## WHITE PAPER ON ENERGY STORAGE IN LATIN AMERICA AND THE CARIBBEAN

CURRENT STATUS, CHALLENGES
AND STRATEGIC
RECOMMENDATIONS







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# Current Status, Challenges and Strategic Recommendations

**Technical Document** 

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ORGANIZACIÓN LATINOAMERICANA DE ENERGÍA

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## **PRESENTATION**



Energy storage has been consolidated as a strategic component to ensure the safety, resilience and sustainability of electricity systems in Latin America and the Caribbean. Our region, with its abundance of renewable resources and geographical diversity, faces the challenge of efficiently integrating intermittent sources, closing access gaps in isolated territories, and modernizing transmission and distribution infrastructure.

This White Paper provides a comprehensive analysis of the state and prospects of energy

storage, highlighting both technological advances and remaining barriers. It addresses the main solutions available -from battery systems (BESS) and thermal storage, to hydraulic pumping, flywheels and chemical carriers such as hydrogen and green ammonia-, evaluating their contribution and development conditions.

One of the central contributions of the document is its multidimensional approach: it combines technical vision with regulatory, financial and social aspects, providing a roadmap for OLADE member countries to design effective public policies, attract private investment and take advantage of existing financing mechanisms. Through regional success stories, the regulatory and planning conditions that enable the execution of large-scale projects and lessons learned are illustrated.

From OLADE, we reaffirm our commitment to accompany the Member Countries in this process, promoting regional cooperation, the exchange of experiences and the formation of local technical capacities. Energy storage is not an optional resource, but an essential part of consolidating safe, reliable and resource-efficient electrical systems.

I invite readers to consider this White Paper as a practical input for action and decision making. That their proposals become catalysts for projects and policies that accelerate the incorporation of storage in the region, consolidating Latin America and the Caribbean as a global benchmark for a just and sustainable energy transition.

Andrés Rebolledo Smitmans Executive Secretary OLADE

# **Energy Storage in Latin America and the Caribbean**

## 1. Introduction

In the context of the global energy transition and the increasing adoption of renewable sources, energy storage has become a fundamental pillar for the design of modern, resilient and sustainable electrical systems. Its main function is to accumulate energy when generation exceeds demand and release it when required, thus balancing the natural fluctuations of energy supply and demand.

This capacity for regulation and backup makes storage essential to face one of the greatest challenges of renewable energy: its intermittency and unpredictability. Technologies such as solar and wind, although clean and abundant, depend on variable weather conditions. Without storage systems, much of this energy is lost or cannot be harnessed efficiently.

Energy storage further contributes to the stability of the electricity grid, improves the quality of service, facilitates the electrification of isolated areas and reduces the need for expensive infrastructure such as new transmission lines or backup fossil fuel-based generation plants.

### 1.1. Strategic importance of energy storage

Latin America and the Caribbean are in a privileged position to lead the global energy transition, thanks to their abundant potential in renewable sources such as solar, wind, hydroelectric and geothermal. However, the efficient and sustainable use of these resources depends to a large extent on the development and integration of technologies that guarantee a continuous, stable and quality supply in all sectors of society.

In this context, energy storage emerges as a technological alternative that allows electricity generated at times of low demand to be accumulated for use when generation decreases or demand increases. This function is essential to manage the intermittency of sources such as the sun and wind, whose availability varies throughout the day and the seasons. In a region with high renewable potential and high climate variability, such as Latin America and the Caribbean, this regulatory capacity is essential to ensure the reliability of the electricity system.

In addition, it offers a strategic opportunity to electrify rural, isolated or island areas, where extending distribution networks is expensive or unfeasible. Through decentralized solutions based on hybrid systems (solar + batteries, for example), it is possible to bring clean, safe and continuous energy to communities historically excluded from energy access, improving their quality of life and development opportunities.

From an economic point of view, storage makes it possible to reduce dependence on fossil fuels - in many cases imported -, stabilize energy costs, optimize the use of existing electricity infrastructure and postpone costly investments in generation and networks. It also opens the door to new business models, such as microgrids, distributed generation or the use of storage as a provider of complementary services in more advanced electricity markets.

