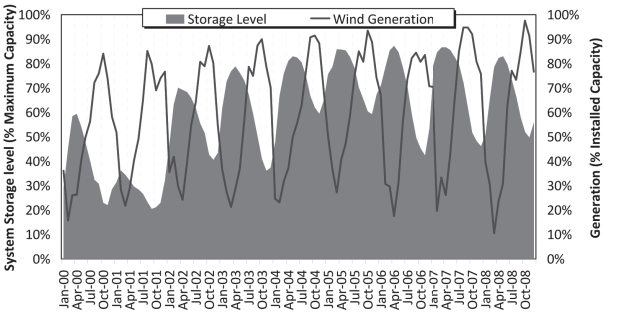
Fostering Wind Power Through Auctions: the Brazilian Experience

By G. Cunha, L. A. Barroso, F. Porrua and B. Bezerra*

Introduction

The development of energy generation in Brazil has historically been focused on hydroelectricity. Over 70% of the country's 120 GW of generation capacity comes from hydro sources, making Brazil's energy mix one of the cleanest in the world. More recently, due to environmental concerns regarding the development of large hydro projects in the Amazon rainforest region, the country has turned its attention to non-conventional renewable energy sources (NCRES).

After small hydro and bioelectricity plants (cogeneration from sugarcane bagasse), wind power has been the third NCRES to be developed at scale in Brazil. Not only are wind resources in the country very abundant, estimated at 300 to 400 GW of installed capacity, wind power presents several characteristics that give it positive synergies with the Brazilian hydro-based electricity mix. Wind power's production intermittency, which represents one of the main obstacles to the widespread development of this technology, are partially offset by the presence of significant storage capacity in the form of large hydro reservoirs, which can provide an operation flexibility that facilitates their technical and economic integration. Furthermore, since a large percentage of wind generation potential tends to peak in the dry season, combining wind and hydro sources contributes to increasing the system's supply reliability (see adjacent figure).



In addition, wind farms can be quickly built (less than two years, as opposed to large hydros which take about 5 years), which is a valuable attribute to hedge against the country's load growth uncertainty and against delays of environmental licensing of large hydros. Finally, the renewable energy sources in Brazil complement each other geographically, which is good for minimizing energy transport costs: wind resources are concentrated in the South and Northeast, while most of the untapped large hydro potential is located in the North region, and the Southeast region has significant bioelectricity potential from by-products of sugarcane culture.

Brazil has had different mechanisms to support the penetration of NCRES. The first major initiative in this sense was the Proinfa, an incentive program instituted in 2002 to contract a total 3,300 MW of new capacity, split evenly between bioelectricity, small hydro, and wind sources. Proinfa followed a "traditional" subsidy model, establishing a fixed feed-in tariff (different for each technology) for the electricity produced over the first 20 years of operation. The cost of these contracts is collected from all consumers through a levy.

Even though Proinfa's role as a pioneer program was very important, attracting the attention of manufacturers and investors to the Brazilian market, it was heavily criticized for its design choices. Some oft-cited problems were the even split among the three renewable energy sources, without taking into account particularities of the technologies, and the use of the issuance date of the environmental permit as the main criterion for deciding which projects would be built, without any incentive to energy or construction efficiency. In addition, a large proportion of nationally-manufactured equipment was required in order to obtain the best financing options available, which in the case of wind put the investors at the mercy of the only wind turbine producer in the country at the time. This resulted in significant delays in the construction of the authorized wind farms: even though in the original plan investors were supposed to sign up until 2004 and start operations until 2006, several projects did not come online until the end of 2011.

Even though another important incentive for NCRES was granted in 2007, in the form of discounts on transmission/distribution tariffs for sales to free consumers, the most important initiative by far was the auction-based approach for contracting wind power. This experience is described next.

