



THE BOTTOM LINE

The Brazilian experience with wind energy auctions illustrates that even carefully designed policies often must be reconsidered in the light of a complex and changing environment. Many considerations need to be taken into account to ensure competitive prices while also delivering the required renewable energy supply.

Promoting Renewable Energy through Auctions: The Case of Brazil

Why is this case interesting?

Brazil's initial success with developing wind capacity had unforeseen consequences

Electricity auctions are at the core of the regulatory framework that Brazil adopted after reforming its electricity market in 2004 (Maurer and Barroso 2011). Since then, periodic energy auctions have made possible the construction of 58 GW of new generation capacity (46 percent hydropower and 29 percent from other renewable sources), through about \$350 billion in long-term contracts.¹ This extensive experience allows a quantitative data-based assessment of the strengths and weaknesses of the country's auction scheme and its application to renewable energy development.

Wind power development is especially interesting because it has progressed in two very distinct stages, both using auctions (Cunha, Barroso, and Bezerra 2014; Cunha and others 2012).

The first stage was marked by a strong will to promote the development of nonconventional renewable sources of energy. Even though Brazil has historically relied on the continuous development of large hydropower generation—hydropower represented 70 percent of the country's total installed capacity of 120 GW at the end of 2012—large amounts of small hydro, wind, and biomass potential remained untapped. The main challenge of this first stage was to create conditions that would allow those sources not only

to emerge in the energy mix, but possibly to become competitive with conventional sources. Contracts were specifically designed to accommodate the characteristics of individual technologies, aiming to attract more investors by offering an attractive product that would shield them from several unmanageable risks—such as inflation and the uncertainty of variable generation.

The results of the first stage were wildly successful: The renewable auctions were very competitive, drawing large investments from both the public and private sectors,² and allowing consumers to benefit from cleaner energy at lower prices.

However, the success of the wind auctions brought other challenges. Critics complained that the terms offered in contracts were too generous for investors and that, as a result, generators had an incentive to bid aggressively and to make unrealistic promises about their plants' likely performance. Note that regular energy auctions in Brazil have the express objective of ensuring adequate system expansion. While this is an important concern in any country where demand for electricity is growing rapidly (over the past decade, Brazil's demand has grown by 4.3 percent per year, on average), in Brazil there is also the need to maintain an optimal management of hydropower reserves: If the system is undersupplied (that is, if there is not enough firm generation capacity to meet demand), reservoirs will deplete faster, which could increase the risk of energy shortages. Therefore, when the first stage of wind farm development through

¹ All amounts in this document have been updated according to Brazilian inflation indexes (either IPCA or IGP-M, depending on the indexing terms of each power purchase agreement) and converted to U.S. dollars at a rate of 2.2 Brazilian *real* to the dollar.

² The government's role in the auctions was felt through the direct participation of state-owned utilities as well as the indirect participation of the Brazilian development bank, which offered attractive loans to investors.



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auctions progressed to the point where wind-based capacity began to constitute a significant fraction of system expansion, security of supply became a concern.

These concerns defined the second stage of wind power development in Brazil, which is the main topic of this note. The Brazilian government began to tackle some of these issues in 2013, revising some aspects of the auction design introduced in 2009 and seeking an optimal allocation of risk in the contracts offered to wind producers.

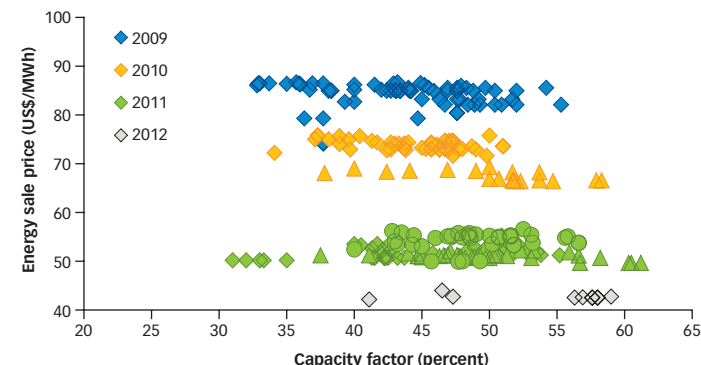
What challenge did Brazil face?

For system planning purposes, the performance of auctioned wind projects needed to become more reliable

Challenges introduced in the first stage of wind power development had to be solved in the second. The chief challenges were (i) the Brazilian system had to be able to balance supply and demand more accurately; (ii) investors were overoptimistic about the amount of electricity they would be able to generate; and (iii) the government’s arrangements for coordinating the planning of generation and transmission left too little room for error.