In environmental terms, storage directly contributes to the decarbonization of the energy matrix by avoiding the use of backup thermal plants and facilitating the penetration of clean sources. This makes it a key ally for countries in the region to meet their climate commitments under the Paris Agreement and move towards low-emission development. Finally, in a regional context marked by vulnerability to natural disasters, energy crises

and structural inequalities, energy storage contributes to improving the resilience of electricity systems, allowing a faster and more efficient response to emergencies, cuts or fluctuations in supply.

## 1.2. Nature of the Challenge

The integration of renewable energy sources into the electricity systems of Latin America and the Caribbean has brought significant benefits in terms of sustainability, emission reduction and diversification of the energy matrix. However, the variable nature of these sources introduces new technical and operational challenges that must be properly managed to ensure system stability and efficiency.

Among the main aspects that characterize this problem are:

- Time variability: Solar generation is restricted to daylight hours and is affected by climatic factors such as cloudiness, latitude, and season. Wind generation, on the other hand, has even greater variability, as wind intensity can change suddenly even in a matter of minutes. This variable nature makes it difficult to schedule and continuously control power generation.
- Gap between supply and demand: In many cases, renewable generation does not coincide with energy consumption peaks. For example, solar production peaks at noon, while the highest levels of demand are usually recorded in the early hours of the morning and at night, when there is no solar availability. This desynchronization generates the need to have mechanisms that allow the surplus to be stored and released when required.

- Difficulties in electrical planning and dispatch: The growing participation of intermittent renewable sources reduces the prediction capacity of the electrical system, which complicates the economic dispatch of generation. This uncertainty requires the maintenance of constant operating reserves or the use of thermal plants as backup, affecting the overall efficiency of the system.
- Overgeneration and energy dumping: In certain contexts, especially during periods of high renewable production and low demand, the electricity system does not have the capacity to absorb all the energy surplus. This leads to the phenomenon known as discharge, in which clean energy is wasted due to the lack of storage infrastructure that allows it to be conserved and used at times of greater demand.

These conditions show the need for technological solutions that mitigate the effects of intermittency, guarantee the continuity of supply and optimize the use of renewable resources.

In Latin America and the Caribbean, many countries have opted for a rapid expansion of renewables, but the lack of associated storage limits the efficiency of the system, producing economic losses, also forcing the maintenance of backup fossil plants, which contradicts the decarbonization objectives.

## 1.3. Storage Role

Faced with the situation described, in general terms, storage plays a crucial role in allowing:

- Store surplus and release during peak demand (e.g. batteries, compressed air, molten salts, hydrogen).
- Provide frequency regulation and voltage control services, maintaining the stability of the system in the face of sudden variations.
- Smooth generation curves (peak shaving), reducing the need for fossil backup plants.

• Increase renewable penetration capacity, allowing more solar or wind projects to connect without destabilizing the grid.

From an operational point of view, storage is an enormously useful resource for operators and electrical systems for its contribution to:

- Intermittent management: Storage allows smoothing the hourly and seasonal variations of solar and wind generation, guaranteeing a more constant supply.
- Load shifting: Energy generated during production peaks can be stored for use at peak times, reducing dependence on fossil sources.

- Backup and continuity of supply: In isolated or rural systems, storage improves energy autonomy, reducing outages and interruptions.
- Dispatch optimization: In interconnected networks, storage improves the operational efficiency of the system by reducing the need for revolving reserves and backup generation.

In summary, energy storage contributes to the optimization of the use of variable renewable sources, improves the stability of the electricity grid and facilitates access to energy in isolated communities. Its positive effects further contribute to reducing dependence on fossil fuels by avoiding the emission of greenhouse gases.

## 1.4. Global trends and their impact on the region

Global trends in energy storage show exponential growth, driven by the rapid cost reduction of lithium-ion batteries (a drop of close to 90% between 2010 and 2023, according to IRENA), improvements in energy density and scalability, which consolidates them as the dominant technology in grid-scale deployments and applications behind the meter. In parallel, long-lasting technologies such as flow batteries, thermal storage and hydrogen are beginning to position themselves to cover flexibility and backup services over broader time horizons. At the regulatory level, there is a growing incorporation of mechanisms that recognize storage as a strategic asset, enabling its participation in energy, capacity and ancillary services markets.

