Ana Zornitta,

RENEWABLE ENERGY CONSULTANT AT CELA – CLEAN ENERGY LATIN AMERICA

Revolutionizing the Energy Sector: Unlocking the Transformational Potential of Battery Energy Storage Systems

Energy storage has many benefits for the electric system and its consumers. But why have we not seen significant growth in this sector in Brazil yet?

As the world focuses more and more on the transition to renewable energy sources, Battery Energy Storage Systems (BESS) gained prominence in discussions in the energy sector. It is no exaggeration to say that the use of batteries is one of the main drivers of the transition towards clean and sustainable energy sources, given their multiple applications and numerous benefits. However, despite their potential, we still face a challenging road ahead before these systems are consolidated as a genuinely transformative solution for the Brazilian Electricity Grid.

Battery technology is nothing new. Their use as energy backup systems and in isolated networks is widely recognized. However, the technological evolution of batteries into what we know today as storage systems has allowed them to be applied in a variety of sectors, bringing substantial benefits to energy consumers, DisCos and TransCos. The BESS consist of a set of devices that enable the storage, management and distribution of energy:

- Batteries: Store electrical energy in the form of chemical energy during the charging process. When discharged, they convert the stored chemical energy into electricity ready for final use.
- Battery Management System (BMS): The software layer responsible for managing the charge and discharge cycles, as well as controlling all the parameters of the electrochemical cells.
- Power Conversion System (PCS): Responsible for converting direct current into alternating current between the battery and the point where power is delivered to the loads or to the grid, and vice-versa.
- Energy Management System (EMS): The power electronics component that monitors and manages the energy flows and critical variables of all the equipment that compose the BESS.

- Security Systems: Essential for ensuring the safe operation of the BESS, security systems include temperature and humidity control, ventilation and air conditioning, among other critical aspects.

The combination of these elements forms a complete system that not only stores energy, but also distributes and manages it effectively, making the BESS a versatile and fundamental solution in the evolution of modern electrical infrastructure.

With the growing consolidation of BESS around the world, the variety of applications both in the electricity grid and for consumers has expanded significantly. This has turned energy storage systems increasingly decisive catalysts in driving the energy transition.

One of the greatest advantages of BESS is its ability to reduce intermittency in renewable generation plants. The integration of these systems with solar and wind power plants allows for more constant energy production, which not only favors the optimization of generation, but also contributes substantially to minimizing constrained off energy flow - called *curtailments* - which are a significant challenge in Brazil especially for photovoltaic plants. As the integration of renewable energy sources becomes more prominent, the absence of rotating synchronous generators in the system can gradually expose the grid to increased vulnerability. This vulnerability, however, can be effectively mitigated through the appropriate use of BESS.

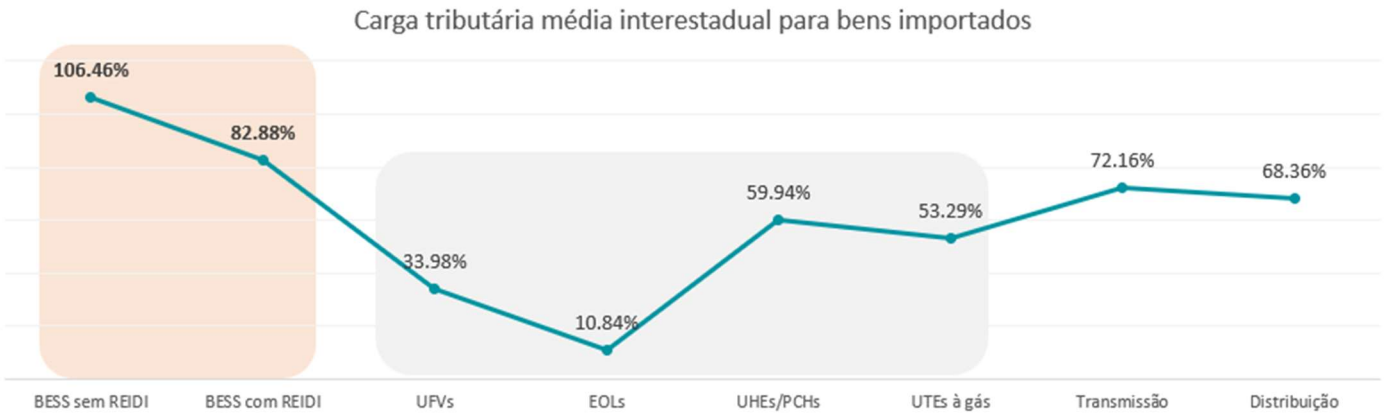
Battery applications also improve power quality. This is achieved through the supply of Reactive Power, which makes it possible to regulate the grid voltage, contributing to the reduction of voltage and frequency fluctuations through Rapid Frequency Response.

