ENERGY SOURCES, PART B: ECONOMICS, PLANNING, AND POLICY
2016, VOL. 11, NO. 12, 1103–1110
http://dx.doi.org/10.1080/15567249.2013.878768

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The evolution of electricity auctions in South America

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ABSTRACT
Regulatory reforms of the power sectors in South America have always been driven by the need of attracting enough investment to guarantee an expansion rate capable of covering the fast-paced demand growth in the continent. In order to achieve this objective, in the last decade several countries in the region have reshaped their regulatory frameworks in the direction of long-term auctioning. This paper first provides a detailed description of the regulatory evolution that resulted in the implementation of auction schemes and then it presents an updated review of the mechanisms implemented in five South American countries, comparing their main design elements.

KEYWORDS
Capacity mechanisms; electricity auctions; long-term electricity contract; system adequacy

1. Introduction

Long-term electricity auctions, introduced during the last decade to correct the flaws of the original price-based capacity mechanisms in attracting new investments, are nowadays the driving regulatory tool for the expansion of the power systems in South America. Maurer and Barroso (2011) dedicated an entire book to the analysis of electricity auctions aimed at solving the adequacy problem all over the World and provided a description also of the South American experiences. However, even if long-term auctioning introduction is quite recent, these mechanisms have been subject to a constant fine-tuning that has in some cases altered their original design, through the addition of novel features aiming at increasing their efficiency or at pursuing particular regulatory objectives. These revisions require a permanent monitoring of these schemes, in order to be aware of the last modifications. The scope of this article is to provide an updated and comprehensive review of the existing system-adequacy auction schemes implemented in five South American countries (Argentina, Brazil, Chile, Colombia, and Peru). The focus is on the identification and comparison of the most significant design elements that constitute them, since these are the key factors that allow understanding the differences among the different designs. In the next section, the regulatory evolution that resulted in the introduction of long-term auctioning is presented, while in Section 3 the mechanisms are analyzed in detail country by country.

2. The regulatory waves in South America

In South America, a region where the economic growth has required to the power sector capacity expansion rates often troublesome to achieve[1], the main goal of the liberalization and restructuring processes implemented to date has always been to establish a playing field as leveled as possible to attract private and foreign capitals, capable of providing the power sector with the large investment needed to boost its development. Chile pioneered market-oriented reforms of the power system; the

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[1]See Apergis and Payne (2013) for a detailed analysis of this correlation in the South American context.

Electricity Act, dating back to 1982, privatized the sector and introduced market competition in the generation segment, opening the system to new agents and basing the generation remuneration on the hourly marginal-cost resulting from a centralized optimization of the scheduling of generation and transmission resources, based on the generating units audited costs, see Batlle (2013). Other South American countries followed this path and restructured their power sectors a decade later than the Chilean ground-breaking experience (Batlle et al., 2010).

From a theoretical point of view, the cornerstone mechanism to attract the necessary investments was sought in the marginal pricing theory. The key factor behind this design was the original belief that the market marginal price is assumed to be all that is required to "guide" the system expansion toward the optimally adapted generation mix. Nevertheless, from the very start, most regulators in the region complemented the short-term market with some kind of price-based capacity mechanisms: capacity markets and capacity payments. These regulatory schemes aimed at providing generators and investors with an extra remuneration out from the market and were also supposed to partially hedge investors against long-term market price and regulatory risk, ensuring a supposedly fixed and continuous income during the economic life of the power plant.

Despite expectations, these capacity mechanisms were not able to attract the large investments expected to sustain the economic growth and several countries suffered supply problems. The poor performance of these capacity mechanisms was studied by Batlle and Pérez-Arriaga (2008), who identified four main reasons for their malfunctioning:

Setting the remuneration coming from capacity payments at the exactly right level happened to be very difficult, if not impossible (if too small, it fails to attract investments; if too large, it results in the entrance of low-efficiency technologies and overcapacity).

In a context in which fuel supplies are often uncertain (not only in the case of hydro plants, but also sometimes in the case of thermal plants), the firm capacity of each plant, i.e. its actual contribution to the security of supply, was hard to be assessed and properly rewarded.

