Brazil and the Energy Integration Process in South America

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Introduction

Energy integration is an issue that is winning attention and concern worldwide due to, on one hand, the increasing need of electricity consequence of the growing economic and social demand and, on the other hand, as a direct result of the advantages for the countries involved. Among other advantages, it could be highlighted: the most efficient use of energy resources; the reduction of wholesale prices; the promotion of efficiency through the increase of competition; and the reduction of greenhouse gases emissions.

An example of this process is observed in the European Union where countries have been integrating their energy policies aiming to create a regional electric market in order to achieve tangible and intangible gains for the countries involved. However, in South America the creation of a regional electric market in the same basis as Europe is still a distant possibility because of the economic and social disparities between countries, but especially because of the different energy trading rules, a factor that largely hinders the process of regional energy integration.

Brazil, the largest electric market in South America, developed energy integration projects with Argentina, Uruguay and Venezuela besides the bi-national hydroelectric of Itaipu constructed with Paraguay. In addition to these projects that are already in operation, there are studies for the construction of two bi-national

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hydroelectric power plants, Garabi and Panambi on the Uruguay River at the border between Brazil and Argentina, and the construction of a bi-national hydroelectric plant with Bolivia on the Madera River.

In this context, this article seeks to point out some of the reasons why Brazil is a key player in the energy integration process of the region, although it is not yet possible to think of a common electric market, at least in the medium term.

Therefore, this paper is divided into three sections following this introduction. The first part presents the reasons why it is not possible to structure a common electric market in South America, at least in the medium-term, highlighting the limitations imposed by the Brazilian model. The second part presents the integration experiences of Brazil with its neighbors and the important role it plays in this process in South America. Finally, the conclusion points out that although the Brazilian model is an obstacle for the conformation of a common electric market, Brazil plays a strategic and key role in the progress of the regional energy integration process.

1. Energy Integration in South America

There are technical and economic reasons to recommend the international integration of power grids. For example, integrating generation matrixes with diverse profiles allows optimizing the use of available resources. Even simple activities, such as sharing resources, could allow the increase of economies of scale and enable projects that otherwise could not be made.

Worldwide, the energy integration paradigm seeks to create regional electric markets. According to Castro, Brandão and Dantas (2011), an integrated power operation between several countries tends to lead to a more efficient allocation of resources than would be possible if national markets remained isolated. However, technical benefits from energy integration are maximized only when it is possible to establish equal and solid commercial rules. In this sense, to achieve integrated electric markets European countries have been unifying their energy policies since

the early 1990s[3], making the domestic energy markets, including the electric market, to have the same regulatory framework.

Energy integration in South America faces resistance associated to economic, institutional and regulatory issues as well as some political restrictions such as the fear of losing national autonomy and some historical differences between the countries (Castro, Leite and Rosental, 2012). Due to these differences and limitations it cannot be expected a substantial convergence of commercial rules in South America at least in the medium term. Because of this, it is difficult to think in an integrated regional electric market.

In addition to those factors, must be also consider the great distances between regions where are placed the generation plants or have hydropower potential and the consumer centers. Thus, the challenge to connect the countries' power grids demands not only the convergence of commercial rules but also large investments in infrastructure; a very different situation than what is verified in Europe.

Specifically with regard to Brazil's position in the regional energy integration process, Castro *et al* (2012) points out that the Brazilian commercial model is a great obstacle to the establishment of integrated markets. The Brazilian model, contrary to other countries in the region, does not trade physical energy because generation depends on the optimized dispatch defined by the National Grid Operator (*Operador Nacional do Sistema* - ONS). All industry players are required to contract energy through a strictly financial mechanism called "physical guarantee", which differs from the plants' generating power potential.

The physical guarantee is a certificate issued by the Ministry of Mines and Energy (MME), which represents a fraction of the energy that a generating plant can produce. The computation of the physical guarantee results from a model based on the optimal functioning of the integrated system. Therefore, each project may result in energy contracts up to the limit of their physical guarantee (Tolmasquim, 2011). In

[3] GARCIA, Y(2006). *El mercado de energía en la Unión Europea.* (p.90).

this sense, it is a system designed in closed format, planned and operated in an optimized and centralized way differing from the European market model, which prevails in almost all South American countries.

Although there are some difficulties and limitations to implement a truly integrated energy market in South America, it does not mean that the prospects for regional power trade are impossible. In fact, the Brazilian commercial model includes both imports and exports of electricity. Currently, Brazil has interconnections with Argentina, Uruguay and Venezuela, as well as a bi-national hydropower plant with Paraguay - Itaipu Binacional. These projects are based in hydropower generation. Aside from Itaipu binacional, trade interactions with other countries are made on specific basis, without long-term contracts, largely due to differences in commercial arrangements.

Projects based on bi-national hydropower projects offer the best terms for commercial arrangements and security of supply. Itaipu Binacional is the best example of a successful integration project involving the construction of a bi-national power plant. Because of this successful experience, recent advances in energy integration between Brazil and other countries are based on this type of projects. In this regard, in 2012, were hired the engineering and environmental studies and also the communications plan for Garabi and Panambi power plants, projects carried out between Argentina and Brazil (Eletrobras, 2010). In addition, in July 2015 was signed an amendment to the 2007 Memorandum of Understanding between Bolivia and Brazil in the field of electricity. This document aims to build a bi-national hydropower plant on the Madera River.