Additionally, BESS play a crucial role in Load Leveling and Grid Support, significantly mitigating grid congestion. Another prominent opportunity in the use of storage systems lies in enabling microgrids, which are small-scale, autonomous energy systems capable of operating both connected to the grid and independently. BESS play a key role in providing backup power during outages and stabilizing the grid, ensuring a reliable supply of electricity even during periods of peak demand.

For consumers, the implementation of BESS offers several additional benefits, such as efficient load and demand management, *backup* options during grid failures, the possibility of energy arbitrage and *peak shaving*, which is reducing grid consumption during times of peak demand, resulting in a reduction of operating costs that is passed on to consumers.

However, even with these obvious benefits, why BESS are not yet largely used? The answer to this question can be resumed up in three fundamental factors: the cost of the solution, the regulatory gap and the lack of clear targets relating to the implementation of storage systems.

Although there have been significant reductions in prices of storage systems worldwide over the years, with a reduction of approximately 80% between 2013 and 2022, the estimated costs for operating BESS are still around US$ 152/kWh (BNEF, 2023). The good news is that these costs are projected to fall significantly over the next few years and could reach US$70/kWh by 2030. However, in the Brazilian context, costs are even higher due to high taxes levied on equipment imports, which can reach an impressive 106.46% for systems without the benefits of REIDI (Special Incentive Regime for Infrastructure Development). When we compare these figures with taxes levied on other energy sources and network infrastructure, the discrepancy becomes clear, as total taxes on wind farms amount to just 10.84%, for example.



Source: Fiscal Benefits to Battery Energy Storage Systems – Activity 1– Current Tax Scenario – Average BESS Tax Burden – Comparison with the tax burden on Energy Generation, Distribution and Transmission equipment. ABSOLAR, 2023

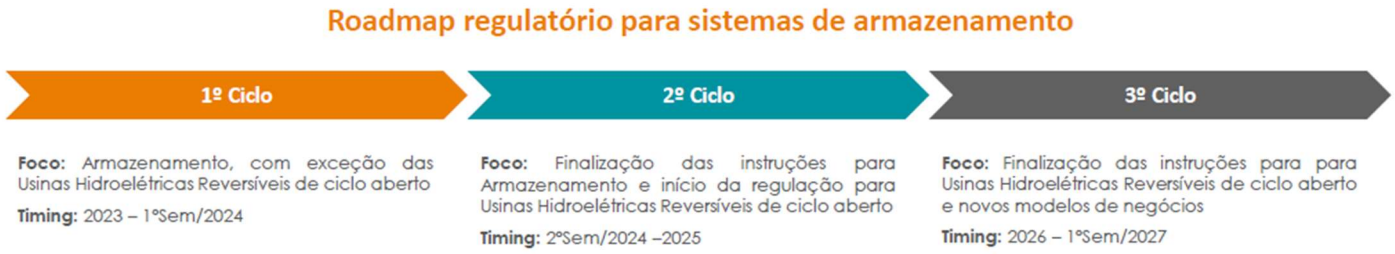
The lack of specific regulation for BESS also plays an important role in the complexity of their tax burden. Currently, these systems are not considered infrastructure equipment and therefore do to benefit from REIDI tax incentive. This is because the current legislation limits this benefit to energy transmission, generation and distribution projects.

