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Regulatory advances and improvements in Latin America: Case study of VPP markets in Brazil

Tania Nalborczyk Leites (1), Luna Leão Glória (1), Neimar de Almeida Oliva (1), Débora Batissoco Sanches (1), Julia Howat da Rosa Rodrigues (2), Alexandre Monteiro Sanches (2)
(1) CERTI Foundation
Campus Universitário UFSC - Setor C, Florianópolis, Brazil
(2) AES Tietê
Tel.: + 55 (48) 3239-2746
tnl@certi.org.br

Abstract

This article explains the actual Brazilian regulatory framework for implementing Virtual Power Plants and estimates a roadmap for the creation of each market in which Virtual Power Plants could participate, contributing to understand the market potential of this new actor in the Brazilian scenario and the novel opportunities for monetizing resources while optimizing the electric grid operation.

Introduction

Globally, with the increasing liberalization of the energy market, opportunities to the emergence of new actors and innovative structures arise. One of these new actors is the Virtual Power Plant (VPP), an entity that aggregates generation and loads capacity, in order to create a single operating profile from a composite of the parameters characterizing each aggregated resource.

When aggregated, individual participants can reach the size and characteristics of a conventional producer or consumer, allowing them to access different markets, providing ancillary services, and flexibility (represented by demand response resources) to the network operators. [1]

Using the VPP concept, aggregated participants can be considered as a substitution for Conventional Power Plants (CPPs) or large Demand Response (DR) resources in both forms of production: energy and capacity. Therefore, each consumption and generation participant can increase its monetization opportunities by participating in different markets. [2]

Moreover, there are two types of VPP: the commercial VPP (CVPP) and technical VPP (TVPP). CVPP is responsible for trading in the wholesale energy market, passing the operating schedules to TVPP.

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CVPPs perform commercial aggregation and do not take into consideration any network operation aspects for a stable operation of an active distribution or transmission network. [3] The CVPP enables [2]:

- Visibility of DER units in energy markets
- Participation of DER units in energy markets
- Maximization of value from participation of DER units in the energy markets

On the other hand, TVPP includes the real-time influence of the local network on DER aggregated profile and considers the cost and operating characteristics of the portfolio to offer aggregated products, providing balancing and ancillary services for transmission and distribution system operators. [3] The TVPP enables [4]:

- Visibility of DER units to the system operator(s)
- Contribution of DER units to system management
- Optimal use of the capacity of DER units to provide ancillary services incorporating local network constraints

Therefore, VPP markets are a composition of markets for commercial purposes and markets for technical purposes, as follows:

- Wholesale market (day-ahead, intraday): A particular class of the service that involves purchases and sales of energy made by the system operator in real time, necessary to correct current or expected imbalances between supply and demand to each trading period of the energy market. Generally occurs after physical bilateral markets have closed. The intraday market complements the day-ahead market and helps to ensure necessary balance between supply and demand in the energy market. The trading occurs daily 24 hours a day until one hour before delivery [5].
- Local ancillary services market: Systemic support or local support of voltage profile, so that it remains within the appropriate range values. The control can be done by means of reactive power injection (the effectiveness of the injections is local) [5].

• Balancing market: actions and processes, on all timelines, through which the Transmission System Operators maintain, in a continuous way, the system frequency within a predefined stability range [6], including the capacity to recover the balance after significant non-planned changes in the demand offer [3].
• Capacity market: It covers the range of capacity payment mechanisms designed to remunerate market participants by compromising a firm volume of capacity to generate power or reduce load in equivalent quantity during hours of peak system demand [7].

