibit a downward trend, while indicators for Electricaribe and EPM increase markedly after 2007. Unfortunately, limited data availability precludes the analysis of a broader time period, particularly since the regulator changed the definition of service quality indicators in 2011 and again in 2018. Nonetheless, the Superintendence of Public Household Services (SSPD) publishes annual service quality reports since 2016. These reports also highlight important differences in service quality across distribution companies (Figure 25). For example, Electricaribe's SAIFI surpassed 100 interruptions during 2018 (more than twice Colombia's average 48 interruptions), while EPM and Codensa were both below the national average (33.4 and 17.5 interruptions, respectively).

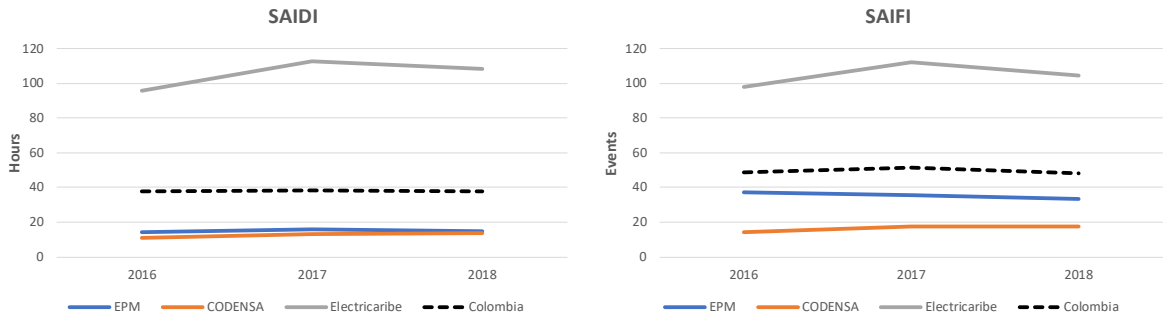
[15] Average interruption frequency (FES) and duration (DES) indicators initially defined in Colombian regulation are calculated on the basis of distribution level feeders (each of which supplies numerous final customers). Thus, comparison is difficult with international standard indicators such as SAIFI and SAIDI, calculated on the basis of customers (Urbiztondo & Rojas, 2005).

Figure 23: Equivalent interruption frequency and duration (FES and DES indicators) between 2003 and 2010



Source: Unified Information System (SUI)

Figure 24: SAIDI and SAIFI evolution for sample Colombian distributors, 2016-2018



Source: SSPD

3.3.2 Institutions

Colombia's power sector reform comprised a relatively low degree of vertical unbundling and private sector participation across the electricity supply chain (Table 8). Colombia's power sector before reforms

was not supplied by one fully integrated utility, but rather several vertically integrated utilities with important municipality participation. Although reforms introduced activity separation and precluded further vertical integration in the industry, the law also allowed some degrees of existing vertical integration to be maintained by utilities (provided accounting is separated for each activity). Thus, Colombia scores relatively low in the utility restructuring indicator (35%), the lowest compared to Peru, Philippines and Vietnam. Moreover, despite privatization of several companies during the 1990's, government participation in electricity companies remain important, especially for distribution. Therefore, Colombia also scores relatively low in the private sector participation indicators (49%) when compared to Peru, Philippines and Vietnam.

Table 6: Extent of utility restructuring and private sector participation in Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International Benchmark
Utility Restructuring	**35%**	**73%**	**100%**	**47%**	**45%**
Vertical Unbundling	70%	80%	100%	60%	55%
Horizontal Unbundling	0%	67%	100%	33%	34%
Pvt sector participation	**49%**	**61%**	**62%**	**10%**	**24%**
PSP in Generation	63%	78%	84%	31%	41%
PSP in Distribution	35%	19%	39%	0%	16%
PSP in Transmission	50%	88%	66%	0%	14%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details go to project website at http://www.esmap.org/rethinking_power_sector_reform

Corporate governance of sample Colombian utilities is relatively high relative to comparators (Table 8). Codensa is a privately managed company, controlled by Italian energy group Enel, scoring very highly in Corporate Governance indicators. In turn, EPM scores 76% in corporate governance, above the international benchmark for the project but below several comparator utilities. EPM is owned by the municipality of Medellin through the Major, who acts as Chairman of the Board of Directors and appoints the CEO and other board members. However, the electricity law requires that government authorities guarantee the public utility administrative autonomy and the continuity for managers that demonstrate efficiency and effectiveness, without prioritizing interests other than good quality in service. Therefore, Medellin municipality control does not lead to a curtailing of the Board's decision-making autonomy and authority. Moreover, an IADB study argues that EPM's excellent performance is influenced by the fact that Medellin citizens consider themselves owners of EPM, therefore overseeing and promoting the company's performance, managerial independence and public transparency (Rodríguez, 2012).

Table 7: Corporate governance of utilities in Colombia and comparators, 2015

	Colombia		Peru		Philippines		Vietnam		International
	EPM	CODENSA	Luz del Sur	Hidrandina	MERALCO	BENECO	NPC	HCMPC	benchmark
Corporate Governance	**76%**	**96%**	**85%**	**40%**	**100%**	**83%**	**8%**	**8%**	**62%**
Accountability	*75%*	*92%*	*92%*	*58%*	*100%*	*67%*	*17%*	*17%*	60%
Autonomy (SOEs)	*78%*	*100%*	*78%*	*22%*	*100%*	*100%*	*0%*	*0%*	63%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details go to project website at http://www.esmap.org/rethinking_power_sector_reform

The utility management indicator is very high for EPM (83%, second only to Peruvian utility Luz del Sur, see Table 9), due to their transparent accounting system, managerial independence for hiring and firing employees, formal operation procedures and usage of latest technologies for customer satisfaction. Although the utility management indicator is very low for Codensa, this is partly due to the lack of information available to calculate the indicator, especially regarding key business processes. In turn, Codensa scores relatively high on the financial discipline index, with a transparent accounting process, a stable credit rating and the ability to pay dividends and issue new bonds (unlike several comparator utilities).

Table 8: Utility management index of utilities in Colombia and comparators, 2015

	Colombia		Peru		Philippines		Vietnam		International
	EPM	CODENSA	Luz del Sur	Hidrandina	MERALCO	BENECO	NPC	HCMPC	benchmark
Utility Management	**83%**	**43%**	**85%**	**70%**	**81%**	**68%**	**65%**	**65%**	64%
Financial Discipline	*76%*	*69%*	*86%*	*65%*	*71%*	*53%*	*53%*	*53%*	59%
Human Resource	*86%*	*60%*	*90%*	*71%*	*79%*	*86%*	*50%*	*50%*	62%
Information and Technology	*87%*	*0%*	*80%*	*73%*	*93%*	*67%*	*93%*	*93%*	71%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details go to project website at http://www.esmap.org/rethinking_power_sector_reform

Incentive-based quality of service regulation has also been instrumental in improving performance. As further explained later, distribution remuneration depends on the company's effective performance. Incentivized by the regulatory framework, Codensa and EPM have invested in infrastructure and innovative projects to increase service continuity. These investments allow the utilities to increase their regulated revenues.

3.3.3 Summary

Colombia's distribution companies widely vary in terms of operational and financial performance. As an example, EPM is a fully-government owned company with a history of excellent performance and one of the best performing utilities in Latin America and the Caribbean. EPM has developed a strong corporate governance and high-quality management, with no evident signs of political intervention. Another successful example under a different ownership model is Codensa, which emerged as the unbundled distribution and commercialization business from the previously integrated Electricity Company of Bogotá. Currently controlled by the Italian energy group Enel, Codensa performs relatively well and has implemented many of the good management and corporate government practices assessed in this project. A third example, Electricaribe, also emerged as a privatized utility, currently owned primarily by energy group Naturgy (formerly Gas Natural Fenosa). However, for several reasons Electricaribe remains

a financially unsustainable company providing very low service quality to its customers. The utility was intervened by the government on November 2016, but the intervention has not solved the utility's problems. In fact, the government established in 2019 a new tariff surcharge to settle Electricaribe's financial obligations.