The Brazilian system needed a more accurate assessment of its supply-demand balance. Typically, the country’s security of supply is ensured through the purchase of firm energy certificates (FECs) by all consumers. (Utilities are responsible for procuring FECs on behalf of regulated consumers). The government issues FECs to generators in accordance with their capability to generate reliable energy. As wind power comes to constitute a larger and larger share of Brazil’s generation system, the technology inevitably takes on a greater role in the security of supply. However, the current method of calculating FECs for wind plants is very simplistic and does not take into account how the wind power injections interact and synchronize with the system as a whole. Because this mechanism does not represent the true expected contribution of wind plants when integrated with a large hydro system, the task of determining the system’s new capacity needs becomes much harder.

Figure 1. Capacity factors declared by winners of energy auctions, 2009–12



Source: Authors.

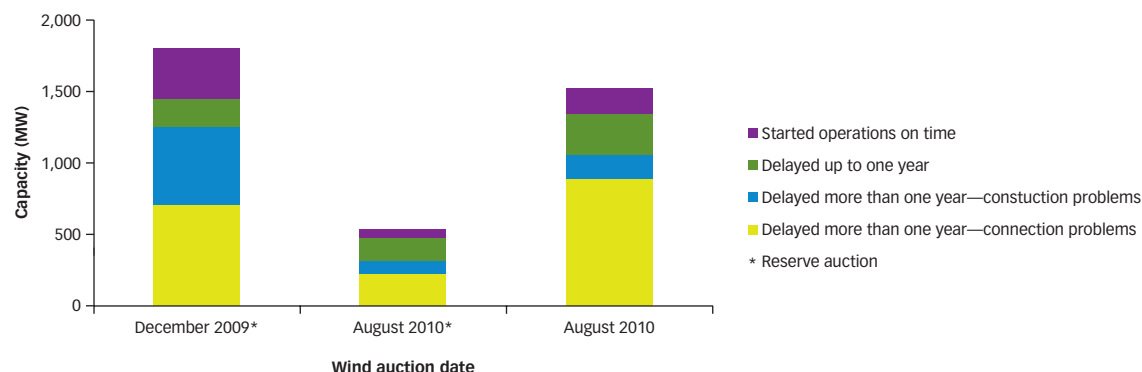
Note: Multiple auctions in the same year are represented by different icons of the same color.

Investors were very aggressive in the certification of their wind generation capabilities. The contract designed for wind producers offered attractive settlement rules that were aimed at protecting generators against unforeseeable wind fluctuations. Even if yearly average generation deviated from the amount promised in the auction, generators suffered only mild penalties, and the full settlement of differences was carried out only once every four years. These rules may have encouraged aggressive certification of wind production on the part of investors. Indeed, as illustrated in figure 1, average capacity factors declared by wind investors in the auctions rose from an average of 44 percent in 2009 to more than 50 percent in 2012—both figures being much higher than most wind production sites in the world. Systematic overestimation of the performance of wind plants threatened to further upset the system’s supply-demand balance.

The government’s scheme to coordinate generation and transmission planning faced difficulties. Another benefit offered to the participants in early energy auctions was that the government was poised to assume responsibility for organizing the reinforcements and expansions to the grid that were needed to accommodate the new generation contracted through auction (Rudnick

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Figure 2. Status of projects auctioned in the first three Brazilian wind auctions, as of December 2013



Source: Authors.

and others 2012). While very attractive on paper, this practice put transmission on a very tight schedule that left very little margin for error. The end result, illustrated in figure 2, was that more than half of the wind plants contracted in the first three Brazilian wind auctions have suffered severe delays (greater than a year) owing specifically to problems in the construction of the transmission lines and substations needed to connect them to the grid. Under the contract terms, consumers must pay for energy that is not actually being delivered, resulting in cost overruns.

Most of these problems can be traced to difficulties with environmental licensing and to management problems incurred by the winners of the transmission auction. These weaknesses are not necessarily intrinsic to the proposed scheme of co-planned generation and transmission, but countries considering a similar policy should keep in mind the possibility that this obstacle may be encountered.

On the other hand, the first stage of Brazilian wind power development had brought benefits to the country, and retracting some of what was offered in the original wind generation contracts might have done more harm than good (by possibly halting the wind development program).

