Challenges for the Expansion of Solar Power in Brazil

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Abstract

Solar power is still not competitive with other sources in Brazil due to its operating cost and to the lack of investments and tax incentives, even though the country has a high incidence of sunlight. There are also challenges regarding to the regulatory model. In order to expand the electric system and not to be totally dependent on large hydroelectric plants, the Brazilian Government needs to develop a policy diversifying its electric matrix and investing in solar, both on large and small scale, as the distributed generation.

Keywords: *Solar Power, Expansion, Large Scale, Distributed Generation*

1. Introduction

Brazil has a high incidence of daily sunlight for most of the year throughout the country and one of the world's largest reserves of quartz, the raw material of solar panels. However, there are many challenges facing solar energy expansion.

This is because solar is not yet competitive with other sources in the Brazilian electric matrix, predominantly composed of renewable sources. According to the recent Decennial Plan for Energy Expansion (PDE 2014-2024), developed by the Energy Research Company (EPE), the basis of the Brazilian electric matrix is hydroelectricity, but currently this source has capacity expansion problems.

This hydroelectricity downward trend is reflected in the governmental PDE planning for the next ten years, where hydropower percentage in the electric matrix will drop from the current 67% to 56.7 % despite a rise in absolute numbers from 90 GW today to 117 GW in 2024. Of the 73,5 GW planned to be installed between 2014 and 2024, 56.7% will come from hydroelectric power, 11.6% from wind power, 8.7% from biomass, 3.8% from small hydropower plants and solar energy is expected to represent 3.3% of the Brazilian electric matrix. In other words, 84.1% of the expansion should come from renewable sources (Energy Research Company, 2016).

In Brazil, energy is exploited by public concession, in accordance with the provisions of Article 175 of the Federal Constitution (Brazil, 1988). Auctions are determined by order of the Ministry of Mines and Energy (MME) and carried out by the Electric Energy Trade Chamber (CCEE) on behalf of the National Electric Energy Agency (ANEEL). The energy that comes from generation projects and the transmission lines are both contracted through regulated market and free market. This model introduces competitive generation, commercialization of open access and the expansion of the parks is responsibility of bidders. Since the enactment of Law Nº 10.848/04, the concessionaires or permit holders of electricity distribution public service are required to purchase by bidding in the regulated market (Brazil, 2004).

The National System Operator (ONS) manages the provision of electricity transmission services, in order to distribute energy between regions, setting the amount that each generation license should produce as well as the amount to be sold by the distribution utilities.

This study will argue that to continue expanding the electric system and not to be dependent on large hydroelectric power plants and extensive transmission lines, the Brazilian government should diversify the

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electric matrix, by investing in the non-hydro renewable power generation, especially solar power, both on large scale and distributed generation.

2. The exhaustion of the centralized model based on hydroelectricity

The Brazilian electric sector has experienced previous crisis, because of power generation problems caused by the construction of dams without large reservoirs. In fact, the dependence on the level of the reservoirs is a consequence of federal government policy: in recent decades, the Brazilian government has invested in large enterprises, injecting substantial amounts of energy at once into the system, through hydroelectric plants without reservoir, due to environmental reasons.

However, since the possibilities for construction of new hydroelectric plants with storage capacity and close to consumption centers were exhausted, hydroelectric developments began to be built in the North Region, in the Amazon, where, for topographical and environmental reasons, large reservoirs remained infeasible. Besides this, there are constitutionally protected environmental areas and indigenous territories units in the North Region. Because of these reasons, the construction of large hydroelectric power plants may create legal conflicts, transforming social and environmental issues into one of the biggest risk factors for the implementation of large enterprises.

The reduction of the storage capacity, the increasing power consumption, the hydrologic crisis as well as the fragility of the transmission system are the reasons why centralized generation has reached its limit. Moreover, the difficulty of selling the contracted energy is caused by the delay in issuance environmental licenses. All these issues have increased the risk of energy deficit, reducing the power supply and overloading the transmission lines.

An audit made by Government Accountability Office (TCU), in 2014, identified major delays in the construction of generation projects and transmission lines auctioned from 2005 to 2012. It was found that 79% of hydroelectric projects had an average delay of eight months, while 83% of the works of transmission lines were also delayed an average of fourteen months. The main causes for the delays were environmental issues. This circumstance led TCU ministers mandated ANEEL and MME to plan bids with consistent deadlines that should guide the planning of future auctions (Brazil, 2014a).