3.4 Tariffs and cost recovery

3.4.1 Performance

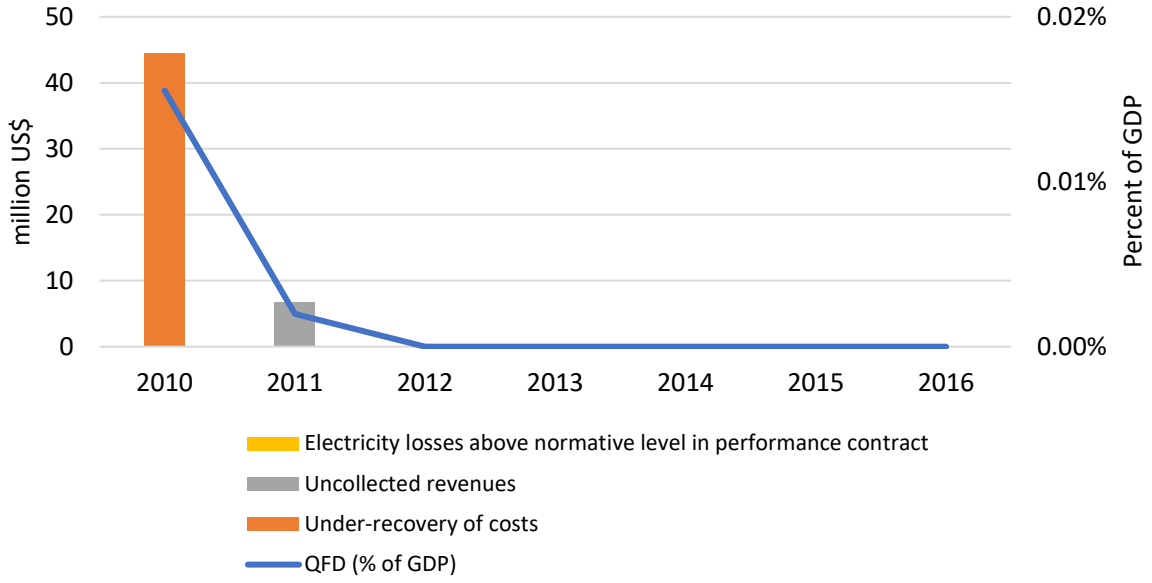
Codensa's financial viability is analyzed next in terms of the degree of cost recovery for the 2010-2016 period.[16] First, the Quasi-fiscal Deficit (QfD) is used to quantify and decompose Codensa's revenue gap, which is close to or equal to zero. Second, tariffs are compared to different cost-recovery levels. Third, subsidies, cross-subsidies and revenue per customer group is compared to cost-recovery levels. Fourth, standard financial ratios are presented for 2016. These analyses suggest that Codensa is financially viable and able to comfortably undertake its investment plan.

The revenue gap in a power utility can be measured using the quasi-fiscal deficit (QfD), a measure that compares the revenues that would be captured by an 'ideal utility' with the revenues captured by the actual utility. The ideal utility would charge cost recovery tariffs, fully collect revenues and keep distribution losses to a technical minimum. Thus, the gap between the ideal and the actual utility can be decomposed according to the portion attributable to under-recovery of costs through tariffs depressed below cost-recovery levels, the portion attributable to the under-collection of revenues due to commercial inefficiencies, and the portion attributable to excessive distribution losses.

There was no quasi-fiscal deficit (QFD) attributable to Codensa in 2012-2016 (Figure 26). Privatization and wider power sector reforms has proven effective in addressing Codensa's financial unsustainability. Codensa's losses fell 6% (from 25% to 19%) in the first year of privatization, and losses are now on-target with the normative level specified in Codensa's performance contract at about 7%, with no QFD attributed to electricity losses in 2010-2016. In 2010, there was a US$ 45 million quasi-fiscal deficit because of tariff losses driven by the impact of El Niño related drought on hydropower costs. In 2011 there was a US$ 6.7 million QfD due to the collection rate dropping to 99.5% (from over 100% in 2010). The QfD was eliminated by 2012.

[16] EPM was not analyzed on tariffs and cost-recovery due to data unavailability.

Figure 25: Quasi-Fiscal Deficit Attributable to Codensa

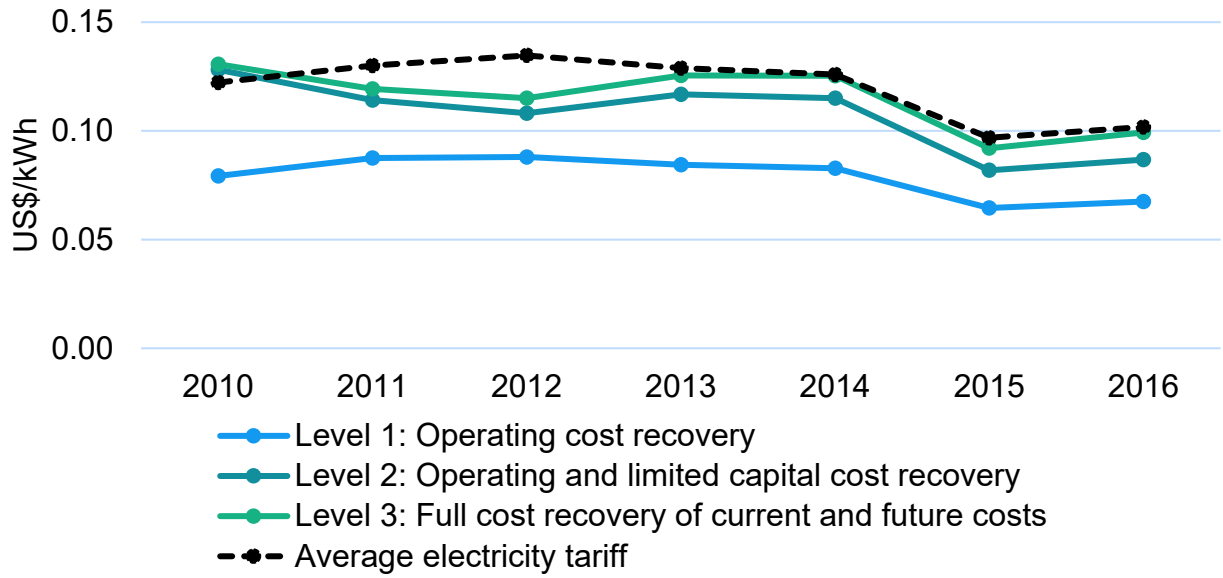


Source: Rethinking Power Sector Reform project

Financial viability of the power sector largely depends on achieving cost-reflective tariffs. To assess Colombia's progress toward cost recovery, a detailed analysis of Codensa financials was conducted. The analysis sets benchmarks for three levels of cost recovery: (i) operating costs only (A1 level); (ii) operating costs plus limited capital costs, such as debt service (A2 level); and (iii) full capital costs on current and planned future investments (A3 level). The financial viability analysis does not account for costs associated with service delivery that are covered separately by other parties, for example if a donor provides concessional capital. In a second stage, the analysis evaluates the sector against a full-cost-recovery benchmark that incorporates any costs that are currently subsidized. Data for the analysis were available for the period 2010–2016.

Codensa's average tariff revenue has exceeded full cost recovery of current and future costs (level 3) in every year since 2011. The tariff methodology appears to track cost changes very well, as is shown by the close alignment of average tariff revenues and level 3 cost recovery in 2013-2016. The regulator implements a monthly tariff adjustment factor for the cost of purchases in the electricity market, to account for price volatility. Higher costs in 2010 were due in part to the impact of El Niño-related drought on hydropower resources. Figure 27 shows average tariff revenues for each year 2010-2016 compared to the three levels of cost recovery.

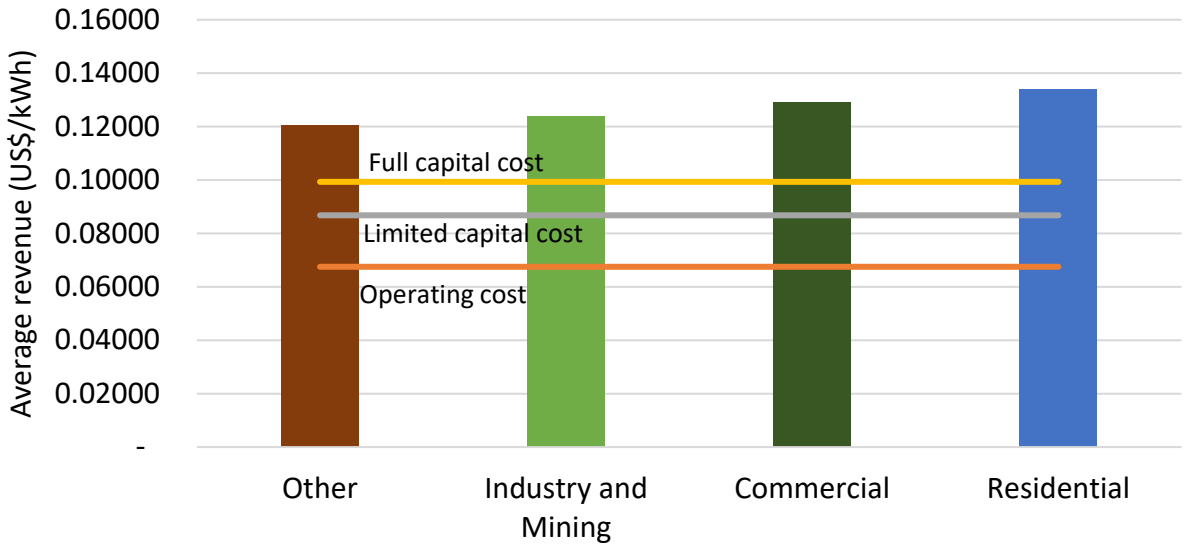
Figure 26: Evolution of tariff and full financial cost recovery for Codensa



Source: Rethinking Power Sector Reform project

There is no significant cross-subsidization between customer classes, but there is cross-subsidization between high- and low-income residential customers. Average tariff revenues for each customer group exceed level A3 cost recovery. The percent of revenue provided by each group is relatively proportional to their consumption (with less than a 2% difference between share of revenue and share of consumption for each customer class). Figure 28 shows the average tariff revenue for each customer class compared to cost-recovery levels A1-A3.