Among the positive effects of the stage-one auctions were (i) undeniable economic development of several sectors; (ii) a lowering of the price of new generation, which has been passed through to consumers in the form of lower tariffs; and (iii) an increase in capacity factors for wind power.³

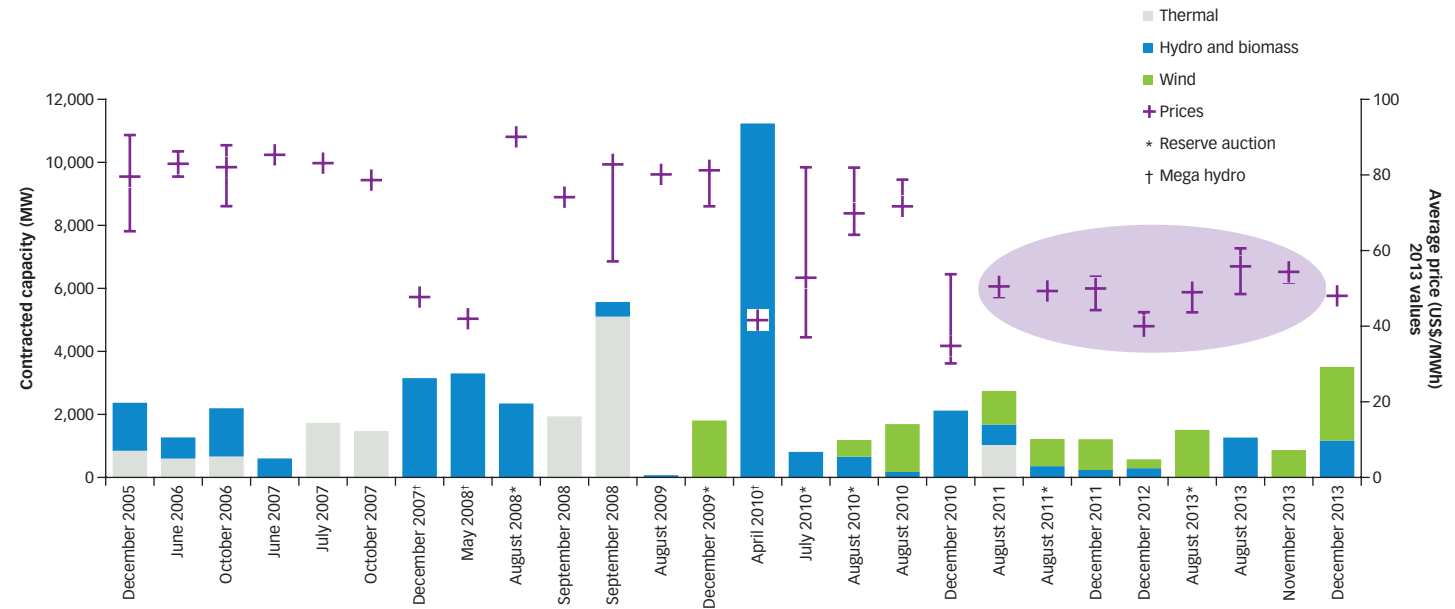
Wind-power auctions contributed to the development of various economic sectors. With periodic auctions providing a steady stream of newly contracted

wind power projects, the wind equipment industry in Brazil flourished. Several manufacturers of wind turbine components set up factories in the country, which in turn helped reduce wind power investment costs. The development of wind power also has brought economic development to historically poor regions in the Brazilian Northeast.

Wind power has driven down the price of new generation as a whole. Since the 2004 power market reform, auction prices for contracts to develop new capacity (conventional thermal and renewable) have trended downward (figure 3). Between 2005 and 2009 auction prices were fairly stable at around \$80/MWh (except in three mega-hydro auctions), but after 2011 prices settled on a lower value of about \$50/MWh. Because these price reductions coincided with the advent of wind power as a competitive generation source, it is reasonable to conclude that the development of the wind power industry in Brazil helped increase competition in *conventional* energy auctions, driving down investors' profits and allowing consumers to capture the benefits of the resulting lower prices.

Auctions have helped raise the average capacity factors of wind power plants. As noted above, the government had been

³ Although the lower tariffs were not large enough to be felt by consumers, the Brazilian tariff structure does ensure that the gains are reflected in the consumer tariff.

Figure 3. Auctions of rights to develop new power capacity (conventional and renewable) in Brazil, 2005–13

Source: Authors.

concerned that the capacity factors of auctioned plants may have been overstated. The short track record of wind farms, coupled with climate variability, makes this issue difficult to assess. However, a comparison of the capacity factors achieved by plants operated under a feed-in tariff policy introduced in 2002 under the Program of Incentives for Alternative Sources (Proinfa) and the auctioned plants reveals that, on average, the auctioned plants outperformed the Proinfa plants by four percentage points in 2012 (38 percent vs. 34 percent capacity factor; figure 4). While this result is not conclusive and may be subject to sampling variance, it suggests that the competitive auction mechanism did indeed motivate the development of better wind sites, even if the capacity factors calculated by the investors were indeed overestimated.