The constant changes in the regulatory framework (and specifically in the determination of the capacity payments) threatened the stability of the incomes.

The lack of independence of regulators from Governments and political interests affected the reliability of the regulatory framework.

On the other hand, the so-called capacity contracting implemented in some countries, which obliged distribution companies to contract their expected peak capacity demand 2 years in advance, failed to guarantee the system adequacy, because of the lack of a lag period and the too short contract duration employed.

These flaws led to mistrust of potential investors and, consequently, to the lack of new investment. Shortages in electricity supply that occurred all over the region at the end of the 1990s, forced the regulators to a re-thinking of the market design.

In 1999, in an attempt to overcome the lack of generation investments, the Colombian regulator launched a public consultation aimed at redesigning its capacity payment mechanism. In response to a request by ACOLGEN (the generators' association), a team headed by Prof. Pérez-Arriaga developed a novel proposal to tackle the matter, the so-called reliability options mechanism[2], subsequently described in full in Vazquez et al. (2002). The solution entailed replacing the fixed capacity payment with an auction mechanism in which the regulator procures, on behalf of the whole system demand, a contract (a call option subject to penalties for non-compliance) with a sufficiently long lag period (or lead time, to allow new entrants to build the plant) and a long-term contract duration (no less than 7 years, to hedge against regulatory and long-term market price risk).

Brazil, on the other hand, independently developed a conceptually similar approach during years 2002–2003. In the Brazilian case the main proposals were to stimulate competition in the contract market rather than in the short-term market and suggested the organization of a centralized procurement process for the captive demand (regulated customers) based on auctions of energy

[2]What are now termed "reliability options" were called "price risk-hedging contracts" in Pérez-Arriaga (1999).

supply contracts with different lag periods and contract durations. This scheme was formally implemented in March 2004 and Brazil then became the first country in South America to implement a new scheme based on long-term contracts auctioning. The Brazilian experience prompted a new wave of regulatory reforms in the South American power sectors. Chile in 2005 and Peru in 2006 introduced similar mechanisms, with minor or more important variations, but always based on auctions of long-term full-supply electricity contracts. In 2006, Colombia, finally introduced a scheme based on the "reliability options" principle.

These two regulatory waves in South American regulation of the power sector can then be summarized as follows: the first one, from vertical-integrated monopoly to market competition, initiated by the pioneering Chilean reform; the second one, from priced-based capacity mechanisms to long-term electricity auctions, inspired by the Brazilian and the Colombian experiences. Nevertheless, Argentina is following a different approach. The evolution of the Argentinean market reform was dramatically blocked by the 2001 economic crisis. However, an initiative resembling long-term electricity auctions can be found in the Energy Plus Programme, implemented in 2006, which forces large free consumers with contracted capacities above 300 kW to cover their electricity demand exceeding their base demand, i.e. their electric power demand in 2005, in a new term market, the Energy Plus market (SE Resolution 1.281/2006).

3. System-adequacy auctions review

3.1. *Brazil*

Brazil is the largest power system in the region, characterized by a hydro-dominated generation mix that results in a very large long-term volatility in the market price, which, together with regulatory risks, has discouraged in the past new investments (Moreno et al., 2010). In order to solve this structural problem and to correct the initial market reform, a new regulatory framework was introduced in 2004, which has long-term electricity auctions as its backbone. This mechanism is based on three main pillars:

All the demand (captive and free consumers) must be 100% covered through electricity contracts. The task of predicting the future load is left to the demand, represented by distribution companies in the case of the captive one. This is verified monthly by the Market Operator and any positive difference between the actual consumption and the contracted energy is penalized at the "cost of new energy".

All the contracts, which are financial instruments with no impact on the physical dispatch, must be covered by "Firm Energy Certificates", which are issued by the Ministry of Energy and represent the maximum energy that a plant, according to the regulator estimations (see description later), is expected to be able to produce during a dry year. Their calculation method is quite complex and differs for each technology (Hreinsson and Barroso, 2004).

In order to exploit the economies of scale and to guarantee the same tariff to all regulated consumers (Batlle & Pérez-Arriaga, 2008), the long-term contracts covering the captive demand must be assigned through centralized electricity auctions organized by the Regulator. Free customers are not obliged to procure their electricity through auctions, as long as they are 100% covered by contracts.