Overview of Energy Auctions in Brazil

In parallel to the implementation of Proinfa, Brazil had been reorganizing its power sector, after a major regulation revision in 2004. The new model implemented an organized market that auctions "firm energy" contracts to acquire

* G. Cunha, L. A. Barroso, F. Porrua and B. Bezerra are with the PSR in Rio de Janeiro, Brazil. Luiz Barroso may be reached at luiz@psr-inc.com

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new energy. The contract auction system has been very effective in promoting the development of new generation, offering long-term contracts (that ease project financing), fostering competition, and providing a transparent and objective selection criterion. Since 2005, these auctions have resulted in the contracting of 31 GW of new capacity (40% of which is conventional hydro, and 20% non-conventional renewable), awarding US$ 300 billion in long-term contracts.

Every energy auction is organized by the government. An auction committee is formed and the main auction tasks are distributed among different institutions (Ministry of energy, market operator, planning company, regulator). This committee defines the auction mechanism, suggest price caps, defines the auction product, prepares the tender documents and coordinates with transmission planning.

There is a long-list of technical pre-requisites to register a candidate project for the auction, including a prior environmental license, a grid access statement, financial qualifications, technology-dependent documents (such as certified wind production or firm fuel supply agreement), etc.

The auction mechanism follows a two-phase hybrid scheme: in Phase 1, a descending price clock auction is executed, and a final pay-as-bid round for the winners of Phase 1 is then carried out (Phase 2). An auction training takes place in advance, and the auction process is quite well documented, with plenty of information to bidders. Winning projects have to deposit several guarantees, including a bid bond of 1% of project's estimated investment cost and a project completion bond of 5% of project's estimated investment cost. Several penalties are applicable in case of delays: during the period in which the plant is delayed, contract price is reduced, replacement firm energy contracts may be required depending on the auction type, and the regulator has the right to ask for contract termination if a delay higher than 1 year in any of the project milestones is observed.

The new power sector model foresaw two main types of energy auction: *regular* new energy auctions, which contract an amount declared by the distribution companies in order to meet demand growth in the regulated market, and *reserve* energy auctions, which are used to contract supplementary energy to increase the system's reserve margin. Demand for reserve energy is entirely determined by the government following its own criteria of security of supply and energy policy, and the costs of these contracts are split among all consumers by means of a system charge. While the energy contracted in regular energy auctions is essential to meet demand, and therefore must be backed up by a certain amount of firm generation (with a firm energy settlement), reserve energy contracts do not provide firm energy to the system and therefore may have much more flexible terms.

Auctions for Fostering NCRES

In both auction types (regular or reserve), the government can interfere in the candidate projects with policy decisions. The government has used this option to organize exclusive auctions for specific large hydro projects, to keep "polluting" sources such as oil- and coal-fired generation from participating in auctions (a standing practice since 2010), and to foster NCRES by means of exclusive auctions: in 2007, there was one auction where the candidate supply was restricted to bioelectricity and small hydro projects.

Particularly, the reserve energy auction model has been strongly oriented towards NCRES development since the beginning: it was first implemented in 2008 in an exclusive auction for bioelectricity projects. This 2008 auction was responsible for the development of a method to facilitate network integration for small renewable facilities, based on the cooperative planning of an integrated transmission and distribution network and sharing collector substations – an important milestone for NCRES.

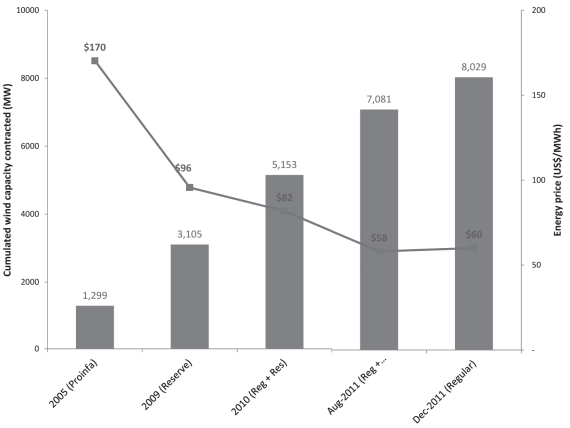
Wind power, at significantly higher costs than other technologies, was excluded from the 2007 auction for NCRES, and for several years it remained without significant incentives to its development other than the Proinfa. Its turn finally came in December 2009, when an exclusive reserve auction for wind farms took place. The 2008 economic crisis had strongly reduced demand for wind equipment in Europe and increased competition among suppliers, resulting in large price drops – which made 2009 the ideal moment to start the development of this technology in the country in large scale. This exclusive energy auction attracted a large number of investors, including local and foreign private generators, wind equipment manufacturers and government-owned companies – a total 13,000 MW in wind power projects subscribed to participate in the auction. The 20-year contracts offered for delivery in July 2012 were specifically catered to the peculiarities of wind power generation: in particular, specific accounting mechanisms allowed the wind farms to compensate in the long run for seasonal and inter-annual wind fluctuations, without compromising the project's yearly cashflow.