2. Integration Experiences and Brazil's Role

The energy integration experiences between Brazil and its neighbors were designed operationally and commercially to properly function according to the Brazilian operation system.

Itaipu Binacional, with 14,000 MW of capacity installed, sells around 90% of its annual production to Brazil. In 2014, for instance, Itaipu Binacional provided 88,467 GWh to the Brazilian market, which represents 19.1% of the country's total energy consumption, while the Paraguayan market consumed 8,751 GWh, which represents 75% of its national demand for energy (Itaipu Binacional, 2013). Although Itaipu Binacional was conceived long before[4] the new Brazilian electric market model was adopted in 2004, the energy commercialized by this plant had to be adapted to the new model's logic while observing what had been established in the Itaipu International Treaty.

As for Brazil´s energy exports and imports, these transactions have been done on specific basis, taking advantage of the imbalance between supply and demand and not representing major international energy exchange operations. In fact, as pointed out by Castro *et al* (2012), energy trade with Argentina and Uruguay has only taken place occasionally and most of the time the existing interconnections remain idle.

Although there have been limited electricity integration experiences in Latin America, Brazil has a strategic role in the development of the region's integration process due to some factors that will be discussed below.

The first factor refers to the Brazilian power system itself, which constitutes a clear and objective example of electric integration demonstrating technical knowledge of this process. Brazil has a continental dimension with an integrated power system with over 4,200 power plants (ANEEL, 2015), 139,800 MW of capacity installed and over 100,000 kilometers of high voltage transmission lines (MME, 2015) operating in a centralized way.

Second, the Brazilian energy matrix has one of the highest shares of renewable sources in the world, especially hydropower. In 2014 this source represented 73.1% of the total installed capacity in the National Integrated System (SIN) (MME, 2015).

4 The construction of the Itaipu power plant was agreed between Paraguay and Brazil in 1973, and the International Treaty establishes the special rules for energy trading between the power plant and their partner countries.

This fact gives the country a high technical expertise for the construction, installation and operation of large hydropower plants. Also must be consider the knowledge acquired concerning bi-national power plants consequence of the construction of Itaipu Binacional. This experience is imperative for the integration process progress, especially when considering that some of the remaining potential lies in the region's border rivers.

In addition, Brazil's total power consumption is the largest in the region. In 2013 Brazil consumed 463,335 GWh, representing approximately 50% of South America's total consumption (EPE, 2014). Therefore, the Brazilian market enables not only binational generation projects, but also allows the construction of power plants which aimed to supply the Brazilian market, once the regulatory and commercial problems are outweighed by a common regulatory framework.

On the other hand, the new electric sector model, implemented in 2004, guarantees and encourages competitive conditions in power generation. The dynamic of new energy auctions ensures the undertaking of long-term contracts with highly predictable revenues that are indexed to the inflation rate. These contracts, which emerge from a competitive process, constitute the financial guarantee for the *project finance* credit with which the project will be constructed. (Tolmasquim, 2011). This commercial design has attracted the interest of entrepreneurs, enabling the expansion of the generation and transmission installed capacity.

Finally, Brazil has borders with almost every country in South America excepting Ecuador and Chile. In addition, it has energy integration projects with Argentina, Bolivia, Paraguay, Uruguay and Venezuela. Thus, Brazil holds a strategic position for encouraging the integration process, in particular due to the annual need of more than 5,000 MW of new generating plants.

Conclusion.

The analysis made in this article demonstrates that due to economic, political and regulatory disparities between Latin American countries, the power integration process in the same basis as Europe will be slower, particularly with regard to the creation of a common electric market.

A hindrance to this process is the Brazilian commercial model implemented since 2004. It relies on the trade of electricity certificates (physical guarantee), defining a closed model, designed and operated in an optimal and centralized way.

However, despite these limitations, an immediate and positive outlook for the regional electric integration is found in the bi-national hydropower projects, they represent a direct integration model as can be confirmed with the results obtained by Itaipu Binacional between Brazil and Paraguay.

It was also pointed out the strategic role of Brazil in the integration process due to five factors: (i) the Brazilian system size which is an example of integration itself; (ii) the renewable energy matrix that allows Brazil to have a broad technical knowledge in the use of these resources, particularly hydropower; (iii) Brazil is the largest energy consumer in the region accounting for approximately 50% of total demand, (iv) the commercial model that operates throughout auctions ensures long-term contracts with predictable revenues; and (v) stable and non-belligerent trade and diplomatic relations between Brazil and other countries in the region, particularly in the energy field.

These factors place Brazil as the central actor to boost the electric integration in Latin America, but within a different paradigm than observed in European countries, especially throughout bi-national power plants that allow exploring shared water resources. This last point is evident with the existing advances in this respect with Argentina and Bolivia.

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