This context will require an effort from the electric planning sector, which is based on rules of the National Energy Policy Council (CNPE), an advisory body of the Ministry of Mines and Energy (MME). The recent Decennial Plan for Energy Expansion (PDE 2014 - 2024) includes the construction of dozens of hydroelectric power plants by inserting about 30,000 MW into the Brazilian park over the ten-year period, but there are only a few references to distributed photovoltaic generation. The study only considered distributed generation as load reduction (Energy Research Company, 2016), maintaining a centralized generation model.

Therefore, to expand the system, which is the largest in Latin America, with an installed capacity of 143 GW, but is also part of a currently recessive economy, the Brazilian Government will need to develop a policy towards the diversification of its electric matrix, stimulating energy efficiency and investing primarily in alternative sources, with the deployment of solar energy.

3. The distributed generation

The PDE 2014 - 2024 incorporated the result of the new energy auctions held up to April 2015. The total potential of the projects that commercialized energy in auctions in 2014 was approximately 7,600 MW, corresponding to an energy power of

approximately 3,900 MW average in the National Interconnected System. This total includes the generation of photovoltaic origin, with a total output of 890 MW. Of this total, 520 MW are located in the Northeast of the country and the rest in the Southeast and Midwest. The heliothermic source is not included in the ten-year planning horizon. However, this source could complement the photovoltaic generation because of its intermittency (Energy Research Company, 2016).

According to ANEEL, among the various processes using solar energy, the most commonly used are water heating and photovoltaic power generation. The first is mostly used in the South and Southeast of Brazil, due to climatic conditions, and the second is used in the North and Northeast regions, in communities not connected to the electricity network.

As for the expansion of solar energy generation in the ten-year horizon, in this plan, the installed capacity in large scale is still unrepresentative, but it already includes R&D projects, power plants installed in the stadiums of the World Cup 2014 and thousands of plants classified as micro and mini generation.

The energy from the solar power plant to be built in Nova Olinda, located in Piauí, was not included in the energy planning but, when completed, it will be the largest in Latin America with 292 MW of installed capacity.

The ANEEL Resolution Nº 482, of April 17, 2012, established the regulatory framework for the creation of distributed generation and compensation system, with the discount of 80% (eighty percent) in the usage rates of transmission and distribution for photovoltaic systems that will enter into commercial operation from 2017 (National Agency of Electricity, 2012a). After the enactment of Resolution Nº 687, of November 24, 2015, there was a great incentive to the spread of distributed generation, especially the increase in installed capacity of up to 75 kW for micro generation and the expansion of maximum from 1 MW to 5 MW for the category of mini generation (National Agency of Electricity, 2015).

Despite the obstacles, the micro and mini generation advanced significantly in Brazil in 2015. The cumulative number of connections reached 1,731, up 308% compared to the same period in 2014, with only 424 facilities. In the current installed capacity of 16.5 MW, photovoltaics account for over 96% of these facilities, with 1,675 accessions and 13.3 MW, coming even before the wind power plants. The numbers continue to evolve according to this growing trend of distributed generation. In February 2016, the country already had 1,917 facilities, of which 77% were in the residential sector and 14% in the commercial sector, all connected at low voltage (Infopetro, 2016).

The ANEEL Resolution Nº 687 introduced new forms of micro generation that allow the development of a number of new business and solar services models such as leasing and Power Purchase Agreement (PPA), acquisition of solar shares, rental roofs and also solar condominiums, among others. ANEEL Resolution created a shared generation, allowing different stakeholders to use a consortium or a cooperative for energy generation, reducing the bills of their members. In addition, the deadline for connecting plants up to 75 kW was reduced from 82 days to 34 days (National Agency of Electricity, 2015).

In this way, there will be a boost to the micro and mini distributed generation in Brazil.

However, the success of distributed generation contrasts with the situation of centralized generation, due to its uncompetitive price.

On October 31, 2014, the source debuted at auctions in the Brazilian market, when around 400 projects were registered, totaling 10,790 MW, a volume almost equivalent to the installed capacity of the hydroelectric plant of Belo Monte. Despite this ambitious debut, due to a restrained demand for many years, only 890 MW of capacity were contracted for the next twenty years, at an average price of BRL 215/MWh (USD 87/MWh). This is one of the lowest prices for solar energy in the world, according to

analyst firm Bloomberg New Energy Finance (BP Group, 2014).