The results of this first auction were no less than outstanding: a total 1,800 MW of new wind capacity was contracted at an average energy price of 95 US$/MWh, representing a 21% discount relative to the

government's initial asking price, and a 44% discount from Proinfa prices. These large discounts can be attributed in no small part to the lowered investment costs due to the 2008 crisis, but also to the competitive environment of the auctions and aggressive behavior of investors, as well as significant improvements observed in capacity factors, which averaged an impressive 44% for the winning projects – among the best in the world.

The excellent results obtained in the 2009 auction surpassed most expectations, and showed that wind power was very close to being competitive with other renewable energy sources. This accelerated dramatically the process of insertion of wind power technology in the Brazilian energy mix: in 2010, wind power was allowed to compete on equal grounds with small hydro and bioelectricity projects in two energy auctions for energy delivery in 2013 (one regular, for firm energy; and one reserve). The contract offered in the new energy auction, like the one formulated in 2009 for reserve wind power contracting, presented robust hedge mechanisms and accounting processes in order to shield the investor against wind generation variance. Wind power outclassed its competitors in both auctions, being responsible for nearly 80% of all energy contracted and reaching average prices of 80 US$/MWh (regular auction) and 73 US$/MWh (reserve auction). A total of 1,500 MW of wind capacity was contracted under regular contracts, and 500 MW under reserve contracts.

In August 2011, once again two energy auctions (one regular and one reserve) for delivery in 2014 were organized, allowing for the participation of wind power. However, while the reserve energy auction remained exclusive for non-conventional renewable sources, in the new energy auction wind power was allowed to compete directly with natural gas-fired thermal plants. In yet another important landmark for the full development of the technology, wind power was able to successfully compete with these thermal plants: the average wind energy price in these auctions was 60 US$/MWh, lower than the average natural gas energy price (62 US$/MWh). An energy mix including 1,000 MW of wind capacity was contracted in this auction; while in the reserve energy auction an additional 860 MW of wind capacity was acquired. Remarkably, competitiveness of wind power in Brazil was achieved in only two years without taking into account positive externalities relative to carbon emissions: wind and gas projects competed in the 2011 auction using a purely economic criterion (the lowest $/MWh offered defined the winner).



A final regular new energy auction took place in December 2011, to contract energy for delivery starting in 2016. Despite the longer construction times, final prices were quite similar to the ones obtained in the August auctions. The evolution of the contracting of wind power throughout Proinfa and all auctions carried out in Brazil is summarized in the adjacent figure. Remarkably, the energy auctions from 2009 to 2011 will increase wind capacity in the country eight-fold.

Future Challenges

Despite the undeniable success achieved in terms of prices and competitiveness of wind power in the last few energy auctions, because this development happened so quickly, in practice wind technology remains largely untested in Brazil. Projects sold in the auctions have offered very high capacity factors and whether the plants will perform adequately remains to be seen (the first wind projects from auctions are scheduled to start operations in July 2012). Because the wind production records are very short, there is a concern that "aggressive certification" is responsible for the unusually high load factor estimates. The government currently has very high expectations about wind and an underperformance in 2013 may lead to disappointment and possible regulatory "backlash", with the introduction of heavy-handed penalties (a situation that has happened before with small hydros).