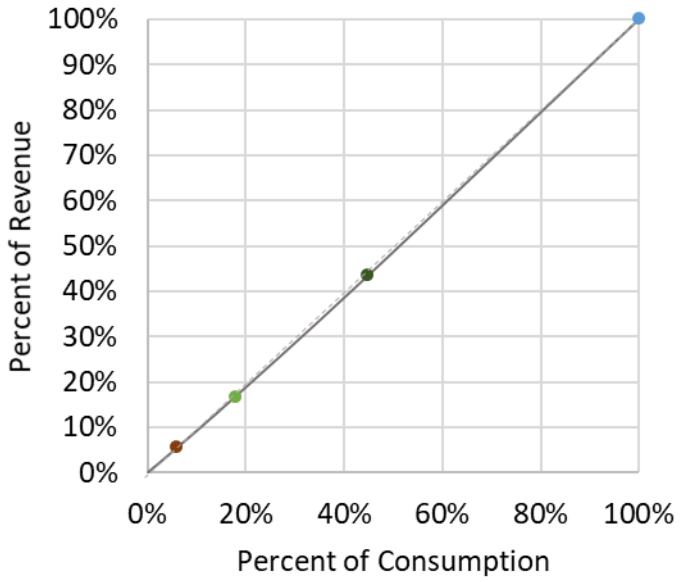
Figure 27: Average Tariff Revenue and cost recovery by customer group, 2016



Source: Rethinking Power Sector Reform project

Figure 29 compares the proportion of consumption for each customer class (in terms of consumption) to the proportion of revenue from that class. The chart seems to imply that cross-subsidies have a very low impact for Codensa when measured against consumption. Indeed, the cross-subsidy established in Colombia levies a surcharge to higher income and industrial customers, in order to subsidize lower income customers (further details of the cross-subsidy are available in Annex D). This cross subsidy is not clearly visible in the figure below.

Figure 28: Percentage of revenue against percentage of consumption by customer group, 2016



Source: Rethinking Power Sector Reform project

Codensa is profitable and able to finance its investments without difficulty. Codensa has made a profit each year 2010-2016 (Table 10), and it distributes 100% of its profits to shareholders. Although Codensa can cover its debt service payments, liquidity problems are suggested by two financial ratios below 1, the current ratio and the quick ratio. In addition, payable days outstanding has increased 38 percent since 2012. The Government does not provide any subsidies to the sector.

Codensa's investments totaled US$ 202 million in 2015, representing about 16% of its revenues. Codensa is able to finance its investments through income from operations and issuing of new shares, with a self-financing ratio of 144 percent in 2016. In fact, Codensa issued new shares in 2016. Codensa's dividends and debt repayment have been greater than new borrowings or issue of new shares in the years observed, and its external financing index ratio has been negative, reflecting negative net cashflows from financing. However, Codensa can attract external financing if needed, with a stable AAA credit rating from Fitch Ratings Colombia.

Table 9: Summary of Financial Indicators against Sample Average

Financial Indicator	Codensa (Colombia)	Sample Average*
Net profit (loss) margin	13%	-13%
EBITDA margin	34%	4%
Current ratio	0.73	0.82
Debt service coverage ratio	1.51	-5.01
External Financing Index Ratio	-0.60	6.90
Investment as a percent of revenues	16%	18%
Average borrowing rate	13%	7%
Government transfers as a percent of utility revenue	0%	5%
Needed investments covered by operating revenue (net operating expenses)	108%	49%

Note: samples average includes Tanzania, Senegal, Peru, Colombia, Pakistan, the Philippines, Vietnam, Kenya, Uganda, Tajikistan, the Indian states of Rajasthan, Odisha, and Andhra Pradesh, Egypt, and Ukraine.

3.4.2 Institutions

The sectoral regulator, Commission for the Regulation of Electricity and Gas (CREG), was created in 1994 through Laws 142 and 143. The law established CREG's organization, its composition, its budget and its functions. CREG is attached to the Ministry of Energy and Mines as a Special Administrative Unit with administrative, financial and technical independence. Among key objectives, CREG pursues the improvement of service and its quality, and promotes competition, efficiency, and sustainability in the energy market. In practice, CREG has a wide range of functions such as regulating end-user tariffs, quality of supply and service, PPAs, market design, and competitive procurement.

CREG's regulatory governance is relatively low, scoring 45% in this project's indicators, below the international benchmark of 59% (see Table 11). Despite the relative success of the Colombian market in some respects, several challenges have emerged (such as persistent difficulties during El Niño events) and there is room for improvement of corporate governance, particularly regarding the regulator's autonomy from government, competitive salaries for qualified experts and transparency.

Table 10: Formal regulatory governance in Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Regulatory Governance	**45%**	**83%**	**48%**	**32%**	**59%**
Accountability	**75%**	**85%**	**95%**	**64%**	**83%**
Regulatory Oversight	67%	67%	100%	67%	81%
Legal Appeals	100%	100%	100%	100%	100%
Transparency	57%	89%	85%	25%	67%
Autonomy	**60%**	**98%**	**51%**	**50%**	**71%**
Decision-Making Autonomy	64%	92%	79%	36%	79%
Budgetary Autonomy	88%	100%	50%	50%	80%
Leadership Autonomy	88%	100%	75%	14%	66%
Managerial Autonomy	0%	100%	0%	100%	59%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details go to project website at http://www.esmap.org/rethinking_power_sector_reform

Although CREG has adopted many of the international best accountability practices, according to indicators developed in this project the regulator has room for improvement. Regarding transparency, no decision-making process legally requires the participation of non-government stakeholders, although in practice stakeholders do participate in key processes. Regarding oversight, the country is also lacking non-governmental evaluations of regulator's performance. As a result, CREG scores relatively low on the accountability indicator: 75%, below the international benchmark of 83%. Nonetheless, a practical example of CREG's accountability efforts is given by five accountability hearings that were held in Cali, Bogotá, Santa Marta and Valledupar in 2015.

CREG also scores relatively low on autonomy with 60%, below the international benchmark of 71%, but in the upper end of comparators (Peru, Philippines and Vietnam). The low score is primarily due to low managerial autonomy (zero as measured by this project), due to employment restrictions and wage limitations associated to the public sector. During CREG's early years, managerial restrictions limited the regulator's ability to retain qualified experts, leading to high staff turnover and regulatory volatility (Millán et al., 2003).

Decision-making autonomy is also limited by the fact that regulations are used instead of laws to prescribe how decisions shall be taken. CREG is also subject to influence (1) by the government (given that the President appoints and replaces CREG officials, and Ministers of Energy and Finance are also commission members with veto power) and (2) by well-organized sectoral agents such as associations of generators or distributors, which exert a high level of pressure in the regulatory debate (Valencia, 2005). Despite the possibility of political pressures, the government has not overturned any of CREG's decisions over the past 5 years. Moreover, while several companies have sued the regulator for unfair burdens new regulations transferred to them, CREG seems to be far from being captured or unduly influenced by sectoral agents.

Colombia's regulatory substance is very effective and above international benchmarks for almost all regulation aspects analyzed in this project (see Table 12).

Table 11: Formal regulatory substance in Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Regulatory Substance	**81%**	**83%**	**95%**	**85%**	**76%**
Tariff Regulation	**92%**	**100%**	**93%**	**83%**	**77%**
Regulatory Framework for Tariffs	100%	100%	86%	100%	90%
Determination of Tariffs	83%	100%	100%	67%	64%
Quality Regulation	**100%**	**100%**	**92%**	**71%**	**75%**
Quality of Service Standards	100%	100%	100%	75%	82%
Quality of Service Enforcement	100%	100%	83%	67%	68%
Market Entry Regulation	**50%**	**50%**	**100%**	**100%**	**77%**
Permitting New Entrants	50%	100%	100%	100%	90%
PPA Approvals	50%	0%	100%	NAP	57%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details go to project website at http://www.esmap.org/rethinking_power_sector_reform

The regulatory framework for tariff determination in Colombia meets almost all the criteria assessed in this project, scoring 92% in the tariff regulation indicator. CREG adheres to Laws 142 and 143 of 1994 which establish a regulatory framework for tariffs following the principles of financial sufficiency (considering a clear definition of cost recovery that includes operating costs, full cash needs, and return on capital), efficiency and quality, among others (further details available in Annex D). Tariff determination follows a written formula that prescribes how end-user tariff levels are to be set, it is publicly available, and the regulator must adhere to it.