Solar power plants are still not competitive with other energy sources due to the lack of investments and tax incentives.

The concession auctions system, especially after the enactment of Law Nº 10.848/2004, which provides as a winner criterion the one who offers the lowest price, has been a factor that discourages the participation and competitiveness in the case of the other renewable energy sources, especially solar energy. This is because investors still do not have the certainty of obtaining credit lines from the official investment bank (Brazil, 2004).

To make solar competitive with other sources there should be demand, official financing and attractive remuneration rates. In the first auction, for example, there was a restrained demand, many projects were registered, but the low price fixed by the government did not attract the bidders, who need to generate revenue and fund the parks.

There is no way to expand or stimulate this source without differential treatment in funding, tax incentives and specific auctions.

4. Regulatory challenges: specific auctions, simplified environmental licensing and tax incentives

Although ANEEL Resolution Nº 482 has created the regulatory framework for the sector, there are still legal issues to be faced by investors in solar energy. As part of a policy of incentives for the growth of alternative sources, an auction system for the source with own reference value, set by the grantor in a reserve policy, could be implemented and be used when demanded. This could lead to the provision of electricity service at lower cost, according to the principle of low tariffs, but closer to the reality of the bidders.

As seen above, the bidding for concessions of generation and transmission services comes from constitutional provision and its promotion is delegated to ANEEL, which draws up the notice given to the auction mechanisms defined by order of the MME, which means that an auction for the source could be practiced today in Brazil without regulatory changes.

A simplified environmental licensing for the solar generation projects should be regulated due to their low environmental impact. For this, the government needs to modify the environmental legislation, which is quite rigid in Brazil, considering that the Brazilian electric sector is undergoing a period of deepening discussion on the trade-off between environmental issues and energy security.

In addition to regulatory difficulties, there is the problem of the high price of photovoltaic panels. Tax incentives are essential to develop the sector and the domestic industry. The state investment bank, BNDES, requires many guarantees, such as the progressive nationalization of specific components and processes, and does not fund individuals.

Some initiatives are emerging as the act CONFAZ/ICMS Nº 101/1997 (National Council for Financial Policy, 1997), which exempts tax on goods, services modules and solar cells, and more recently, the act CONFAZ/ICMS Nº 16/2015 (National Council for Financial Policy, 2015), which focuses on micro and mini generation. There is the Senate bill (PLS Nº 8.322/2014) providing for the exemption of the Tax on Industrialized Products (IPI), PIS/PASEP and COFINS for photovoltaic panels and other components made in Brazil and exempts from import tax components that are manufactured in other countries, while there are no national products equivalent to those imported. The text also allows workers to use part of the balance of the Service Time Guarantee Fund (FGTS) for the purchase of photovoltaic systems (Brazil, 2014b). Finally, it is important to highlight that distributors should acquire the energy produced through distributed generation, within the limits of contracting and passing on to

tariffs, according to the Law Nº 10.848/2004 (Brazil, 2004).

According to Rodolfo Nardez Sirol, in a period of economic recession, "the micro and mini distributed generation is another possibility for industries wishing to reconcile sustainability and cost reduction, producing its own energy from alternative renewable sources." For this author, also promoting actions on energy efficiency can bring a direct benefit to businesses in a short time (Sirol, 2016).

5. Investments in energy efficiency and technology along with smart metering

Moreover, a strategic planning policy is necessary to increase targeted energy efficiency for intelligent consumption in various systems, creating a culture of eliminating waste and optimization of processes, as well as increased competitiveness with cost reduction and with the use of information and telecom technologies.

In this context, the use of Smart Grid system defined as "wide range of mapping technologies, monitoring, information and telecommunications, aimed at a more efficient performance of services" is essential (Mori, 2011).

In fact, the concept of Smart Grid is more than just automation and modernization of the distribution network. The smart metering with the distributed generation could reduce costs and improve the electrical system as a whole. Through the Smart Grid utilities, distributors could make remote operations, control the customer consumption without using manpower to make the measurement, and give more agility in decision making, avoiding also losses in cuts and reconnections. There are also advantages in asset management, because it can monitor the performance of equipment and know when it is overloaded and the time for maintenance. All this is energy efficiency.