In Latin America and the Caribbean, energy storage shows a growing trend marked by the rapid incorporation of large-scale battery systems (BESS) associated with solar and wind projects, the development of hybrid tenders (renewable + storage) and the preparation of specific auctions for capacity and flexibility.

Countries such as Chile, Brazil and Mexico lead the region by integrating explicit goals into their energy planning, while others, such as the Dominican Republic, Honduras and Argentina, are moving forward with pioneering projects that

will serve as a reference for neighboring markets. At the same time, there is growing interest in diversifying technologies - including hydraulic pumping, thermal storage and even hydrogen - and in adapting regulatory frameworks to recognize storage as an independent resource capable of participating in energy, capacity and ancillary services markets.

Regional trends are nuanced by:

## Growing recognition of storage as a necessary technology

Most countries have started to include storage in their national energy plans, climate policies and rural electrification strategies. Even without specific regulation, storage is already seen as a necessary complement to the expansion of renewable energies.

#### Predominance of pilot projects and isolated schemes

Many countries have initiated demonstration projects with international cooperation support, mainly in rural areas, islands or with weak networks. These experiences have served to validate the technical and social feasibility of storage, but have not yet been scaled to national levels.

## Orientation towards electrochemical storage

Lithium-ion batteries are the most widely implemented technology, due to their modularity, availability in the market and ease of installation, factors that add to a sustained reduction in prices. Other technologies such as thermal, gravitational or chemical storage (green hydrogen), are still in the early stages or evaluation.

## Strong participation of multilateral organizations

Regional organizations such as the Latin American Energy Organization (OLADE), international agencies such as the International Renewable Energy Agency (IRENA) and the Green Climate Fund, and multilateral banking (IDB, World Bank, CAF), have been important actors in the promotion of storage, through financing, technical assistance and local capacity building.

## 2. Energy storage in Latin America and the Caribbean

Within the framework of the global energy transition, energy storage has become an essential component to ensure the stability, efficiency and sustainability of electricity systems. Its ability to manage the intermittency of renewable sources, optimize demand and improve energy resilience positions it as a strategic tool for developing countries. In this context, Latin America and the Caribbean face the double challenge of taking advantage of its enormous potential in renewable energies and, at the same time, advancing in the integration

of energy storage within their energy matrices.

The region has begun to take important steps in this area, driven by the growth of solar and wind projects, the interest in green hydrogen and the need to improve access to energy in remote areas. However, the degree of progress is heterogeneous among countries with institutional limitations and structural barriers that must be overcome. Storage technologies are still at an incipient stage compared to other regions of the world.

## 2.1. Energy outlook of the region

Latin America and the Caribbean have a diverse and constantly evolving energy matrix, characterized by a high share of renewable sources, especially hydroelectric, and a growing interest in the expansion of solar, wind and geothermal energy. However, this energy wealth coexists with inequalities in access, dependence on fossil fuels in certain countries, and challenges in infrastructure and regulation. This evolution also introduces new operational challenges, especially in terms of variability, security of supply and resilience to extreme weather events.

As the share of intermittent sources such as solar and wind grows, the need to incorporate energy storage systems that efficiently manage surpluses, stabilize the electricity grid and guarantee supply during periods

of low generation becomes evident. This need is even more critical in island countries, rural areas or regions with weak electricity networks, where storage may represent the only viable way to ensure reliable and sustainable energy access.

According to the information of the Energy Outlook of Latin America and the Caribbean, OLADE 2024, in 2023 25 GW of renewable capacity were installed, of which 16 GW were solar photovoltaic technology, 7 GW wind and 2 GW hydro, with which wind and solar generation reach a share of 21% of installed capacity and 15% of electricity generation throughout the region. By 2024, the estimate of new renewable additions amounts to 40 GW. At the end of 2025, it is estimated that wind and solar production will reach 20%.