For monopoly activities such as distribution and transmission, only efficient costs (those that guarantee cost recovery for company with efficient management) are passed on to tariffs and there are incentives to improve efficiency (related to losses) as well as quality of service (further details in Annex D). The specific method for distribution remuneration changes every 5-year tariff period, and recently moved from the former price-cap reposition value (established in 1997) to a revenue-cap depreciated utility asset approach (established in 2018), for low to mid-voltage networks. An important policy for distribution remuneration are Distribution Areas (ADDs) established by Ministry's Decree 388 of 2007. ADDs group distributors in the same geographic zone, despite differences on customer density, for example (which are theoretically and empirically very important determinants of efficiency). All distributors in the same ADD must recover the same distribution charge for each voltage level. Some argue this mechanism introduces inefficient distortions to distribution remuneration (ECSIM, 2013).

Generation and commercialization components of tariffs are also regulated by CREG in the case of regulated customers who cannot choose among alternative suppliers, whereas non-regulated customers can freely negotiate these competitive components with alternative suppliers. Given that regulated customers account for about 70% of total electricity demand, CREG's regulation of the generation and commercialization tariff components are very important. In general, there is relative agreement that the principles established in the Law are followed in the establishment of tariffs, although there are several complaints regarding recent price dynamics and control of high volatilities in the wholesale market.

Quality of service regulation is also strong in Colombia, scoring 100% in the respective indicator. Quality of service received little attention before reforms. Laws 142 and 143 of 1994 introduced a formally established framework for ensuring minimum levels of service quality, based on transparent reporting of quality indicators. Despite several methodological changes in the period 1998-2019, incentives for quality of service have been provided since the inception of the new distribution regulatory framework (see Annex C for further details).

Quality of service incentives have proven effective in improving performance for well-functioning companies such as EPM and Codensa, whom implement investment plans to improve quality, thus reducing compensations to worst-served users and increasing incentive incomes. However, the overall regulatory and market environment has failed to achieve financial viability and minimum service quality across Colombia, particularly in some rural areas and the Caribbean zone.

3.4.3 Summary

Specific regulations from CREG are normally complied with and the entity is recognized as the regulator of the energy market. The regulator is respected and, even if some decisions and regulations have been questioned by the press and energy providers, regulations are enforced and complied with, and the public's rights are being reasonably protected. Regulations are strong and well-functioning in terms of tariffs and quality of service, both in theory and practice as reflected by the closely related De Jure and perceived indicators (see Table 13). However, serious challenges remain for financially distressed and poor performing distributors. Furthermore, despite CREG's legitimacy and high-quality regulatory substance, there is ample room for improvement in terms of its governance. Indeed, CREG's autonomy is not shielded from the government given the President's power over its board.

Table 12: Power sector regulation in Colombia: de jure vs perceived performance, 2015

Indicators	De Jure	Perceived
Overall regulation	**36%**	**34%**
Regulatory Governance	**45%**	**42%**
Accountability	**75%**	**70%**
Regulatory Oversight	67%	67%
Legal Appeals	100%	100%
Transparency	57%	43%
Autonomy	**60%**	**60%**
Decision-Making Autonomy	64%	64%
Budgetary Autonomy	88%	88%
Leadership Autonomy	88%	88%
Managerial Autonomy	0%	0%
Regulatory Substance	**81%**	**81%**
Tariff Regulation	**92%**	**92%**
Regulatory Framework for Tariffs	100%	100%
Determination of Tariffs	83%	83%
Quality Regulation	**100%**	**100%**
Quality of Service Standards	100%	100%
Quality of Service Enforcement	100%	100%
Market Entry Regulation	**50%**	**50%**
Permitting New Entrants	50%	50%
PPA Approvals	50%	50%

Note: Scores based on index developed for the Rethinking Power Sector Reform Project. For more details go to project website at http://www.esmap.org/rethinking_power_sector_reform

4 Conclusion

Following widespread blackouts during 1992's El Niño events, and amidst fiscal pressure from financially distressed electricity companies, Colombia adopted deep reforms in 1994 through Laws 142 and 143, which laid out the foundations for the new market, including independent regulation, privatization efforts, partial vertical unbundling and a competitive generation market. The new system successfully increased plant-level efficiency and attracted new private and foreign investment, allowing the country to withstand the 1997-1998 El Niño event without requiring demand rationing. However, in the early 2000's generation investment stalled, and distributors exhibited mild and slow performance improvements.

A new generation capacity market (firm-energy market) was introduced in 2006, and stronger, incentive-based regulation adopted for distribution in 2008. Although some generation investments materialized under the new framework, the country faced serious problems in the most recent El Niño event and further regulatory improvements were introduced during 2017-2018. Some distributors have improved performance significantly, but quality of service vary widely across regions, and some companies remain financially distressed or even bankrupt.

The results of Colombia's efforts to reform its power sector along the four dimensions of security of supply, access and affordability, utility efficiency, and cost recovery are summarized in Table 14 and in the succeeding paragraphs.

Table 13: Summary of Colombia's power sector reform efforts

Dimension	Performance	Institutions
Investment & Security of Supply	Rationing due to hydro scarcity has been successfully avoided, but the country remains highly hydro-dependent and exposed to risks during severe situations, such as the 2014-2016 El Niño event which, coupled to facilities outage, justified voluntary demand reductions programs and temporal regulatory intervention to ensure security of supply.	The original regulated capacity payment was replaced in 2008 by a competitive firm-energy market aimed at diversifying the generation mix and reducing exposure to low hydro availability. Design weaknesses were addressed by the regulator in 2017-2018 following the recent shortcomings exhibited by the mechanism. UPME, a highly capable planning unit of the Ministry develops indicative generation expansion plans and mandatory transmission plans.
Access & Affordability	Urban access remains practically universal, while access in rural and some remote areas has improved continuously but remains difficult to achieve in remote locations. Although affordability varies widely across different distributors, Colombia is close to the sample average when considering affordability of subsistence consumption, ranking 10th out of 15 countries with an indicator of 1.8% (sample average is 2.1%, and sample median is 1.3%). Cross-	Coverage expansion is driven by a variety of public policy instruments, planning and regulation, and is supported by several funds levied on the electricity spot price. Approaches vary depending on the economic and technical challenges for access across different zones. Competition is yet to put downward pressure on the electricity cost for regulated customers. Possible ways forward include promoting more

Dimension	Performance	Institutions
	subsidies help poor households alleviate the burden of electricity costs.	renewable energy auctions, organized futures market and day-ahead markets.
Utility Efficiency & Financial Viability	Following comprehensive reforms, losses have fallen on average and efficiency has improved for several distribution companies, with sustained and relatively good profits. However, performance vary widely across distribution companies, with one company practically bankrupt and intervened by the government since 2016.	Colombian distributors EPM and Codensa are relatively well-managed and following best international corporate practices, under two radically different ownership structures (EPM is municipality-owned, while Codensa is mostly private). Although some weaknesses exist regarding governance (EPM) and formal process codification (Codensa), these do not seem to have had evident impacts in performance.
Tariffs & Cost Recovery	Tariffs for distributor Codensa have been closely linked to full cost-recovery, including operating and capital costs. The regulator has introduced improvements in every five-year tariff period.	Tariffs are set by the regulator through a formally established, transparent and organized process. However, the regulator has room for improvement in managerial and decision-making autonomy.

On security of supply, 25 years since reforms began, Colombia's primary challenge is still related to El Niño events and fuel supply disruptions. El Niño events, that occur every 2 to 7 years but cannot be predicted, lead to low hydro inflows and availability. Given low volumes of long-term hydro storage capacity and the large share of hydropower in Colombia's generation mix (68% in 2018), El Niño events periodically test the energy sector's resiliency. Indeed, widespread blackouts were among key drivers for 1994 power sector reforms. Avoiding demand rationing has since been among the primary objectives of Colombia's regulator and power market. Despite a working firm-energy market which has incentivized some thermal generation investment, the country is still susceptible to El Niño events. Moreover, the 2014-2016 El Niño drove the Colombian system to its limit, exposing market design and regulatory weaknesses, particularly regarding the approach to generation based on liquid fuels (given their exposure to upstream supply disruptions). Regulations have been developed to avoid these problems in the future, and long-term supply auctions are being promoted to diversify Colombia's generation fleet.

On access and affordability, Colombia has substantially expanded coverage through the continuous support of policy, planning and regulation instruments over the past decades. However, there is still a long way ahead for expanding coverage to remote or isolated zones which cannot be economically interconnected to existing distribution systems. Indeed, almost 200.000 people have no access to electricity, and access is very low in some regions such as Vichada, with less than 60% electricity coverage in 2018. Regarding affordability, Colombia ranks 10th out of 15 analyzed developing countries. An average consumption of 136 kWh/month accounts for 7% of annual income for households in the bottom 40% of Gross National Income (annual cost of US$ 208 as of 2016). In turn, subsistence consumption of 30 kWh/month represents 2% of annual income for these households. Although targeted cross-subsidies alleviate the burden of electricity costs for poorer households, sustained upward trends in generation and distribution costs to ensure financial sustainability and security of supply have taken a toll on electricity affordability.