Separate auctions are organized for new and existing power plants, with different lag periods and contract durations (A1, 1-year lag period, targeting existing plants, and A3 and A5, respectively 3- and 5-year lag periods, targeting new power plants with different construction times). Also contracts differ according to the technology (in A3 and A5 for example, 30-year forward contracts for hydropower plants and 15- to 25-year option contracts for thermal plants and renewable energy facilities are offered).

Distribution companies are required to forecast their future demand and to communicate to the Regulator the quantity of energy they need to procure in each auction. The Regulator is in charge of

summing up all these requirements and of launching a centralized tender. However, despite the centralized approach, the buyers in the auction are still the distribution companies and each selected generator signs a bilateral contract with each distributor taking part to the auction, in proportion to their share of the total contracted energy. A3 and A5 auctions can be technology specific; in this case, at the moment of launching the tender, the Regulator declares from which technologies bids will be accepted. This kind of restrictions had rarely been applied in the past, but has been used in the most recent new energy tenders. Also project-specific auctions have been launched for the construction of very large hydropower projects (Belo Monte plant).

On the top of energy contracted through these system-adequacy auctions, the Regulator can also launch so-called reserve auctions, which aim at increasing the reserve margin of the entire system, in case it is deemed to be insufficient. These tenders are completely centralized: the Regulator establishes the energy to be procured, the technologies that can participate and all the contract provisions (lag period and duration). The cost of the energy procured in this kind of auctions is to be shared among all the consumers. In Brazil, reserve auctions have been used in recent years to foster the installation of renewable energy technologies. Nonetheless, in Brazil wind power projects are bidding at low prices that make them competitive even in standard new energy auctions (in December 2012, 282 MW of wind power were procured in a A5 auction at an average price around 45 USD/MWh, data from CCEE).

3.2. *Chile*

Chile was the first country in the world to liberalize the power sector in 1982, but after a promising start in which new agents slowly entered the generation sector, during the 1990s this pioneering reform showed its limitations in attracting new investments. A new regulatory scheme based on auctions was introduced in 2005, through the so-called Short Law I and II. The target of the reform is only the captive demand (regulated customers), which is required to cover 100% of its consumption needs through long-term contracts to be procured by auctions. However the auctions follow a decentralized approach, i.e. each distribution company is supposed to launch the tender on its own (even if joint auctions from a group of distributors are allowed), and the Regulator only sets a price cap for each auction and ranges for the lag period (commonly larger than 3 years) and the contract duration (usually lower than 15 years).

The distinctive feature of the Chilean tenders is the combinatorial auction format, in which several different products (e.g. uniform or profiled blocks of energy with different time ranges) are auctioned at the same time. In order to increase competition, generators are allowed to bid above their actual capacity, in order to cover several products, but they have to declare their maximum capability. The final objectives of the auction are cost minimization and demand coverage maximization. This is achieved through a heuristic procedure, which calculates the non-restricted prices, then considers maximum capabilities declared by generators and calculates several restricted prices for different scenarios, and finally identifies the scenario which minimizes deviations between non-restricted and restricted prices.

Existing generation units and new power projects compete in Chile in the same auctions. Theoretically the contracts are not supposed to be covered by any availability certificate; nonetheless, generators have to specify to the Regulator, on a yearly basis, which plants, existing or projected, will be used to cover the contracted demand. It is important to note how in the Chilean case, as in the Peruvian one, capacity payments have not been cancelled with the introduction of auctions. In fact, the long-term contracts still consider two terms: one related to energy, whose price is set competitively through the auction, and one remunerating the available capacity, whose price is set by the Regulator.

3.3. *Colombia*

The Colombian power sector is characterized by hydropower predominance (around 70% of the energy produced in 2010, according to data from EIA) and it faces similar price volatility issues than

Brazil. The capacity payment considered by the original market reform did not succeed in ensuring system adequacy, due to the difficulties in correctly determining its value, and in 2006 an innovative approach was implemented, whose conceptual basis was to "auction" the capacity payment. In fact, the product auctioned is a "reliability charge", i.e. the annual fee of an option contract. By signing this contract, the generator commits to provide electricity at a strike price when the spot market price exceeds this strike price, therefore limiting future but very volatile incomes from the short-term market in exchange for predetermined payment from the auction. This option contract mechanism also allows to identify scarcity conditions as the days when the strike price is exceeded. During scarcity conditions, selected bidders are required to generate energy; therefore the financial contract must be backed by physical resources.