Brazilian Regulatory Scenario

Current scenario

In the current Brazilian regulatory scenario, electricity trading must be carried out either in the Regulated Contracting Environment (or Regulated Market) or the Free Contracting Environment (or Free Market).
An important rule for both environments is the obligation of 100% contracting coverage for buyers and vendors (by purchase contracts and/or physical guarantee from power plants). It is allowed to make contracts ex post, when it is already known the spot price and the exactly amount of energy required to cover the energy requirement. Agents exposed (below 100% coverage) in the average of the last 12 months before the calculation month are heavily penalized. [8].
The Regulated Market is composed mainly of distribution companies and captive consumers, and ANEEL - Brazilian Electricity Regulatory Agency - regulates their commercial relationship. The distribution companies charge a regulated tariff for the power they supply. However, they must acquire their entire power demand through energy auctions organized and supervised by ANEEL. There are two main types of public energy auctions, regular auctions that contract for a certain amount to meet demand growth; and reserve auctions, used to contract for supplementary energy to increase the system's reserve margin. In addition, there are A-5, A-3 and A-1 auctions that purchase electricity for new generation projects that are underway five, three or one year before the starting date of electricity delivering [9].
Free consumers, generators and trade agents are the main agents in the Free Market. These agents are free to negotiate their own power volumes, prices and delivery options through bilateral contracts. The differences between contracted and delivered/consumed are determined in the accounting and settlement process and settled in the Short Term Market. In this market, trade takes place through free negotiation and prices agreed by the parties, driven by competition between power generation concessionaries and permit holders, trading companies and energy importers [9].
The Brazilian electric system is characterized for having only one Independent System Operator (ISO), which is responsible for managing and coordinating the entire system, ensuring the load/generation control. The Chamber of Electric Energy Commercialization (CCEE) is responsible for accounting and cash settlement in the short-term energy market. These two (physical and commercial) operators are independents.
The National Electric System Operator (ONS) manages the national interconnected transmission system (Sistema Interligado Nacional) (SIN) and dispatches power plants in a centralized way to optimize the hydrothermal system and to ensure the efficient operation. Since generators are not allowed to decide their own generation in order to comply with their contracts (there is not a bid based market), and the ISO decides their outputs without considering their commercial commitments, there is a mechanism known as MRE – Mechanism for Energy Reallocation. Shortly, aiming to offset this centralized dispatch, the MRE reallocates energy, transferring the surplus generated from those that

produce beyond their monthly-allocated physical guarantee to those that produce below. Finally, all contracts must be registered at the market operator (CCEE), who also measures the energy produced/consumed by each market participant and automatically uses the MRE rules in the settlement process of the Brazilian short-term market (MCP) [10].
Thus, a power plant may sell part of its physical guarantee in the Regulated Market, part in the Free Market, and still have a fraction to be automatically settled in the short-term market [10].
The ONS is responsible for coordinating and controlling the operation of electric power generation and transmission facilities in the national interconnected transmission system and planning the operation of the more isolated systems under the supervision and regulation of the National Electric Energy Agency (ANEEL). To perform its legal and institutional missions, the ONS undertakes a series of studies and actions carried out on the system and its proprietary agents to manage different sources of energy and the transmission network. This ensures a continuous supply throughout Brazil and a sustainable, secure and balanced supply/demand relationship [9].

Ancillary Services

In the current regulatory framework, the National Electric System Operator (ONS) is the entity responsible for ancillary services management. However, not every agent is able to provide these services. Generators able to provide ancillary services are only those holders, by concession or authorization, of plants classified in the type of operation as Type I - Centralized scheduling and dispatch [11].
Moreover, the dispatch of those generators elected to provide the ancillary service is controlled by ONS, and the remuneration is regulated [11]. Table 1 shows a classification of ancillary services and the beneficiary, specifying also the entity responsible for the management of those services.

Table I - Ancillary services

Ancillary Services	
Service	Beneficiary / Management
Voltage control	Distribution network / Utility
Frequency regulation	Distribution network / Utility Transmission Network /ONS
Load following Supplementary reserve	Distribution network / Utility Transmission Network /ONS
Black start service	Transmission Network /ONS
Reactive power supply	Distribution network / Utility Transmission Network /ONS
Special Protection System	Transmission Network /ONS

The Aggregator Figure

In the VPP market context, the aggregator figure is defined as the VPP operator [12], and it is an essential player to provide and leverage flexibility, supporting the sale of this flexibility in various markets. The aggregator may or may not have the role of trader or utility [13].
A load aggregator is a service provider who operates a set of demand facilities in order to sell the flexibility available from pools of electric loads as single units in different markets [5].

