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THE BOTTOM LINE

Many biomass cogeneration plants and small hydropower plants are already in operation in Brazil, and more are under construction. Brazil met the challenge of connecting those plants to the grid by devising a shared transmission system that allocates transmission costs among providers of renewable energy and allows providers to incorporate those costs into their bids for supply contracts. The process has built the confidence of renewable energy developers by providing certainty about the interconnection and the energy contracting processes.



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Transmitting Renewable Energy to the Grid: The Case of Brazil

Why is this case interesting?

Brazil has a system for connecting hundreds of small dispersed renewable energy projects

Brazil has one of the world's cleanest energy portfolios, with 85.3 percent of overall energy production coming from renewable sources (compared with the worldwide average of 16 percent), and with 75 percent of the country's 105,000 MW installed generation capacity coming from hydropower plants alone. In the last five years, biomass from sugarcane production, small hydropower plants (below 30 MW capacity), and wind energy have rapidly increased their share in the renewable energy mix because of their relative ease of construction, low investment requirements, and lower overall investment risk.

Hundreds of biomass cogeneration plants and small hydropower plants are already in operation, totaling 5,200 MW in capacity, and an additional 2,700 MW of capacity are under construction. The biomass plants use *bagasse*, the fibrous matter that remains after sugarcane stalks are crushed. More recently, wind power has emerged as the fourth pillar of the country's renewables portfolio: 800 MW of capacity are already in operation or under construction.

The country has improved its procedures for building new energy facilities and connecting them to the grid. New energy producers enter the market by participating in centralized energy auctions for contracts with Brazilian distribution companies. An auction conducted in 2009 contracted an additional 1,800 MW of wind energy.

What was the challenge?

Local distributors were responsible for expanding networks but lacked the capacity to do so

One of the most promising sites for renewables in Brazil is the Center-West region, which includes parts of the states of Mato Grosso do Sul and Goiás, where hundreds of biomass cogeneration and small hydropower projects are spread over 200,000 square kilometers (figure 1). The problem is that these resources are dispersed and located far from the grid. Connecting 80 biomass cogeneration and small hydropower plants totaling 4,100 MW required an investment of almost \$400 million in 2,500 km of transmission and subtransmission infrastructure (that is, lines less than 230 kV). Integrating so many small plants challenged previously existing transmission planning and regulatory practices, raising doubts about the country's ability to secure sufficient contracts to support the development of renewable energy.

The distribution companies in the zone where transmission services were needed lacked the personnel to plan network expansion. In addition, in certain cases, the network needs of the renewable energy providers requesting transmission services dwarfed in size and capital cost the entire existing distribution network in the area. While the government planning agency, Empresa de Pesquisa Energética (EPE), had the wherewithal to handle these network expansions, it lacked the legal mandate to plan investments in subtransmission and distribution.

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Mato Grosso do Sul (right)

"Integrating so many small plants challenged previously existing transmission planning and regulatory practices, raising doubts about the country's ability to secure sufficient contracts to support the development of renewable energy."



Figure 1. Brazilian interconnected power system identifying Mato Grosso do Sul area (left), and renewable energy candidate projects in

CORRMA (MAD) (MAD)

Source: Madrigal 2010.

What solution was adopted?

The government revealed transmission costs to potential bidders before renewable energy auctions

To address the challenges of planning and paying for the transmission infrastructure needed to bring energy from renewable sources to the grid, Brazil devised a competitive process to develop shared transmission networks for renewable energy (figure 2). In this forward-thinking process, EPE, with help of technical consultants, takes the lead on network planning (at both the transmission and subtransmission levels) where an auction to award energy contracts for renewable providers is to be held (and, of course, where there is interest in connecting to the national grid). The network needs of renewable providers are considered in the context of the auctioning of supply contracts. The providers are told that they will be responsible for bearing most of the cost of extending the transmission system through what is known as a "shallow allocation policy." The expense is allocated among all the providers of renewable energy who will share the transmission facilities based on the distance over which the energy must be transmitted (according to the usagebased MW/mile transmission pricing methodology). Once the plan is determined, the national electrical power regulator, ANEEL, informs potential bidders of the transmission costs before the auction. This is crucial: Before they enter into the auction to offer their energy supply, renewable energy developers know that they will have access to the grid and are fully aware of the costs they will incur for



Figure 2. Brazil's competitive process to develop shared transmission networks for renewable energy

Source: Prepared by the World Bank.

Note: EPE = Empresa de Pesquisa Energética; ANEEL = Agência Nacional de Energia Elétrica, the national power regulator; RE = renewable energy; TSO = transmission system operator.

that access. By knowing the network costs ahead of time, generators can safely bid in the auction and ensure sufficient operating revenue and return on their investment. Winners of the auction receive a long-term energy purchase contract that simplifies the process of obtaining project financing since access to the transmission network is assured.

Based on the winning bids, the network expansion plan may be modified. Once the final shared transmission network is defined and approved, renewable energy developers commit to reserve network capacity and ANEEL initiates a competitive bidding process to select a new transmission owner to finance and maintain the infrastructure used by the developers. Similar to the process used for the expansion of the main transmission system, the bid is awarded to the participant that requires the lowest annual revenues to develop and maintain the assets that will interconnect the renewable suppliers. The winner receives a transmission concession for a period of 30 years. The allowed revenue (a result of the bidding process) is fixed for the first 15 years and reduced by 50 percent for the remaining 15 years. The revenues for the transmission concessionaire are derived from network charges and applied only to the renewable providers connected to the shared network that won energy contracts in the auction. Costs not covered by the power providers are passed along to the customers.

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What is the key lesson?

Anticipatory planning led to a faster and more efficient roll-out of renewable energy

Brazil's competitive process to develop shared transmission networks for renewable energy not only has helped develop infrastructure that previously had languished in a regulatory void (not clearly covered by other regulations and beyond the institutional capacities of existing distribution utilities); it also has built the confidence of renewable energy developers by providing certainty about the interconnection and the energy contracting processes. The planning process also minimizes infrastructure and operational costs, allocates such costs more efficiently, and reduces electricity losses for the benefit of the consumer and a healthier generation sector:

- Sharing the cost of an integrated network can greatly reduce connection costs for renewable generators. Using an anticipatory approach to plan the integrated network eliminates the need to develop individual connections exclusively between each generator of renewable energy and the high-voltage grid.
 Planning also reduces the lengthy time delays associated with such exclusive connections. High upfront costs and delays previously left many renewable sites undeveloped or unconnected to the grid.
- Assessing network usage fees in conjunction with energy auctions provides price signals that ensure that the best renewable resources are developed first. While Brazil's sector was competitive before the current process was adopted, the absence of a "locational" signal as provided by the network

usage fees gave no incentive to develop the projects whose combined generation and transmission costs were minimized.

• Awarding transmission concessions to investors using a competitive scheme reduces the up-front costs borne by renewable energy developers.

The procurement process provides transparency that helps reveal the cost of efficiently delivering infrastructure, supports a realistic and sustainable pricing structure, and creates an environment for both generation and transmission that is attractive to the private sector. Further detail on transmission planning for renewable scale-up can be found in Madrigal and Stoft (2011).

References

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