On efficiency, Colombia has shown improvements both on average and for particularly well-managed utilities, both publicly and privately owned. For example, EPM is a fully-government owned company with a history of excellent performance across Latin America and the Caribbean. EPM has developed a strong corporate governance and high-quality management, with no evident signs of political intervention. Another successful example under a different ownership model is privately controlled Codensa, which emerged as the unbundled distribution and commercialization business from the previously integrated electricity company of Bogotá. Codensa performs relatively well and has implemented many of the good management and corporate government practices assessed in this project. In turn, privately-owned Electricaribe remains financially unsustainable, providing very low service quality and under the government's intervention since November 2016.

On cost-recovery, retail tariffs generally allow utilities to recover their full operation and capital costs, following a formally established regulatory process for tariff setting. Regulations are strong and well-functioning in terms of tariffs and quality of service, both in theory and practice. However, serious challenges remain for financially distressed and poor performing distributors such as aforementioned Electricaribe. Furthermore, despite CREG's legitimacy and high-quality regulatory substance, the President's power over the regulatory board and the lack of managerial autonomy are two governance issues with room for improvement.

Colombia's experience with power sector forms offers some lessons for other developing countries which are currently considering or in the implementation process of similar reforms.

First, the institutional and resource endowment of a country is highly determinant on the shape of reforms, which should simultaneously address electricity and fuel markets. Colombia's hydric resource endowment and traumatic rationing episodes have had a defining impact on market design and the wider reform approach. Despite having a heavily hydro based generation fleet, Colombia pushed in 1994 a reform package based on the thermal-based UK reform. Reforms were initially successful in attracting private generation investment, but it was later acknowledged that a second wave of reforms tailor-made for the Colombian context was needed to ensure enough energy is available during scarcity periods. The firm-energy market was established as a response in 2008, providing a second push for thermal based generation. However, problems emerged due to ill-defined regulatory parameters and the lack of a comprehensive approach to gas and liquid fuels supply, among other reasons.

Second, weak institutions and coordination failures can delay and even hamper the benefits from power sector reforms. After shortcomings witnessed during the 2015-2016 El Niño, sectoral agents in Colombia seem divided as to both the diagnosis on security of supply, and the way forward. Some consider the firm-energy market has been successful and only needs further adjustments (some of which were addressed by CREG in 2017). Others consider that security of supply is currently very low (despite the absence of rationing); regulation and policy-making has been erratic; the regulator has eroded confidence through market intervention; and a rather different approach is needed in the future (such as organized futures and day-ahead markets).

Coordination failures among Ministry and Regulator, lack of strong leadership on energy policy and systematically lagging regulations, are perceived by most agents to have delayed necessary developments for higher technological diversification, energy security and efficiency. Several agents consider that the regulator focuses on excessively detailed regulations and ultimately lags in developments required for effectively improving performance. Pending issues relate to upstream fuel markets (gas and liquid fuels);

ensuring power plants fulfill their firm-energy obligations in times of scarcity; incentivizing renewable generation; demand participation; among others. Recent efforts such as the promotion of long-term supply auctions may be a step in the right direction.

Third, reforms have improved distribution performance through strong governance and high-quality regulation. Both analyzed utilities, privately-owned Codensa and publicly-owned EPM, are relatively well managed and provide good service to their customers. EPM is a rather rare case among public utilities: a tradition of managerial excellence and the control that citizens exert over the utility have been key to EPM's success, despite the potential for political intervention (Mejía-Dugand, Hjelm, & Baas, 2017; Millán et al., 2003). Nonetheless, these examples suggest that performance is not necessarily determined by ownership structure. Instead, performance is closely related to corporate governance, tariff-setting consistent with cost-recovery levels, and adequate incentives for quality of service. Hence, the impact of regulation and its improvement over time have been evident in the performance of at least some Colombian distribution companies.

Fourth, corporatization, unbundling and privatization of utilities can be extremely difficult, but its effects are very long-lasting. Successful privatization of power plants in the late 1990s has enabled a competitive power market and financially sustainable generation segment in the long-term. However, incomplete vertical unbundling is still reason for concern regarding wholesale and retail competition in the market. Moreover, privatization of distribution utilities was deferred and stalled in 2000, prolonging financial distress for some utilities and curbing performance improvements. Financial viability and minimum efficiency and quality of service are still a serious issue for several distribution companies, highlighting the persisting difficulties of this segment in Colombia.

The 1994 reform package of Colombia's power sector has been successful in many respects. Tariff and incentive-based regulation has achieved efficiency and quality of service improvements at least for some distribution utilities. The power sector has increased its financial sustainability and is no longer a major source of distress for the country's finances. Despite mixed views from sectoral agents on security of supply, no demand rationing has been imposed, even under the most severe El Niño event ever recorded (which coincided with high-impact outages).

Many challenges lie ahead, such as the need for further competition to put downward pressure on retail tariffs, improving security of supply institutions, expanding coverage and service continuity to remote areas, and addressing mixed outcomes for distribution utilities (some of which perform very poorly).

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Annex A. Detailed RPSR Indices

A. Global reform index

The standard package of reforms prescribed by international donors in the 1990s included four principal components: restructuring (vertical and horizontal unbundling of power utilities); private sector participation; creation of an independent regulator; and competition in power generation.

In order to aggregate across the four dimensions of power sector reform considered in this study, a simple Power Sector Reform Index is constructed. The index gives each country a score on an interval of 0 to 100 on each dimension of power sector reform. The scores are based on giving equal weight to each step on each dimension of the reform continuum (see tabulation below). The average of the four 0-100 scores is used to provide an overall summary of the extent of reform.

Regulation	No regulator = 0			Regulator = 100	
Restructuring	Vertically integrated = 0	Partial vertical unbundling = 33		Full vertical unbundling = 67	Vertical & horizontal unbundling = 100
Competition	Monopoly = 0	IPPs = 25	Single Buyer Model = 50	Bilateral Contracts = 75	Competitive market = 100
Private Sector Participation	0.5*(Percentage of generation capacity with private sector participation) + 0.5*(Percentage of distribution utilities with private sector participation)				

Legend	
○	Satisfactory result
●	Unsatisfactory result
NAP	Not applicable
NAV	Not available

B. Generation and transmission planning index for Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Planning and Procurement	95%	77%	59%	59%	70%
Generation Planning	86%	43%	71%	71%	56%
Country has a generation master plan	○	○	○	○	94%
Country has an overall energy plan	○	○	○	○	65%
Competent entity is responsible for producing the plan	○	●	○	○	88%
Inter-governmental committee oversees the planning unit	○	●	○	●	29%
Power generation system plan is mandatory	●	●	●	○	19%
Plan leads to timely initiation of procurement	○	●	●	○	38%
Planning process is transparent and participatory	○	○	○	●	59%
Transmission Planning	100%	75%	50%	100%	72%
Competent entity is responsible for producing the plan	○	○	○	○	100%
Explicitly linked to power generation plans	○	●	○	○	88%
Plan is mandatory	○	○	●	○	29%
Planning process is transparent and participatory	○	○	●	○	71%

C. Generation and transmission procurement index for Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Procurement of Generation	95%	90%	100%	50%	85%
There is a framework for procurement	○	○	○	●	82%
Country allows International competetive bidding or public auctions for procurement	○	○	○	○	94%
Types of procurement methods allowed-					
Unsolicited bids	○	●	●	●	29%
Direct negotiation	○	●	●	○	47%
International competitive tendering	●	○	○	○	88%
Public auctions	○	○	●	●	41%
Stand-alone capacity market	●	●	●	●	0%
Auction design score	0.86	0.71	NAP	NAP	80%
Country uses public auctions for procurement	○	○	●	●	41%
Clear and comprehensive established rules	○	○	*NAP*	*NAP*	100%
Credible penalties for violating the rules	○	○	*NAP*	*NAP*	86%
Guarantees and penalties to ensure timely completion	○	○	*NAP*	*NAP*	86%
Standard, non-negotiable contracts	○	○	*NAP*	*NAP*	86%
Stapled financing terms or risk mitigation instruments	○	●	*NAP*	*NAP*	86%
No concerns regarding the transparency and fairness of the auction	●	●	*NAP*	*NAP*	14%
Efforts to inform and attract bidders to the auction	○	○	*NAP*	*NAP*	100%
Transmission Procurement	100%	100%	17%	17%	68%
There is a framework for procurement of new transmission lines	○	○	●	●	59%
Methods used to procure new transmission-	○	○	●	●	71%
Competitive tender	○	○	●	●	71%
Direct negotiation	●	●	●	●	29%
All projects are awarded to the incumbent transmission company	●	●	○	○	47%