In most cases, VPP consumers do not know their flexibility, so the aggregator can provide and leverage flexibility to the consumer. Moreover, aggregators can guarantee the performance of generators. The aggregator is a consolidated figure in the USA, Australia, Austria, Belgium, Finland, France Ireland and Great Britain [13].
In Brazil, the Retailer Energy Trader – a Free Market Agent which was created in 2016 – can partially represent the figure of an aggregator in the energy market. This agent acts as a consumer and generator representative before the market operator (CCEE), aggregating consumers and generators in the energy market, and helping the market operator to reduce its administrative and management expenses. It is expected that the Retailer Energy Traders emulate what the distributors do in the regulated market, but with greater flexibility, because the aggregator is able to manage and optimize load profiles and energy contracting for different customers.

Recent Trends, Barriers and Expected Changes

The Ministry of Mines and Energy have sent contributions made by players in the energy sector as part of a public consultation on legislative changes to Government evaluation. Changes seek to correct problems and settle disputes in the sector. Although changes are expected, the main principles of the legislative framework are not supposed to be modified.
Moreover, in July 2017, the MME started discussions to restructure the regulatory framework of the energy sector. Their main purpose is creating measures to improve the legal, institutional and regulatory frameworks to provide an environment of trust, innovation and competitiveness in the Brazilian energy sector, which will then attract more investment.
In practice, the MME proposes changes to increase the cohesion of industry segments and agents, increase the flexibility for contracts and legal models for the power sector, improve the allocation of costs, charges and responsibilities among the sector's participants and improve the sustainability of the energy sector. Some of the proposals include reducing restrictions for entering into the Free Market, adopting measures to grant legal security for tariff composition, and adopting measures to reduce transaction costs in the sector.
However, in the current regulatory scenario and in the regulatory framework restructuration, Demand Response (DR) figure does not exist and, therefore, it is not yet considered in regulation improvements. In addition, in terms of the energy market, the possibility of contracting ex post (in settlement process) does not allow DR participation (characterized by a pre-sale of capacity).
In this current context, VPP operators could only offer services to substitute generators value, but not the value of flexibility, represented by demand response resources. Furthermore, capacity and balancing markets do not exist yet, and therefore VPPs have limited opportunities of monetizing aggregation.
Some of ongoing efforts in Brazil that are expected to contribute to leverage flexibility include an industrial demand-response pilot program (considering free consumers in North and Northeast subsystems), approved in November 2017 and valid until June 2019. The pilot aims to prove the value of Demand Response as an alternative for operating reserve and frequency regulation, encouraging a future regulation. Demand Response will be used in this pilot to supply operating reserve, peak power and frequency regulation [14].
Lastly, there is a market need of flexibility provision, due to the increasing growth of renewables. Information provided by the government's Energy Research Company (EPE), in its 2026 Energy Plan, shows the diminishing share of hydroelectricity and the increase of variable renewables, as shown in Figure 1, which requires solutions to provide flexibility

[14]. In this context, there is a trend of increasing flexibility participation in the Brazilian electric markets.