An additional challenge that must yet be overcome are unexpected delays. Even though a three-year construction period is granted between the auction date and the energy delivery date, which should be more than enough for wind power, monthly reports from the energy authority indicate that several projects are suffering from various problems that may result in delays (out of 70 wind farms auctioned in 2009, 52 are behind their schedules). In the past, delays had also plagued the Proinfa wind farms, although this could be partly explained by the immaturity of the regulatory processes. Currently, problems faced by wind farms are in one of the following categories:

- Environmental permits**:** the Brazilian environment ministry implements a complex three-phase

system for granting environmental permits. Although the first phase is completed before the energy auction, the following phases often take more than expected due to incomplete environmental studies and a lack of personnel from the environmental agency. Measures have been taken to simplify and better streamline this process, although gains so far have been small;

- Transmission delays: after the energy auction, the energy authority coordinates which transmission lines are to be built and whether some with projects will share collector substations, and organizes a transmission auction to build these lines at minimum cost. Since the time for obtaining environmental permits and constructing this system is even shorter, and since a generation project can't operate before the transmission lines are complete, this represents a significant risk (though a risk that is burdened by the consumer, not the generator);
- Financial leverage: many projects have offered in the auctions a load factor associated to the p50 of their certified production and based their prices on a 70% leverage. As banks usually define the leverage based on a financial evaluation considering the p90, the leverage is actually reduced to about 55%, which affects the project economics and profitability.
- Financing restrictions: in the specific case of the 2010 regular energy auctions, most of the energy sold was bought by a state-owned distribution company that was deemed uncreditworthy by most important banks. This reduced significantly the financial guarantees the wind projects could present to potential lenders, which proved a major obstacle. This problem should be addressed in the future with the privatization of said distribution company.

Conclusions

Long-term auctions are the main tool to promote NCRES in Brazil. Auctions appear as an effective mechanism to stimulate competition between investors, to provide price disclosure while managing the right amount of investment and reducing risk aversion with long-term contracting. The product offered will depend on the auction's main objective and is key to the auction's success (risk allocation is everything). Auctions do not operate in a vacuum: they must be an integral part of a country's overall energy and procurement policies. On the other hand, its main challenges include the definition of criteria to select the quotas for each NCRES, the design of a relevant set of guarantees (financial, technical and operational) and the attraction of competition, which is the ultimate condition for the success of an auction. Efforts were devoted in Brazil to meet these requirements and the overall experience so far is quite successful. In case of wind, the country's abundant wind resources and the positive reception from both investors in the auctions and the general public all point in this direction. A total 7,670 MW of wind capacity is expected to be developed by 2014, and five wind turbine manufacturers are currently installed in the country. Nonetheless, it is important to solve the issues discussed in the paper before they become major concerns. The proof of the pudding will be in some years' time, when the winning projects will have to start delivering energy.

Footnote

[1] Estimated potential at 100m, extrapolated from a detailed study from 2001, which calculated wind potential at 50m to be 143 GW.

References

L. T. Maurer, L. A. Barroso , "Electricity Auctions: An Overview of Efficient Practices", Worldbank, 2011 (available at www.psr-inc.com).

C. Batlle, L. A. Barroso, "Review Of Support Schemes For Renewable Energy Sources In South America" MIT-CEEPR Working Paper 11-001. IAEE Energy Forum. Third Quarter 2011, pp. 27-31

L. A. Barroso, H. Rudnick, F. Seinsuss and P. Linares, "Economic and market impacts of renewable integration in Europe and Latin America" — IEEE Power & Energy Magazine, Vol.7, Issue 4 , September-October 2010, Page(s): 28 – 36

H. Rudnick, L. Barroso, D. Llarens, D. Watts, R. Ferreira, "Transmission challenges in the integration of renewables in south America" – IEEE Power & Energy Magazine, Vol.8 ,March 2012

F. Porrua ; B. Bezerra; L. A. Barroso; P. Lino; F. Ralston; M. V. Pereira,"Wind Power Insertion through Energy Auctions in Brazil" IEEE General Meeting, 25-29 July 2010, Minneapolis, Minnesota, US

G. Elizondo, L. A. Barroso, "Design and Performance of Policy Instruments to Promote the Development of Renewable Energy: Emerging Experience in Selected Developing Countries", Energy and mining sector board discussion paper No 22, April 2011.