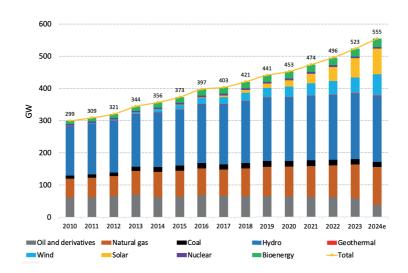


Figure 1 OLADE - Evolution of Installed Capacity for Electricity Generation in LAC

For its part, the prospective studies carried out by OLADE determine that, in the BAU (Business As Usual) scenario, total electricity generation capacity will grow from 520 GW in 2023, to 736 GW in 2030 and 1549 GW in 2050, while to reach the NET-0 (net zero emissions) scenario, electricity generation

capacity will have to grow to 825 GW in 2030 and practically quadruple to 2155 GW in 2050. For wind and solar renewable generation sources, an increase of 241 GW is estimated by 2030 and 1205 GW by 2050, reaching a share of 43% in 2030 and 61% in 2050.

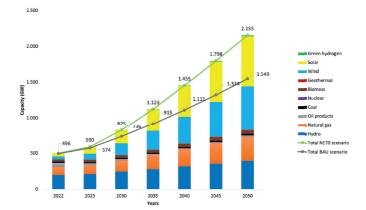


Figure 2 Energy Prospective 2050, OLADE

In the scenario of net zero emissions by 2050 (NET-0), the following variations are presented in relation to the participation of the different technologies in the base year of the study (2022):

- Hydro's share is reduced from 40% to 18%
- The share of solar and wind increases from 17% to 61%
- Oil and coal reduce their share from 13% to 1%
- Natural gas reduces its share from 22% to 16%

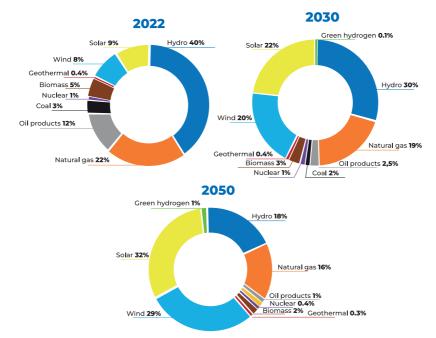


Figure 3 Structure of installed electricity generation capacity, LAC, NETO scenario, OLADE

OLADE has not yet included an estimate on storage incorporation in its prospective analyses, while the IEA assumes that a 3x multiplication in renewable installed capacity by 2030 requires a 6x multiplication in installed storage capacity.

## 2.2. Technological advances and early implementations

In recent years, several countries in the region have begun to incorporate storage systems, especially lithium-ion batteries, in combination with solar and wind projects. These systems have been used to:

- Provide electrical support in rural or isolated communities, such as in the Galapagos Islands (Ecuador), Patagonia (Argentina) or Amazonian areas of Brazil and Peru.
- Integrate with hybrid microgrids in places without connection to the national grid.
- Stabilize distributed generation systems in urban or industrial areas.
- Provide ancillary services, such as frequency regulation, in partially liberalized electricity markets.

The most used technologies so far are electrochemical batteries (mainly lithium-ion), due to their modularity, commercial availability and relative ease of installation. Explorations have also begun in other solutions such as: thermal storage (Chile), hydraulic pumping (Argentina and Brazil), hydrogen and green ammonia systems (Chile, Brazil, Colombia). No developments of systems based on flywheels and gravitational storage have been identified.

Countries such as Chile, Brazil and Mexico have taken the first steps to include storage in their energy expansion plans, although only Chile, plus Guatemala and the Dominican Republic have specific regulations.

Argentina, Costa Rica, El Salvador, Ecuador, Honduras, Peru and Uruguay are developing action plans that include proposals and design of regulatory mechanisms to enable storage.

These initial experiences have been essential to adapt technologies to regional contexts, identify operational challenges and build technical capacities on the ground. In

addition, they have opened the way for new business models, financing schemes and regulatory reforms that recognize the value of storage in the energy system.

## 2.3. Installed capacity and projects in operation

Energy storage in Latin America and the Caribbean has been modest but progressive over the last decade and has begun to consolidate as an essential component in the energy transition. Although installed capacity is still limited compared to regions such as Europe, Asia or North America, projects in operation in the region have demonstrated the technical feasibility and strategic value of storage, both for the integration of renewable energies and for the strengthening of weak or isolated electrical systems.