However, it is possible to argue in favor of extending REIDI to BESS associated with generation, distribution, and transmission projects. The legislation does not clearly state the equipment that can be considered part of the infrastructure, and there are cases of energy transmission and distribution projects that included the use of BESS as essential components being approved. Therefore, there is a solid basis for advocating the inclusion of BESS in this tax incentive, which could significantly reduce its tax burden.

Regulation for stationary storage systems is still in its infancy and lacks important definitions regarding the scope of action, type of agent, business model and remuneration.

The first steps towards integrating storage systems into the Brazilian grid were taken in 2016, through an ANEEL Strategic R&D call. The aim was to discuss applications and issues relevant to the planning of the Brazilian electricity system. However, it was only in 2019, through EPE Technical Note No. 098/2019, that this subject began to gain greater relevance and structure.

This issue unfolded in Subsidy Call 011/2020, designed to collect contributions for the preparation of proposals aimed at the regulatory adjustments necessary for the effective inclusion of storage systems in the Brazilian Integrated Energy Grid. The subsidy-taking process and the compilation of contributions took more than two years and was only completed in November 2022. As a result, a regulatory *roadmap* was established for the upcoming years, divided into three cycles, as illustrated in the figure below:



Source: ANEEL Technical Note No. 137 2022, adapted by CELA -Clean Energy Latin America, 2023.

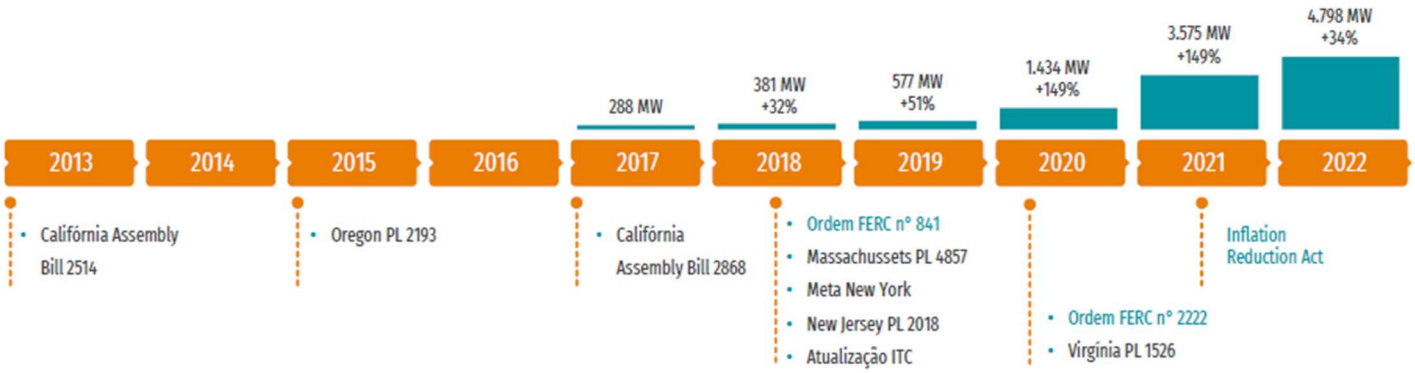
The 2019 Technical Note also had significant repercussions on the publication of Decree No. 10,707/2021, which regulates the contracting of Reserve Power Capacity. With the enforcement of this decree in 2021, the first Reserve Capacity Auction took place, in which power and energy capacity were contracted separately. However, it is important to note that this auction excluded energy storage systems (BESS), allowing only flexible thermoelectric plants to be contracted.

In the legislative sphere, there are currently two bills that present crucial points of interest for energy storage systems:

- Bill 414/2021: Proposes the separation of Energy Backing and Energy, which opens up interesting prospects for storage systems, especially considering how Energy Backing is contracted.
- Bill 1.224/2022: Popularly known as the "Energy Storage and Prosumer Bill", this bill introduces fundamental definitions for energy storage activity. It addresses the creation of the Energy Storage Agent, establishes guidelines for energy storage systems within the regulatory framework of the electricity sector and outlines the services that can be offered by Energy Storage Agents. This includes ancillary services, price arbitrage, demand management, power capacity and seasonal storage.