D. Access policy framework index for Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Energy Access Regulation	**67%**	**57%**	**74%**	**7%**	**58%**
Regulation of New Connections	**68%**	**88%**	**57%**	**14%**	**65%**
Roles of regulator, utility, rural electrification agency clearly defined	○	○	○	NAV	93%
Utilities have regulatory obligation to connect new customers	○	○	○	○	94%
Regulatory entity has authority to approve connection charges for new customers	○	○	○	●	71%
Connection charges are set using shallow entry	●	○	●	NAP	58%
Government provides subsidy for new connections	●	●	●	●	53%
Connection has to be provided in a specified time	○	○	○	●	94%
Regulatory entity monitors tiem taken to provide new connections	●	○	●	●	44%
Regulator has authority to levy penalties for not connecting customers on time	NAP	○	NAP	NAP	71%
Time taken to provide connections publicly available	○	○	●	●	24%
There are connection charges	○	○	○	NAV	94%
Customer pays limited connection charges	●	●	●	NAP	43%
Connection charge is publicly available	○	○	○	●	71%
Regulation of solar home systems	**100%**	**50%**	**100%**	**0%**	**66%**
Minimum technical standards and post-installation warranty requirements for solar home systems	○	○	○	●	71%
Regulator reviews and approves prices of surplus SHS sales of electricity to the grid operator	NAV	●	○	NAV	62%
Regulation of mini-grids	**33%**	**33%**	**67%**	**NAV**	**44%**
Privately owned mini-grids legally allowed to operate	○	○	○	NAV	81%
Clear options for mini-grid operator when the interconnected grid reaches the area, including compensation	●	●	●	NAV	7%
Subsidy or other mechanism to help mini-grid operators recover their costs	●	●	○	NAV	47%

E. Corporate governance- accountability index for Colombia and comparators, 2015

Corporate governance	Vietnam		Philippines		Colombia		Peru		International
	NPC	HCMPC	MERALCO	BENECO	EPM	CODENSA	Luz del Sur	Hidrandina	benchmark
Accountability	**17%**	**17%**	**100%**	**67%**	**75%**	**92%**	**92%**	**58%**	**60%**
Private or public shareholders appoint board	●	●	○	○	●	○	○	○	36%
Transparent process exists for Board selection	●	●	○	○	●	○	○	●	36%
Board members cannot be removed at will	●	●	○	●	●	○	○	●	29%
Chairperson & CEO are separate positions	●	●	○	○	○	○	○	○	75%
Function of Company Secretary exists	○	○	○	○	○	○	○	○	82%
Board Sub-Committees for different issues	●	●	○	●	○	○	●	●	68%
Audit committee of the Board	●	●	○	○	○	○	○	○	71%
Board Code of Conduct exists	●	●	○	○	○	○	○	○	64%
Requirement to declare conflicts of interest	●	●	○	○	○	○	○	○	75%
Utility has carried out any third party transactions in last five yrs	●	●	○	●	○	●	○	●	46%
Minority shareholders' rights are protected	●	●	○	●	○	○	○	●	39%
Utility publishes an Annual Report	○	○	○	○	○	○	○	○	93%

F. Corporate governance- autonomy index for Colombia and comparators, 2015

Corporate governance	Vietnam		Philippines		Colombia		Peru		International benchmark
	NPC	HCMPC	MERALCO	BENECO	EPM	CODENSA	Luz del Sur	Hidrandina	
Autonomy	**0%**	**0%**	**100%**	**100%**	**78%**	**100%**	**78%**	**22%**	**63%**
Board is the final body to take decision on-									
Defining corporate strategy	NAP	NAP	○	○	○	○	○	●	96%
Approving business plans	NAP	NAP	○	○	○	○	○	●	96%
Setting and monitoring performing objectives	NAP	NAP	○	○	○	○	○	○	92%
Selecting, appointing and overseeing the CEO	NAP	NAP	○	○	○	○	○	●	56%
Raising capital from debt	NAP	NAP	○	○	○	○	○	●	68%
Raising capital from equity	NAP	NAP	○	○	●	○	○	●	48%
Major capital expenditures	NAP	NAP	○	○	○	○	○	●	88%
Deciding and implementing tariff adjustments	NAP	NAP	○	○	●	○	●	●	24%
Human resource hiring and firing decisions	NAP	NAP	○	○	○	○	●	○	72%

G. Utility management- financial discipline index for Colombia and comparators, 2015

Utility management	Vietnam		Philippines		Colombia		Peru		International benchmark
	NPC	HCMPC	MERALCO	BENECO	EPM	CODENSA	Luz del Sur	Hidrandina	
Financial Discipline	**53%**	**53%**	**71%**	**53%**	**76%**	**69%**	**86%**	**65%**	**59%**
Utility has a credit rating	●	●	○	●	○	○	○	●	36%
Utility can issue new bonds	●	●	●	●	○	○	○	●	36%
Utility can issue new equity	●	●	○	●	●	NAV	○	●	26%
Utility pays dividends to shareholders	●	●	○	●	○	○	○	●	29%
Public service obligations are explicitly defined	○	○	○	○	○	○	●	○	46%
PSO is publicly disclosed	●	●	○	○	●	●	NAP	○	38%
PSOs are costed	●	●	●	●	●	●	NAP	●	0%
PSOs are compensated by government	●	●	●	●	●	●	NAP	●	0%
Utility required to meet financial performance targets	●	●	●	●	○	○	○	○	52%
System of internal financial controls exists	○	○	○	○	○	●	○	○	96%
Internal audit function exists	○	○	○	○	○	●	○	○	93%
Utility is subject to state auditing procedures	○	○	●	●	○	○	●	○	71%
Financial accounts are produced	○	○	○	○	○	○	○	○	96%
Financial accounts are audited by external auditor	○	○	○	○	○	○	○	○	93%
Financial accounts are publicly disclosed	○	○	○	○	○	○	○	○	79%
Financial accounts meet national standards	○	○	○	○	○	○	○	○	82%
Financial accounts meet international standards	○	○	○	○	○	○	○	○	57%

H. Utility management- human resources index for Colombia and comparators, 2015

Utility management	Vietnam		Philippines		Colombia		Peru		International benchmark
	NPC	HCMPC	MERALCO	BENECO	EPM	CODENSA	Luz del Sur	Hidrandina	
Human Resource	50%	50%	79%	86%	86%	60%	90%	71%	62%
Annual staff performance reviews exist	○	○	○	○	○	NAV	○	○	93%
Employees receive performance related bonuses	○	○	○	○	●	NAV	○	○	70%
Employees can be fired for poor performance	○	○	○	○	○	○	○	○	79%
Government employment regulation don't apply	●	●	○	○	●	NAV	○	●	26%
Wages not based on government pay scales	●	●	○	○	○	NAV	○	●	48%
Staff training policy exists	○	○	○	○	○	○	○	○	86%
Managers are free to hire employees	●	●	●	●	○	●	NAV	●	12%
Managers are free to fire employees	●	●	●	●	○	●	NAV	●	24%
Managers can execute budget	●	●	○	○	○	●	NAV	○	60%
Managers can implement investment projects	●	●	●	○	○	●	NAV	○	44%
Recruitment involves advertisment of positions	●	●	○	○	○	○	●	○	71%
Recruitment involves short-listing candidates	○	○	○	○	○	○	○	○	89%
Recruitment involves interviewing candidates	○	○	○	○	○	○	○	○	82%
Recruitment involves reference checks	○	○	○	○	○	○	○	○	75%

I. Utility management- information & technology index for Colombia and comparator, 2015

Utility management	Vietnam		Philippines		Colombia		Peru		International benchmark
	NPC	HCMPC	MERALCO	BENECO	EPM	CODENSA	Luz del Sur	Hidrandina	
Information and Technology	93%	93%	93%	67%	87%	0%	80%	73%	71%
SCADA system	○	○	○	○	○	NAV	○	○	93%
IT system to support incidence resolution	○	○	○	○	○	●	○	○	75%
IT system to support distribution management	○	○	○	○	○	●	○	○	79%
IT system to support energy management	○	○	●	●	○	●	○	●	64%
Geographic Information System (GIS)	○	○	○	○	○	NAV	○	○	78%
KPIs are used to monitor quality of supply	○	○	○	○	○	NAV	○	○	100%
Advanced Metering Infrastructure (AMI)	○	○	○	○	●	NAV	●	●	52%
Accurate customer database	○	○	○	○	○	NAV	○	○	96%
Call center for dealing with customer complaints	○	○	○	○	○	NAV	○	○	96%
Website for submission of customer complaints	○	○	○	●	○	NAV	○	○	85%
Customer satisfaction regularly monitored	○	○	○	○	○	NAV	○	○	59%
Commercial management system (CMS)	○	○	○	●	●	NAV	○	○	41%
Resource Management System (RMS)	●	●	○	●	○	NAV	○	○	35%
KPIs are used to monitor commercial cycle	○	○	○	○	○	●	●	●	86%
KPIs are used to monitor corporate resource management	○	○	○	●	○	●	●	●	54%