How were the problems of stage one addressed?

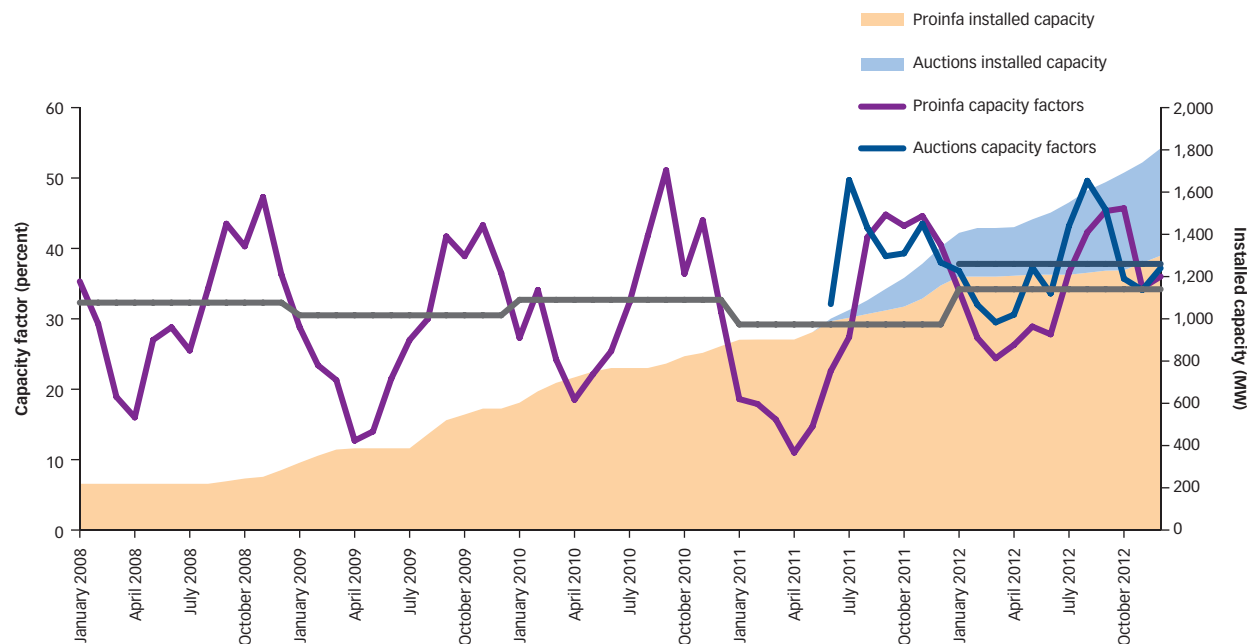
The benefits offered to the auctioned plants were reduced, as was government involvement in planning and coordinating transmission expansion

To address the issues identified in the second stage of wind development in Brazil, policy makers pragmatically proposed two significant changes to the auction scheme. The changes began to take effect with the three wind energy auctions carried out in 2013.

The fraction of certified wind production that can be sold at auction was reduced. Originally, wind farms could sell at auction an amount of electricity equal to their mean certified wind production (close to the 50th percentile, or “P50”), calculated by an independent company based on historical wind measurements.

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Figure 4. Installed capacity and capacity factor of wind generation in Brazil, 2008–12



Source: Authors.

(The FEC issued to a given wind farm was also equal to this mean certification when applicable.) Starting in 2013, however, wind farms could offer at auction not the mean but a lesser amount of their certified wind generation—namely, an amount known as P90 (90th percentile), which, according to the independent certifying company, is expected to be lower than future annual generation in 9 out of 10 years. Under this new policy, a lower amount of firm energy would be associated with new wind farms (all else being equal), leading to a slight overcontracting of new capacity that should help to avoid the potential issues of undersupply.