Defining the regulatory framework for a Storage Agent is extremely important, given the wide range of applications for these systems. It plays a fundamental role in determining the costs and revenues associated with storage systems, which are crucial to making their operation economically viable and attractive in the Brazilian Energy Sector.

Implementing regulations, setting targets and offering incentives play a crucial role in the development of the energy storage sector. In the United States, a leader in this sector, it is possible to trace a timeline that correlates regulatory decisions and incentives with the increase in installed capacity of energy storage systems around the country.



Source: CELA - Clean Energy Latin America, 2023.

Among the regulatory acts approved in the United States, there are three significant initiatives that boosted the development of the energy storage sector:

- FERC Order No. 841 of 2018: Required system operators to revise their market rules to allow BESS and other energy storage resources to participate in wholesale electricity market. It recognized the physical characteristics of BESS as well as their ability to provide energy and ancillary services.
- FERC Order No. 2222 of 2020: Aimed to eliminate barriers that limited the participation of distributed energy resources in wholesale electricity markets. It applied the distributed generation rules to small scale BESS, an equivalence that could also be adopted for batteries connected to distributed generation in Brazil. The order fostered the participation of small, distributed energy resources in wholesale markets through aggregation.
- Inflation Reduction Act (IRA) of 2021: Extended the Income Tax Credit (ITC) for energy storage systems, even when not linked to renewable energy sources. It also extended the eligibility period for these credits to 2032. This measure provided tax benefits that increased the economic viability of storage systems.

These regulatory actions and incentives have played a key role in promoting the growth of the energy storage sector in the United States, serving as important examples for other countries seeking the sustainable development of this segment. They placed the United States among the global leaders in BESS production and adoption, increasing installed capacity from 288 MW in 2017 to an impressive 4,798 MW in 2022, an increase of more than 16 times in just five years.

Although the Brazilian Regulatory Roadmap indicates that regulation for storage systems will only be completed in the first half of 2024, suggesting a lack of priority on this issue, speed is needed to guarantee opportunities in certain business models, such as through Capacity Reserve Auctions.

Power contracting represents an opportunity for the inclusion of storage systems in the Brazilian Integrated Grid and there are already indications that BESS will be able to participate in this tender. However, there is still uncertainty about how BESS will participate, mainly related to the current state of regulation and the ongoing discussions about its integration into the Brazilian electricity market.
The expectation of all the agents involved in the BESS value chain is that they will be able to offer Power Capacity in the next auction. However, the lack of prioritization in the publication of the auction guidelines leads us to believe that storage systems will need to be associated with generation sources to be eligible.

The market has shown that the inclusion of independent systems in the Reserve Power Capacity Auction requires a number of critical definitions:

- The need for the Brazilian Energy Research Office to revise the "f" factor, so that it can start discussing and guaranteeing the viability of storage systems;
- A review of the structure of auctions to make them sensitive to the frequency control and flexibility attributes of BESS;
- Deepen discussions on the use of storage systems to provide ancillary services, stacking additional revenues other than provision of power to the system.

The storage systems market is experiencing significant growth. An analysis of various studies identifies a potential increase in the Compound Annual Growth Rate of installed capacity to approximately 12.8% per year by 2040. This could result in a total capacity of up to 7.2 GW and a market size of more than US$ 12.5 billion per year, considering current regulations. However, with appropriate incentives, well-defined regulations and established targets, this potential could be increased to up to 18.2 GW capacity, without considering the potential of behind-the-meter systems.

According to the literature and the examples of advanced BESS markets, achieving these growth levels in Brazil will require the implementation of clear targets for storage systems, investments in research and development, consolidation of regulations and the establishment of fiscal adjustments. This includes setting tariffs for ancillary services and revenue stacking, which can significantly increase the financial attractiveness of BESS projects.

Despite all the challenges, Brazil has a historical vocation for the adoption and growth of innovative solutions for the energy sector – which have made Brazil a benchmark in renewable energies – as well as tools for contracting Energy and Power, such as the auction system, which are acclaimed worldwide. Just as the countries at the forefront of storage systems implementation have done to develop their market to full potential, Brazil must develop regulatory certainty for the market, set clear targets, and use its tools, such as the Reserve Power Capacity Auctions.