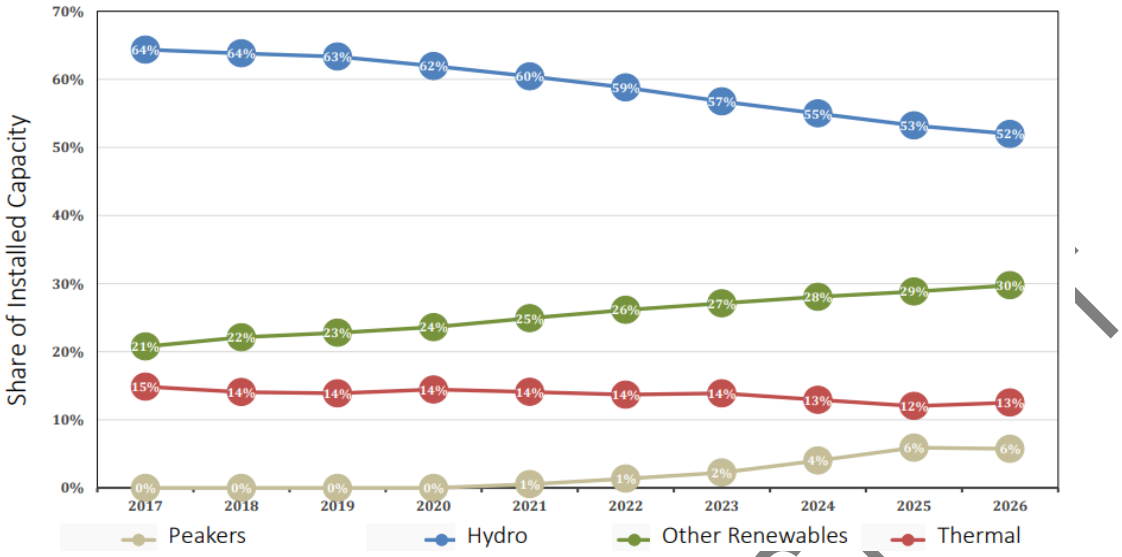

Figure 1 - PDE 2026: Summary of Energy Plan Results [14]

Roadmap

Considering current Brazilian regulatory context and future trends, a roadmap of expected market implementation was developed, in order to estimate future markets for VPP participation. The roadmap is shown in Figure 2.

Figure 2 – Markets Roadmap

The following sections give a brief explanation of actual scenario and future trends that support each market time allocation.

Energy Market (current)

The free and spot market are the current energy markets that presents opportunities for VPP participation. Auctions of regulated market do not allow the participation of aggregated generation.

Yet, the main barrier for the participation of demand response in these markets would be the lack of physical guarantee. Without physical guarantee, there is no way to have 100% contracting coverage, an obligation of the Free Contracting Environment, which hampers several longer-term market instruments such as the DR participation in capacity markets.
However, indirect participation of demand response in the free market already would be possible, within the figure of the Retailer Energy Trader. Despite of punctual restrictions regarding to load profiles, there are no barriers for starting the operation of DR bellow the retailer aggregator in the current Free Contracting Environment.
Consumers who participate in the Free Contracting Environment purchase their energy requirements in bilateral contracts, where the trading conditions, such as price, quantity and period, are freely traded with the vendors. The transaction is 100% over the counter, i.e., there is no organized environment to purchase and sell energy [8].
Therefore, there is low liquidity on the short-term energy market due to the absence of a common trading tool for the over-the-counter market that occurs before the settlement period, and to the selling discretization characteristics, where contracts are made for load blocks within a week. Yet, the low liquidity is also a consequence of the Surpluses and Deficits Compensation Mechanism (MRE), a mechanism of the regulated market that allows exchanges between utilities (Monthly, Quarterly and Annual) that does not favor market liquidity.
In the current Brazilian market design, the conciliation between commercial commitments and the physical dispatch is not smooth. There is a lack of trading opportunities to encourage hydro companies to comply with their contracts and there is no flexibility for hydros to better address their exposition risk according to their own risk perception and market strategy (since the MRE mechanism is automatically activated). Moreover, the Brazilian short-term market just corresponds to a mechanism to settle differences rather than a true market, given that there is not a bid-based dispatch.
Neither the short-term price (PLD) nor the dispatch schedules are determined by the market given that they are both a result of the application of a chain of software models that are operated by the System Operator [10].
As a result, even though there are opportunities for VPP participation in these markets, they are still restricted. The regulation restructuration includes some contributions to improve liquidity such as the creation of the hourly price and the application of the locational signal concept [15].

Balancing Market

Currently, frequency control is operated exclusively by ONS, and executed by all Type-I generators, according to availability and merit/cost order [11].
Moreover, frequency ancillary services are not procured competitively. For example, in the case of secondary reserves services, the selection procedure is based on a direct selection of providers (all hydros), with a regulated payment basically to cover investments in control and IT, and expenses with O&M personnel [14].
Nonetheless, there is an initiative to implement demand response via intraday and day-ahead products for peak demand supply (product 1) and mitigation of wind generation intermittency (product 2). The implementation will be pre-tested through a pilot project implemented by the system operator (ONS), ANEEL, CCEE and the Brazilian Association of Large Industrial Energy Consumers and Free Consumers (Abrace). Abrace acts in the pilot project representing big industries that already have experienced the model in other countries. The pilot took place in 2018, via a provisory regulation. Implementation of the actual regulation is expected for 2019 [16].