As countries in the region advance their energy transition agendas and strengthen the integration of intermittent renewables, storage has begun to gain relevance in both large-scale projects and distributed, community or isolated solutions. Installed energy storage capacity has seen remarkable growth in recent years, although it is still at an early stage compared to other regions.

Table 1 Estimated Installed Capacity 2025 (MW)

## **STORAGE INSTALLED CAPACITY IN LAC** (As of July, 2025)

		COUNTRY	BESS (MW)	HYDRO (MW)	VOLINERTIA (MW)
1	•	Argentina	17.50	974	
2	Ψ	Barbados	5,00		
3	•	Belize			
4		Bolivia			
5		Brazil	171,25	20	
6	*	Chile	1105,00		
7		Colombia	8,90		
8	•	Costa Rica	9,50		
9		Cuba	10,00		
10	-81	Ecuador			
11	0	El Salvador	64,00		
12		Grenada Guatemala			
13 14	w		27.72		
15		Guyana Haiti	23,32 18.00		
16	:-:	Honduras	16,00		
17		Jamaica	20.00		4,5
18	•	Mexico	192.00		4,5
19		Nicaragua	0.20		
20	*	Panama	0.37		
21		Paraguay	0,07		
22		Peru	26,50		
23		Dominican Republic			
24	*	Suriname .	9,00		
25		Trinidad and Tobago	0,00		
26	•	Uruguay	0,03		
27	778	Venezuela	0,00		
		SUBTOTALS	1.680,57	994	4,5
		TOTAL 2025		2679,07	
		In Percentage	62,73%	37,10%	0,17%

Source: Own elaboration

The availability of specific, up-to-date data on installed storage capacity across the region is limited. However, based on a collection of data from different sources, it is estimated that until June 2025 the region has an installed

storage capacity of approximately 2.7 GW, adding operational projects of different types, mainly battery and hydraulic pumping systems, without neglecting some thermal storage projects.

### 2.4. Development of storage systems

The degree of development of storage is different according to the conditions of each country, including its energy matrix, the regulatory framework, the availability of renewable resources and the investment capacity. In Latin America and the Caribbean, this diversity is reflected in the presence of regional leaders with large-scale projects and consolidated regulations, intermediate-stage countries with significant but still limited progress, and nations where storage remains in its nascent or pilot phase. This classification into three categories - greater development, medium development and very little development - allows us to identify both current strengths and opportunities to accelerate the adoption of storage solutions that promote the integration of renewable energies, the flexibility of the electricity system and regional energy security.

#### 1. More developed countries

This category includes countries with significant installed capacity, operational flagship projects and a robust pipeline, in addition to ongoing regulatory frameworks and in some cases with storage incorporated into their planning.

- Chile Regional leader, 1 GW of operational BESS, target 2 GW by 2030, large-scale projects under implementation and others in the pipeline.
- Brazil 685 MWh installed in BESS, hydraulic pumping in operation, first specific rules in development, industrial incentives (PPB).
- •Mexico 192 MW BESS installed, technical standards published in 2025, obligation to include storage in renewable projects.
- Argentina 17.5 MW BESS and 974 MW

of hydraulic pumping, first hybrid solar + storage projects in tender.

 Honduras – Awarded project of 75 MW / 300 MWh, the largest in Central America.

#### 2. Medium-developed countries

This group includes countries with moderate installed capacity, pilots or projects under construction, but with incomplete or early-stage regulatory frameworks.

- Peru: 26.5 MW BESS operational, regulatory debate open to enable storage services.
- Costa Rica: 9.5 MW, BESS pilots on ice, no mass deployment yet.
- Ecuador: definition of storage included in energy reform. Microgrids project with BESS in the Galapagos (Conolophus 40.9 MWh project) to be completed.
- Jamaica: 24.5 MW Li-ion hybrid + flywheel from 2019, expansion plans.
- Dominican Republic: Target of 300 MW BESS by 2027, tender in process.
- Uruguay: Technical evaluations and pilot projects, favorable regulatory environment.
- Paraguay: According to ANDE's 2021-2040 Generation Master Plan, seven projects have been identified that combine PV with battery storage.