The auction is completely centralized and the Regulator procures "firm energy obligations" (OEF, *obligaciones de energía firme*, in Spanish) on behalf of the whole system demand (captive and free). A tender is launched whenever the Regulator deems that the future reserve margin must be increased. The demand for reliability is not considered as completely inelastic and a peculiarity of the Colombian mechanism is the negative-sloped demand curve used to clear the auction, which is drawn around the so-called cost of new entrant. However, this curve is centrally defined by the Regulator and there is no possibility for the demand (either captive or free) to opt out from the mechanism. It must be also underlined that, contrary to other South American mechanisms, in Colombia the reliability product is only an option that can be called "by the system" during scarcity conditions, not a full energy-supply contract. Therefore, distribution companies and free consumers are supposed to cover their electricity demand independently from the auction, either through long-term contracts or in the spot market.

Existing and new plants compete together in the same auction, but they are discriminated through different contract durations (1 year for existing and up to 20 years for new plants) and separated price caps. However, since the 4.5-year lag period of the first auction does not usually allow large hydropower projects to participate, a second auction (called GPPS) is organized for those projects with larger construction time, with lag periods up to 10 years. Two reliability charge auction processes (2008 and 2011) have been carried out until now.

3.4. *Peru*

Electricity auctions were introduced in Peru in 2006, through Law no. 28.832, as a response to a critical situation generated by the fact that the energy tariffs of regulated customers, calculated by the Regulator, were not reflecting the growth of the short-term marginal costs of the system. The new approach aims at fixing such energy tariffs in a competitive way, through the introduction of auctions, with the goal of complementing the original capacity payment, which had proved to be ineffective in attracting new investments, as no generation was entering the system.

The reform introduced the obligation for distribution companies to cover through auctions 90% of their demand 3 years in advance, signing contracts that must have durations larger than 5 years for 75% of the demand. As in Chile, the auction fixes the price at which the energy will be remunerated, while the capacity payment, still calculated by the Regulator, enters the energy contract through the calculation of the associated capacity. The approach is completely decentralized (distributors launch tenders on their own), but a strong control on the auctions is applied by the Regulator, who fixes indexation formulas and price caps for each tender. The price cap is discovered in case the bids are not able to cover the entire demand and a new auction, with a different price cap, is launched.

The main objective of this reform in the Peruvian sector was to foster investment in large hydropower plants, in order to exploit the large share of the hydro potential still untapped in the country. This goal was explicitly introduced in the auctioning mechanism starting from 2010, when it was established that bids from new hydropower projects must be ranked considering a 15% discount factor, not affecting the final remuneration. Nonetheless, due to the decentralization of the tenders and to the short lag periods and contract durations, these auctions proved not to be suitable

to foster the installation of new large generation plants. For this reason, the Government launched a second type of auctions, under the framework of the *Proinversión* Programme, which target exclusively the construction of new large hydropower and thermal plants and consider contract durations larger than 10 years. These tenders are project specific and the lag period is tailored to the project. They are completely centralized and the Regulator establishes the amount to be contracted.

3.5. *Argentina: a different approach*

Argentina liberalized its power sector in 1992, but the development and evolution of the reform were dramatically affected by the 2001 economic crisis. Consequently, Argentina did not follow other South American countries in the second wave of regulatory reforms and did not introduce a proper system-adequacy auction mechanism. The regulatory measures undertaken by Argentinean Governments to guarantee the security of supply (e.g. the creation of ENARSA, a state-owned company with functions also in the power sector, and the FONINVEMEM Programme, for the construction of CCGT plants budgeted through the State debt to electric companies) have been criticized by some authors as a violation of market principles (Haselip and Potter, 2010).