The government would no longer coordinate expansion of generation and transmission. In the August 2013 auction, the government organized preliminary subauctions for each collector substation in the basic grid in order to ensure that no unplanned transmission infrastructure would be needed to accommodate the winning projects. At some substations, this constraint had eliminated some competitive projects that could have been contracted based on price alone. In the other two auctions (regular energy auctions in November and December 2013), the government declared simply that it was the investors' responsibility to ensure that the connection to the grid became operational at the same time as the generation

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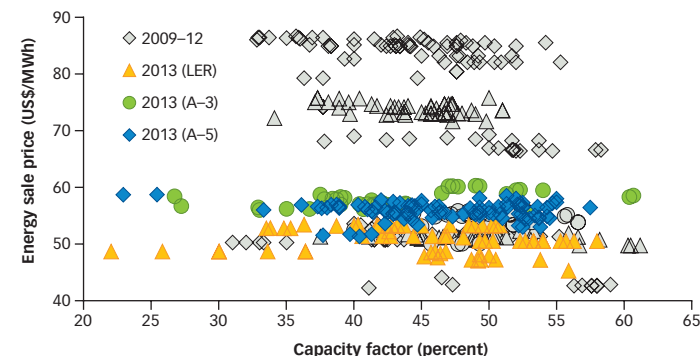
facility. The practical limitations of centralized coordination of planning for the expansion of generation and transmission proved to be too great, as shown after the first Brazilian wind auctions. The new paradigm is expected to be the norm going forward.

Periodic revisions and successive adjustments are necessary to ensure both competitive prices and effective supply. Despite the government's efforts, it is not likely that these changes will completely solve the issues that have been identified. One concern is that investors still seem to be promising more than they can deliver. Another is that the government's policy for setting auction price ceilings needs to be revised.

Certification based on the P90 does not seem to have altered investors' incentives to overpromise. Under the current scheme, generators' contract revenues will tend to be higher in the first few years if the certified generation is overestimated, despite the fact that this effect would be nullified in the long run as the plant's true mean annual generation became known. This aspect of the original design has not been meaningfully modified. A small additional penalty has been introduced, but its effect is expected to be minor (Cunha, Barroso, and Bezerra 2014). Even though it is now more difficult for generators to overstate their certified annual generation (because of the more conservative P90 approach), the incentives for generators to do so remain in place, with the result that estimates of capacity factors are likely to remain unreasonably high. Indeed, as seen in figure 5 (compare to figure 1), declared capacity factors in 2013 (based on the P90) are close to 47 percent on average—a very optimistic figure.

The government's policy for auction ceiling prices is in need of revision. The Brazilian auction mechanism involves a two-phase hybrid scheme, so that the auction price ceiling is the opening price of the descending-clock auction in the first phase. (For more information on auction design mechanisms, see Maurer and Barroso 2011.) Despite the changes introduced in the 2013 auctions, which could in principle justify higher revenues for investors (to compensate for less-attractive contract terms), the ceiling prices issued by the government have been comparatively low. As a result, the marginal price of each of the three auctions was very close to the ceiling price, indicating that competition in those recent

Figure 5. Capacity factors of winners of energy auctions in 2013



Source: Authors.

auctions was relatively low (even bids offering the ceiling price were accepted). This is a dangerous path to follow, since if the entirety of the auctioned demand is not met, consumers will incur a higher risk of undersupply. The benefits of enforcing a lower price ceiling in Brazilian wind auctions are questionable, since the experience with past auctions has shown that competition has been driving prices much lower than the ceiling.

What is the key lesson?

Standing policies should be challenged and revised in response to a changing environment

The Brazilian experience with wind energy auctions illustrates that even carefully designed policies often must be reconsidered in the light of a complex and changing environment.

The wind auction scheme put in place in Brazil in 2009 was designed to address concerns with the wind power sector at the time: (i) that significant untapped potential needed to be exploited, (ii) that major uncertainties (with respect to stochastic wind fluctuations and the volatility of Brazilian spot prices for electricity) worried investors, and (iii) that the Brazilian wind sector needed to reach critical mass before prices could fall substantially. This diagnosis was

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generally correct, and, as a consequence, the policies adopted by the government in this first stage were very successful in ensuring the initial scale-up of wind power in the country, as well as a dramatic drop in prices.

But new conditions emerged with the success of stage one, bringing other important considerations to the surface. Security of supply became an important consideration when wind plants began to represent a substantial portion of the contracted expansion of the system.

Although the challenges imposed by the second stage of the development of wind power in Brazil have not yet fully been solved, the constructive responses of policy makers reflected in the 2013 auctions are an encouraging sign. Ultimately, a technical analysis is needed to evaluate the ability of Brazil's system to accommodate wind power expansion. Fortunately, that analysis is already on the agenda.

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The peer reviewers for this note were Luiz Maurer (principal industry specialist for climate strategy and business development, IFC) and Katharina Gassner (senior investment climate economist, World Bank Group).

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