Local Ancilary Services Market

As explained before, there are no regulatory instruments allowing the provision of these services by other players than the ones chosen by the Operator of the National Electricity System. Moreover, there are no monetizing tools for these services, meaning that the market is not developed yet.
Nonetheless, federal government is studying the possibility of provision of ancillary services within the distribution system, mainly from Shared Generation. The main idea includes the creation of regional operators or aggregators to manage distributed resources. The Mines and Energy Ministry believes that this model could be implemented in the actual regulatory context, and that adds value to distributors who currently perceive losses with Distributed Generation growth [17].
Moreover, Brazil is evaluating an unprecedented model in the world in the restructuring of the regulatory framework, by considering the implementation of a locational distribution tariff, bringing value to the benefits provided by resources in certain locations of the grid [18]. This could be seen as a first step to incentive the local ancillary services regulation.

Energy Market (future)

Day-ahead and intraday markets are still non-existent in Brazil.
Thus, System Operator pilot initiative contemplates the creation of day-ahead and intraday products, which can lay the foundations for the creation of such markets.
Moreover, the implementation of the hourly spot price, which is currently being tested, is expected for 2019. [15]. The hourly spot price can also be considered as a previous step for the creation of intraday and day-ahead markets.

Capacity Market

The Capacity Market is designed to ensure that sufficient reliable capacity is available by providing payments to encourage investment in new capacity or for existing capacity to remain open. Because Brazil counts with long-term forward auctions to guarantee security of supply, the electricity sector is not structured for capacity market.
The Regulated Contracting Environment covers 70% of the market and requires contracting of energy in advance (up to 5 years). The current regulatory framework relies heavily on the obligation to contract energy early. In this environment, all regulated consumers support the expansion of supply through the demand declared by auction distributors, whose results are formalized through long-term bilateral contracts between generators and distributors.
In the Free Contracting Environment, on the other hand, consumers are not required to hire energy in advance. Therefore, bidder generators in regulated auctions take on the risk portion of its energy to be sold to free consumers.
Moreover, there is a need of expanding capacity (5000 MW of new additions needed per year). According to [19], capacity expansion did occur in Brazil in recent years, but there were signals of exhaustion of the current model.
Due to these facts, the principle of getting long-term contracts to help to trigger investment decisions with revenue guarantees is henceforth recognized, if long-term competition exists to allocate them. Nevertheless, if capacity markets are well designed, they induce material capacity and therefor they could be seen as a possible solution for the growing need of capacity. However, capacity markets are most efficient in inducing “low-cost” resources rather than new plant capacity [7]

In terms of future trends, the development of the capacity market is mentioned in bills PL 1917/2015 and PLS 232/2016. In these bills, the capacity market is seen as essential for a robust and reliable expansion of the system (ACR/ACL).

Conclusions

In this paper, a roadmap for VPP implementation was presented. The roadmap was created through the analysis of current and future Brazilian regulatory context.
A series of trends indicate the future creation of different markets in which VPPs could participate. After the creation of balancing, day-ahead and intraday markets, for a proper regulatory market for VPP, there is the need of creating a set of criteria assessing the possibility for demand-side resources to participate in Brazilian markets.
Thus, the main point that should be improved in Brazilian regulatory context is the creation of a legal for Demand Response figure, in order to capture the benefits of this new entity participation in several markets.
In addition, it is relevant to adopt measures to improve the level of liquidity in the Brazilian electricity market. These actions intend to increase the number of market participants, promote the standardization of contracts and products; create higher market transparency, and would improve wholesale market for VPP participation.
The Retailer Energy Trader was recently created and incorporated in the Brazilian short-term energy market. This agent can be seen as a precursor of the VPP operator.
Finally, to enable VPP participation in markets, a set of regulatory steps should be fulfilled [5]:

- Participation of demand-side resources in markets should be authorized. It is evident that general market opening is a fundamental pre-condition for Demand Response to evolve.
- Aggregated load should be allowed and encouraged to participate. In order to make a significant quantity of demand-side flexibility resources available to the system, TSOs and market operators have to open the markets to aggregated load.
- Enable independent aggregators access to the market (promote investments and greater concurrence, have the demand response as core business).

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