The only initiative resembling long-term electricity auctions is the Energy Plus Programme, implemented in 2006. The underlying principle of this "hidden" reform of the Argentinean power system is that the electricity traded in the spot market (i.e. that coming from existing plants) must be used during scarcity conditions to cover the demand of regulated customers, while large and free users are supposed to secure their electricity supply independently. Practically, the resolution obliges all those consumers with contracted capacities above 300 kW to cover their electricity demand exceeding their base demand, i.e. their electric power demand in 2005, in a new term market, the Energy Plus market. The counterparts in the Energy Plus Market are new-generation plants. Those Energy Plus consumers who were not able to sign any contract to back their baseline demand increase can request the Secretary of Energy to organize an auction to cover their power requirements. However, to date, there is no information regarding any auction carried out under this scheme.

4. Overall comparison

Table 1 provides a summary and an overall comparison of the main design elements used in the auction mechanisms implemented in South America[3]. The heterogeneity of the design elements observable in the table gives an idea on the wide range of different auction designs that can be used to achieve the same objective, i.e. the system adequacy. However, it is not possible to identify an optimal auction design and to rank the different mechanisms according to their design elements, because, apart from few general best practices that can be true regardless of the context, auctions must be tailored to the electricity system and regulation of the country where they are implemented.

5. Conclusions

Long-term electricity auctions are nowadays the key regulatory tool used in South America to attract the large investments in new capacity required by the fast-paced growth in demand, thus ensuring the system adequacy. Introduced in several countries of the region in the last decade, they are assuming a large and increasing importance in the power sector regulatory framework. However these instruments must be designed carefully, taking into account the regulatory intervention in the market that they represent and tailoring them to the regulatory objectives of each system where they are implemented. This is not only true for South America, where significant experience on long-term auctioning has been developed in recent years, but also for other contexts where these mechanisms can be introduced, above all the European Union, where capacity remuneration mechanisms are at the center of the regulatory debate (ACER, 2013).

[3]The Argentinean Energy Plus auctions have not been included in this summary, because of the lack of executed tenders to date.

Table 1. Comparison of the design elements of long-term electricity auctions in the four South American countries implementing them.

	Brazil A1	Brazil A3	Brazil A5	Chile	Colombia OEF	Colombia GPPS	Peru Law 28.832	Peru Proinversión
Buying side	Captive demand			Captive demand	All system demand		Captive demand	
Selling side	Existing plants	New plants	New plants	Existing and new plants	Existing and new plants	New plants	Existing and new plants	New hydro plants
Auction process	Centralized			Decentralized	Centralized		Decentralized	Centralized
Demand forecasting	Decentralized			Decentralized	Centralized		Decentralized	Centralized
Lag period	1 year	3 years	5 years	> 3 years	4 years	> 4 years	> 3 years (90%)	> 3 years
Contract duration	3 to 8 years	15 years (thermal) and 30 years (hydro)		< 15 years	< 20 years	< 20 years	> 5 years (75%)	> 10 years
Contract type	Forward (hydro) and option (thermal)			Forward	Option		Forward	

This paper reviews the long-term auctions introduced in five South American countries through the identification and comparison of the key elements that compose each scheme, an exercise that allows to highlight the current heterogeneity in their design and to outline a comprehensive classification of these mechanisms. Several distinctions can be made from this taxonomy. The most relevant probably regards the level of centralization. On the one side Brazil and Colombia opted for a centralized approach, in which all the demand to be auctioned is joined together in the same tender and the process is under direct control of the Regulator. On the other side, Chile and Peru implemented a more decentralized mechanism, based on obligations for distribution companies to contract their demand in advance through long-term electricity auctions. This distinction results also in diverse lag periods and contract durations, which are generally lower in decentralized approaches. Another differentiation of these mechanisms can be made according to the separation of existing and new plants in the auction. Taking into account this element, Brazil opted for a clear division, through the call of different auctions for existing (A1 and adjustment auctions) and new plants (A3, A5 and reserve auctions). On the other hand, Chile let existing and new plants compete in the same auction. Finally, in Colombia and in Peru existing and new plants compete in the same tender mechanism, but a parallel mechanism can be used for the contracting of new power projects (GPPS auction in Colombia and Proinversión auction in Peru).

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