J. Regulatory governance- accountability index for Colombia and comparators, 2015

Regulatory governance		Colombia	Peru	Philippines	Vietnam	International benchmark
Accountability		**75%**	**85%**	**95%**	**64%**	83%
Regulatory Oversight		67%	67%	100%	67%	81%
Regulator's objectives formally stated in law		○	○	○	○	100%
Regulator required to report on its activities		○	○	○	●	88%
Independent third party evaluations of regulator have taken		●	●	○	○	56%
Legal Appeals		100%	100%	100%	100%	100%
Legally established process to challenge/appeal regulatory		○	○	○	○	100%
Transparency		57%	89%	85%	25%	67%
Publicly availabe annual reports		○	○	○	○	94%
Recommendations are required to be made public		NAP	○	●	●	33%
Government body receiving recommendations required to respond publicly		NAP	●	●	●	33%
Regulator is required to publish its decisions on-	End-user tariffs	○	○	○	NAP	100%
	Licensing generation or supply	NAP	NAP	○	NAP	100%
	Wholesale or PPA prices and contract terms	○	○	○	NAP	100%
	Market design	○	NAP	○	NAP	100%
	Oversight of regulated utilities	NAP	○	○	NAP	85%
Regulatory decision-making process legally requires the participation of non-government stakeholders in case of-	End-user tariffs	●	○	○	○	69%
	Licensing generation or supply	NAP	NAP	○	●	69%
	Wholesale or PPA prices and contract terms	●	○	○	●	38%
	Market design	●	NAP	○	●	30%
	Oversight of regulated utilities	NAP	○	○	●	38%

K. Regulatory governance- autonomy index for Colombia and comparators, 2015

Regulatory governance		Colombia	Peru	Philippines	Vietnam	International benchmark
Autonomy		**60%**	**98%**	**51%**	**50%**	**71%**
Decision-Making Autonomy		**64%**	**92%**	**79%**	**36%**	**79%**
Areas where entity has a mandate to regulate-	End-user tariffs	○	○	○	○	100%
	Quality of supply and service	○	○	○	○	100%
	Electrification or increased access to energy	●	○	●	●	53%
Decision of the regulatory entity are legally binding in the area of-	End-user tariffs	○	○	○	●	88%
	Grid access charges	○	○	○	●	87%
	PPA/wholesale prices	○	○	○	●	92%
	Quality of supply/service	○	○	○	●	87%
	Market design	○	NAP	○	●	50%
	Licensing	NAP	NAP	○	●	85%
	Utility oversight	NAP	○	●	●	71%
Government body rejecting or modifying regulatory decisions		NAP	●	●	●	17%
Law precribes decision making process for-	End-user tariffs	●	○	○	○	94%
	Grid access charges	●	○	○	○	81%
	Quality of supply/service	●	○	○	○	87%
Budgetary Autonomy		**88%**	**100%**	**50%**	**50%**	**80%**
Funding for regulator established by law		○	○	○	○	100%
Percentage of regulator's budget that comes from levies or taxes		0.752	1	0	0	59%
Leadership Autonomy		**88%**	**100%**	**75%**	**14%**	**66%**
Legal basis for existence is primary legislation		○	○	○	○	100%
Power to determine own organizational structure and rules		○	○	●	●	50%
Power to determine the allocation and use of budget		○	○	○	●	44%
Legal requirements or restrictions regarding professional profile leadership		○	○	○	●	94%
There is a fixed term for the leadership of the regulatory entity		○	○	○	●	88%
Legal provisions under which leadership an be removed from office		○	○	○	●	75%
Current leadership of entity connected to government or utilities		●	○	●	●	25%
Over 60% of employees are in technical positions		○	○	○	NAV	57%
Managerial Autonomy		**0%**	**100%**	**0%**	**100%**	**59%**
Pay scale not linked to govt pay scale or is 90% of utility pay		●	○	●	NAV	53%
Not required to follow govt employment regulations		●	○	●	○	63%

L. Regulatory substance- tariff regulation index for Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Tariff Regulation	92%	100%	93%	83%	77%
Regulatory Framework for Tariffs	100%	100%	86%	100%	90%
Objectives in determining tariffs mentioned explicitly in policy or legal mandate	○	○	○	○	100%
Principles of tariff-setting clearly articulated	○	○	○	○	88%
Authority over the tariff level	○	○	○	○	94%
Clear definition of "cost recovery"	○	○	○	○	88%
Legitimacy of costs is used as a basis for tariff calculations	○	○	○	○	88%
Tariff-setting based on a clearly specified regulatory framework	○	○	○	○	88%
Frequency and schedule of revisions determined by law or regulation	○	○	●	NAP	75%
Determination of Tariffs	83%	100%	100%	67%	64%
Publicily available written formula is to be used for tariff setting and utilities are legally required to adhere to it	○	○	○	○	88%
Avoid passing-through inefficient costs to customers	○	○	○	○	76%
Requirement to submit financial information according to set standards	○	○	○	○	53%
Users bear the costs of incentive mechanisms for renewable energy generation	○	○	○	●	75%
Regulatory mechanisms to compensate generators for the provision of firm capacity or ancillary services	○	○	○	○	58%
Utilities are compensated for the costs of stranded assets	●	○	○	●	25%

M. Regulatory substance- quality of supply index for Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Quality Regulation	100%	100%	92%	71%	75%
Quality of Service Standards	100%	100%	100%	75%	82%
Requirement to meet quality of service standards	○	○	○	○	100%
Specific quality of service standards are formally written and publicly available for- quality of the product, quality of the service	○	○	○	○	97%
Performance on quality of service standards is public	○	○	○	○	71%
Fines for failing to meet quality of service standards	○	○	○	●	59%
Quality of Service Enforcement	100%	100%	83%	67%	68%
Requirement to report technical data on a periodic basis	○	○	○	○	100%
Regulator specifies how to collect technical performance data	○	○	○	○	71%
Regulator reviews or validates technical performance data	○	○	○	●	47%
Automated information management systems are required to measure the quality or reliability of the power supply	○	○	●	○	71%
Measurements of the quality or reliability of power supply are made public	○	○	○	○	65%
Financial incentives to meet customer service standards or increase customer satisfaction	○	○	○	●	53%

N. Regulatory substance- market entry index for Colombia and comparators, 2015

	Colombia	Peru	Philippines	Vietnam	International benchmark
Market Entry Regulation	**50%**	**50%**	**100%**	**100%**	**77%**
Permitting New Entrants	50%	100%	100%	100%	90%
Responsible for monitoring compliance with the terms of the license or permit	●	○	○	○	88%
Authority to impose penalties for violating license or permit terms	NAP	○	○	○	100%
Penalties are formally written and publicly available	NAP	○	○	○	80%
Provisions to force companies to relinquish licenses or permits for violation	○	○	○	○	100%
PPA Approvals	50%	0%	100%	NAP	57%
Legally required to approve all power sales contracts either directly or indirectly	●	●	○	●	59%
Approve or refuse a proposed PPA in a legally specified period of time	NAP	NAP	○	NAP	60%
Authority over the process by which utilities can select or procure power from IPPs	○	●	○	●	50%

Annex B. Political and Economic Country Context

After the end of the National Front[17] in 1974, one of the most important milestones in recent Colombian political development was the 1991 national constituent assembly (NCA), whose main goals were: (i) to fortify a participative democracy that would allow the consolidation of new actors and (ii) contribute to the creation of a new political order. The result of the NCA was the National Political Constitution of 1991, whose predecessor had been in force for more than a century. In this new legal and institutional framework pluralism and Social Rule of Law are the core concepts.

The NCA itself was a response to a critical situation that Colombia was experiencing, where political parties and national congress were perceived as inoperative and corrupt. There was a widespread perception that central government was unable to guarantee quality of life improvements and citizen participation in political institutions, and therefore a re-composition of the political regime was necessary (Novoa, 2008).

Considering the legitimacy crises, since the mid-eighties a number of reforms were implemented to strengthen a decentralization process, seeking to achieve political openness and democratization (Novoa, 2008). The National School of Public Administration identifies two significant "moments" in said process. In the first moment actions were promoted to reduce local and regional migration, increase efficiency in public services provision, create communication channels between government and citizens, create a number of political participation mechanisms and reduce social conflicts (violence). The second moment was embodied in the constitution of 1991 and was characterized by a set of efforts to modernize state, increase its efficiency and change the assistance-based approach. These reforms gave municipalities an important set of responsibilities in provision of public services and expanded the scope of local political management.

Alongside this transition to consolidate a true participative democracy, a debate on the need to transform Colombia's productive structure began in the country, aiming at securing long-term economic growth. Modest economic growth in the 1980s, the depletion of a national import substitution model, the adoption of liberalization models in other countries in the region, and external pressures -especially from the World Bank- to dismantle protectionist trade instruments, contributed to the generation of consensus around the need to adopt a new economic development model (Garay et al., 1998).