#### 3. Other countries.

The rest of the countries in the region report a lower installed capacity, absence of a defined regulation or with initiatives only in the announcement/pilot stage.

## 2.5. Storage requirements in the countries of the region.

The application of energy storage systems (ESS) must consider the renewable energy incorporation goals of each country, as well as the specific characteristics of its electrical systems and their technical, geographical, economic and energy conditions. Latin America and the Caribbean is a diverse

region, where energy needs vary according to the degree of electrification, matrix composition, grid quality, and energy transition targets. Below is a synthesis of a general analysis by country, highlighting the needs and approaches in energy storage:

Table 2 Storage requirements of Latin American and Caribbean countries

#### Storage requirements of Latin American and Caribbean countries

		Country	Renewable Target Se	torage Requirement
1	-	Argentina	20% renewable electricity in the mix by 2025 (Law 27.191)	Improve the reliability of the electrical system, reduce marginal costs and ensure supply during peak demand.
2	Ψ	Barbados	100% renewable generation by 2030	BESS to stabilize the grid and facilitate energy transition on islands
3		Belice	85% of electricity from renewable sources by 2030	Microgrids and solar systems with storage for rural communities
4	-	Bolivia	79% electricity with renewables by 2040 (National Strategy)	Evaluation of solutions for system stability
5	•	Brasil	45% of total energy and 84% of elect with renewables (sustained target to	tricity Water storage with pumping and batteries for efficiency. o 2030) Pumping + battery projects with targets of 1 GWh by 2030.
6	<u>-</u>	Chile	70% renewable electricity generation by 2030	BESS for network stability and continuity. At least 1,500 MWh of BESS under development by 2030.
7		Colombia	30% non-conventional renewable share by 2030	Need to conduct studies to determine system needs.
8	0	Costa Rica	99% renewable electricity matrix maintained until 2030	Storage to manage variability
9	<b>&gt;</b>	Cuba	24% renewable share in the energy matrix by 2030	Battery systems for island network backup and stability. 200 MW of BESS planned, 10 MW already installed.
10	-8-	Ecuador	35% non-conventional renewable electricity by 2030	Storage integration in isolated networks and hybrid systems
11		El Salvador	60% renewable electricity generation by 2026	BESS for grid stability and solar backup. 14 MW / 10 MWh operational in Neoen projects
12		Grenada	100% renewable electricity and transport by 2030	Airport BESS, island microgrids and distributed storage
13	G.	Guatemala	80% renewable electricity by 2030	Storage systems for reliability and regulation
14	<b>&gt;</b>	Guyana	70% renewable electricity by 2035 (LCDS 2030)	Storage in microgrids and solar hybrid projects in rural areas, 34 MWh already committed to hybrid solar projects.
15		Haiti	35% electricity coverage with a focus renewables (target with international	s on Solar microgrids with BESS for hospitals, communities and al support) industrial sectors
16	1+1	Honduras	60% renewable generation by 2030	BESS on grid and solar hybrid projects for night backup. BESS 75 MW / 300 MWh project awarded (2025)
17	×	Jamaica	50% renewable energy in electricity generation by 2030	BESS in solar/wind projects, storage for frequency regulation. Regulatory target: 493 MW of BESS (2h) until 2041 (~986 MWh)
18	•	Mexico	35% of clean generation by 2024 (target established by the Energy Tra	PV + BESS in hybrid projects and recent regulation ansition Law)
19		Nicaragua	52% renewable participation by 2023 and growing target	3 Storage for rural electrification and microgrids
20	*	Panama	70% of renewable generation by 205 (Law 6 of 2020)	Tenders that integrate storage in renewable projects. At least 50 MW / 200 MWh considered in tenders.
21		Paraguay	100% renewable electricity already achieved (mostly hydroelectric)	Complement with storage for seasonal flexibility. 40–70 MWh planned for international investments (2024-2025).
22		Peru	15% non-conventional renewable shain electricity generation by 2030	are Support for variable sources and new regulation for BESS
23	==	Dominican Republic	25% renewable in electricity generat by 2025, 30% by 2030	Storage to stabilize network and manage intermittency. 200 MW / 400 MWh in current auctions (2024)
24	*	Suriname	100% renewable rural electrification with microgrids by 2030	Hybrid microgrids with thermal storage and batteries in indigenous villages. 5.3 GWh/year estimated by combined rural microgrids.
25		Trinidad and Tobago	30% installed capacity in renewables	s by 2030 Microgrids and potential battery manufacturing
26	•=	Uruguay	98% renewable electricity matrix sus since 2018	stained According to the studies carried out, the current need to incorporate storage has not been identified
27		Venezuela	Proposal for renewable diversificatio energy transition (without clear targ	