However, there are no sufficient studies to know if the devices would increase or reduce the tariffs. This is why the definitive deployment of the Smart Grid in Brazil is still a challenge. But there are important initiatives such as: the creation of a working group to its implementation (Decree Nº 440/2010) (Ministry of Mines and Energy, 2010) and the R&D program created by the Brazilian Association of Power Distributors (ABRADEE, 2012) in order to evaluate costs and benefits to the system in the country.

Finally, even with the publication of ANEEL Resolution Nº 502/2012, which regulates the deployment of smart meters, there is a lack of standardized equipment in economic scale and adaptable to the world system in order to ensure interoperability between different systems, regardless of the country and the manufacturer (National Agency of Electricity, 2012b). Also, the measuring costs for information technology and telecommunications are high. There is a lack of R&D regarding a smart rate. The share of assets and disposal of low-voltage networks, poles and larger cables are eliminated in the intelligent system, but in Brazil there are no sufficient underground distribution networks. In addition, the deployment of Smart Grid requires the decoupling of rates and sales, the pursuit of efficient and dynamic tariffs design. Mechanisms to protect consumers and energy bills (cyber-security) are needed, using software to increase productivity and reliability of protection systems, given the integration into networks and automated substations.

6. New technologies for the generation: hybrid systems and the floating photovoltaic plants

Some technologies, such as the hybrid parks and the floating photovoltaic plants, are stimulating the development of the source.

The first hybrid wind-solar park began operating in Pernambuco, Northeast, in late September, with an installed capacity of 11 MW of photovoltaic plants and a wind farm of 80 MW. The

hybrid parks allow sharing of infrastructure, such as the connection to the transmission lines, thereby avoiding losses, and promoting a better use of natural resources: during a reduction in the incidence of sunlight, the wind blows more strongly and vice versa. The result is an almost unbroken generation.

Another initiative was the first pilot project in the world of solar energy exploitation in hydroelectric lakes, using floats. It was released on the 4th of March, at the Balbina Dam, in the municipality of Presidente Figueiredo, Amazon. According to the Ministry of Mines and Energy, the initiative has been implemented in other countries, but at common water reservoirs. In Brazil, the floating photovoltaic plant in the Amazon reservoir will generate initially one megawatt (1 MW) of power. It is expected that, in October 2017, the power will be expanded to five megawatts (5 MW), which is enough to supply 9,000 houses. The floats of this first stage were produced in Camaçari, Bahia, and the next will be manufactured in the Amazon. The substation that could be carrying some 250 MW is using only 50 MW. The non-used hydropower 200 MW could be supplemented with solar power plants with a very low cost.

All these initiatives result in energy efficiency and in the possibility to decrease the cost of the electricity tariff.

The floating photovoltaic power plant allows the problem of decreased of hydroelectricity capacity to be solved, due to social-environmental conflicts and the hydrological crisis, as well as the problem regarding to the congestion of transmission lines, using entirely Brazilian technology, creating jobs, besides increasing the utilization of conversion capacity of solar energy.

This engineering design uses the capacity of the reservoirs and the infrastructure of hydroelectric plants, especially those with low power generation capacity. A government research will analyze the degree of efficiency of interaction with a solar power plant and the influence on the reservoir ecosystem (Ministry of Mines and Energy, 2016).

7. Conclusions

The Brazilian electric sector experienced previous crisis because of the power generation problems caused by the construction of dams without large reservoirs using extensive transmission lines. The social environmental issues and the hydrological crisis are also a constant challenge in the construction of large hydroelectric power plants, which are still the basis of the Brazilian electric matrix. Therefore, to increase its installed capacity and not to be totally dependent on the large hydroelectric plants, Brazil should diversify its matrix, investing in solar power plants.

The sector faces both challenges and opportunities.

Solar power plants can generate local energy, avoiding transmission losses due to long distances, and can provide countless benefits, as it is a clean, renewable and abundant source throughout the country. Amongst other benefits that could be mentioned are: the low environmental impact; the strengthening of national and regional economies with incentives to local manufacturers of solar photovoltaic panels and equipment used in the entire production chain; and the possibility of job creation and economic development, especially in areas with low HDI.

There is no way to expand solar power without specific auctions, funding and tax incentives. It is also necessary to invest in technology, as automated distribution, that, along with distributed generation, will reduce the costs and improve the system. Thus, as demonstrated in the Brazilian government's planning, with the PDE 2014, for the expansion of the Brazilian solar sector there are only economic and strategic planning barriers, not natural ones.

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