There was a gradual shift from a state-supported industrialization model to a model of economic openness (1990-1994, under Cesar Gaviria presidential term). Pro-market reforms were implemented in this period to increase efficiency through competition.

Reforms changed the composition of economic activity, reducing the importance of the manufacturing industry whilst increasing that of the mining sector. The manufacturing industry, once the most dynamic sector of the Colombian economy, lost share in the national GDP. The mining sector, which played a rather secondary role in the national economy since the beginning of the 20th century, gained broad prominence. The boom of the mining sector was the result of changes in national oil policy, important discoveries of oil and gas reserves, followed by the development of large nickel and coal state projects, in

[17] A political and electoral coalition between the two main Colombian political parties (liberal and conservative). Lasted between 1958 and 1974 and emerged in response to the strong violence that the country was experiencing due to bipartisan polarization. The coalition selected a common candidate and agreed to alternate presidential terms (4 years for a liberal candidate and 4 years for a conservative one); official charges were evenly distributed.

partnership with multinational companies. While some argue that this was in fact a deindustrialization process, others argue that it is not possible to speak of a deindustrialization process per se, since production in absolute values and number of products has increased. Moreover, this productive restructuring can be partly associated with the "Dutch disease" described in economic literature, namely the apparent relationship between the development of mining and the decline of manufacturing (Ocampo, 2015). Nonetheless, there is agreement that the manufacturing industry has lost momentum and infrastructure-related actions need to be undertaken to improve domestic market supply and seek new export niches.

It's worth noting that the 1990 decade was very complex for Colombia in social and economic aspects. Production of illicit drugs intensified and violence soared, reducing foreign investment, infrastructure development and aggregated growth. By 1999 the country was in the most serious financial crisis it experienced in the last century, affecting all sectors, especially housing.

A process of economic recovery began in 2002. Among some of the contributing factors for said recovery are: international demand boom -which improved the terms of trade of raw materials and minerals-, incentives for fixed capital investment and the improvement of security conditions (Ortiz, 2014). All these factors positively affected the attraction of Foreign Direct Investment -which almost increased sevenfold between 2000 and 2014- and contributed to a relatively stable growth rate.

In the first decade of 2000 labor flexibility was further deepened; new bilateral free trade agreements were signed, and national investment projects were designed to improve commercial and transport infrastructure, which remain a challenge for Colombia in the short and medium term.

At present, dependence on oil resources causes high vulnerability to external price shocks. This has been the case in recent years, when oil price reductions have negatively affected economic performance and exports. The dynamism of financial, commercial and construction services have partially offset falls in the extractive sector, becoming an important growth driver.

All things considered, it can be said that the effects of Colombian reforms show a positive aggregated balance, both politically and economically, when comparing current indicators with those of the 1990's decade. Colombia has had an extraordinarily prudent macroeconomic policy and the country stands out in Latin American context because it has not experienced serious inflationary problems or systematically unsustainable debt levels - external or domestic.

However, Colombia still faces significant challenges, particularly in productive diversification, increased competitiveness in a global context, and fight against inequality and political corruption. Moreover, after signing a peace treaty with the country's oldest armed group, there are challenges and opportunities for deepening expansion processes of economic and social growth.

Annex C. Quality of Service Regulation

In Colombia, quality of energy supply refers to two main elements: continuity and voltage stability (power quality). Before laws 142 and 143 these aspects received little attention; there was no consolidated information or regulations on quality parameters to be adjusted by utilities.

This situation changed with the enactment of specific distribution regulation (Resolution CREG 070, 1998), where two quality specific indicators were defined: Equivalent Frequency of Service Interruptions (FES) and Equivalent Duration of Service Interruptions (DES). As their names indicate, DES and FES track interruptions in energy supply and its duration. Although DES and FES are similar to SAIDI and SAIFI, DES and FES are calculated per distribution circuit, whereas SAIDI and SAIFI are calculated at the customer level.

Acknowledging differences in sub-regional distribution systems, Resolution CREG 089 of 1999 defined 4 quality groups:

- Municipal capitals with population greater than or equal to 100,000 inhabitants.
- Municipal capitals with population of less than 100,000 inhabitants and greater than or equal to 50,000 inhabitants.
- Municipal locations with less than 50,000 inhabitants.
- Areas outside the urban area of the respective municipality or district.

In the early 2000's regulatory scheme, network operators (OR) register DES and FES for their respective users, for each circuit and voltage transformer. Each OR makes monthly reports to a monitoring entity, who makes a quarterly review of compliance with maximum values established in the regulation for each quality group. Failure to comply with said values will generate economic compensation for users.

Since 2008 distribution incomes can either increase or decrease depending on effective quality of service, and compensations where established for the worst-served customer, promoting a minimum level of quality. These changes were introduced by CREG resolution 097 of 2008, which modified DES and FES definition and integrated a new indicator known as Grouped Quarterly Index of Discontinuity (ITAD). ITAD is calculated based on average energy that users didn't consume due to service interruptions (ENS: energy not supplied) in relation to energy consumed by the users of the respective network operator in the quarter where measurement is performed (ES: Energy Supplied). However, interruptions were not tracked, despite their huge potential impact for some businesses (ECSIM, 2013). Moreover, ITAD is not comparable across utilities.

The 2018-2022 distribution tariff methodology introduced explicit targets for annual performance improvements (CREG resolution 015 of 2018). Moreover, quality of service is now based in the international standard SAIDI and SAIFI indicators.

For transmission, quality regulation is made by setting a maximum number of unavailability hours for different asset classes. In case of exceeding the maximum number of hours allowed, a compensation established by law shall be deducted from the annual revenue of the transporter. Distribution quality regulation is analogous.

Annex D. Tariff Regulation

Before 1994 power sector reform, one of the main characteristics of Colombian utilities was insufficient income generation that forced government intervention to save companies from financial collapse. In this context an adjustment process was initiated, seeking to lead tariffs to levels that would guarantee financial self-sufficiency and release the state from financial burdens related to bailouts.

Law 142 of public services established the need to define a tariff structure, summarized in a formula stated by CREG that would be updated every 5 years (tariff period). Said structure corresponds to an efficient economic cost per kWh (called CU), which guarantees cost recovery for a company with efficient management. CU results from adding components of generation (G), transmission (T), distribution (D), commercialization (C), losses (including technical and non-technical losses), and "restrictions" such as the costs of out-of-merit dispatch required for the system's operation security.

The tariff formula calculation method is mandatory to set tariffs for regulated customers. Non-regulated customers have the same components of the formula but can freely negotiate generation and commercialization components. Current tariff structure is enacted on CREG Resolutions 031 of 1997 and Resolution 119 of 2007, which defines the core of the unit cost for service provision. These resolutions were modified by CREG Resolution 173 of 2011 and more recently by CREG Resolution 015 of 2018.

The main principles on which CREG relies to set the calculation method for regulated charges are:

- Ensure commercializators financial sufficiency, allowing cost recovery incurred in service provision with conditions of economic efficiency.
- Maintain efficiency and productivity criteria, in determining maximum prices for commercializators, encouraging conditions of competition in service provision.
- To establish signals of an efficient cost that allows entry of new commercializators which will stimulate competition.
- Maintain adequate balance between price signals that reflect abundance or scarcity and moderation of high volatility in generation component.
- Encourage efficient purchases in the wholesale energy market, in both regulated and un-regulated market purchases.

In general, there is relative agreement that these principles are followed in the establishment of tariffs, although there are several complaints regarding recent price dynamics and control of high volatilities. It is worth noting that Colombian regulation contemplates the option that monitoring organisms conduct research to determine causes of price increases, when use of anticompetitive practices or operational inefficiency in the market is suspected.

A final note on Colombian tariff regulation is the existence of a cross-subsidies system for regulated customers. Customers are separated into 6 strata, based on income level, where strata 6 comprises customers with the highest income and strata 1 those with the lowest income. Residential users in soecioeconomic stratas 5 and 6, and users in commerce segment, must pay a parafiscal contribution equivalent to 20% on unit service cost. These resources are used to cover subsidies granted to soecioeconomic stratas 1 and 2 (before, strata 3 was included but the subsidy is currently being

eliminated). The subsidy is up to 60% of the unit cost for strata 1 and up to 50% for strata 2. The subsidy is provided to those who consume less than the "subsistence" consumption, set at 173 kWh/month for clients living below 1000 meters above the sea level, and 130 kWh/month for the rest.[18] However, Decree 2860 of 2013 abolished the 20% contribution for industrial customers.

Other tariff surcharges include contributions to funds such as those for rural electrification (FAZNI and FAER) and network normalization (PRONE). Also, following enactment of the National Development Department's 2019 plan, customers of strata 4, 5 and 6, as well as commercial and industrial customers, will be levied an additional charge to support SPPDs interventions, such as the ongoing Electricaribe intervention which requires funds to cover accumulated debts.

[18] See **https://www.celsia.com/Portals/0/Documentos/Documento sobre la tarifa de energ%C3%ADa (final).pdf**