Source: Own elaboration

## 3. New Energy Storage Technologies

As the share of renewable energies in the electricity matrix grows, it becomes essential to have technologies capable of storing surplus energy to be used at times of high demand or low generation, thus guaranteeing the continuity and quality of the electricity supply.

There are various types of energy storage, classified according to: i) its operating principle; ii) the type of energy they store;

iii) their capacity, response speed; and iv) specific applications within the electrical system. These technologies range from widely known systems such as electrochemical batteries, to more complex solutions such as thermal, mechanical or chemical storage (including green hydrogen).

## 3.1. Electrochemical storage (batteries)

Electrochemical storage, mainly using batteries, has become a substantial technology for the energy transition in Latin America and the Caribbean. Lithium-ion batteries are the most widespread today thanks to their efficiency, fast response times and high energy density, although alternatives such as flow and sodium-sulfur batteries are beginning to be incorporated into large-scale projects.

In this context, Battery Energy Storage Systems (BESS) play a central role. Its function is to accumulate renewable surpluses in times of low demand and release them when generation decreases, stabilizing the grid and improving the integration of solar and wind. This process is optimized by intelligent management software that maximizes efficiency and reduces costs.

#### Technological advances

BESS have evolved into lithium-ion batteries with higher density and shorter charging time, and into emerging developments such as solid-state batteries, with more safety and lifespan. Hybrid systems that combine storage with hydrogen or thermal, and integration with smart grids supported by Al and big data are also incorporated. Recycling and second life strategies are also gaining relevance, reusing modules in lower-demand applications, recovering critical minerals and promoting models such as Battery-as-a-Service.

#### **Benefits of BESS**

The benefits cover different levels of the electrical system:

- They stabilize the network in milliseconds, improving the quality of supply.
- They facilitate the integration of renewables by avoiding discharges.
- They reduce operating costs by displacing backup fossil generation.
- Increase energy security in emergencies.
- They participate in ancillary services such as frequency regulation and voltage control.
- They contribute to optimizing the existing infrastructure, by deferring new investments in transmission and distribution.



Figure 4 BESS Storage Plant

#### Components of a BESS:

A BESS system is made up of several main components: electrochemical batteries, the power conversion system or bidirectional inverter (PCS), which transforms direct current into alternating current and regulates charge and discharge flows; transformers, which adjust voltage levels for safe integration with the grid; fire suppression systems, which ensure operational safety; and HVAC systems, which control internal temperature to preserve battery performance.

#### BESS App:

As for applications, BESS can be used in backup power, supplying electricity in the event of grid failures; in peak shaving, reducing the need for additional generation during high demand hours; and in grid connection, supporting with frequency regulation services, voltage support and general stabilization of the electrical system. These functions make electrochemical storage a strategic resource for the modernization of electrical systems in the region.

#### Role of grid forming in the BESS

An emerging aspect in the development of battery storage systems is their ability to operate in grid forming mode. Unlike grid following, where batteries rely on the signal of an existing grid to synchronize, grid forming allows BESS to act as virtual generators capable of setting the frequency and voltage of a power grid. This feature is essential for systems with high penetration of intermittent renewable energies, since it allows to maintain the stability of the system even in low inertia scenarios, where traditional sources of synchronous generation (such as hydroelectric or thermal) have less participation.

The deployment of BESS with grid forming capability represents a strategic opportunity to improve the resilience and reliability of the network. By assuming functions of frequency control, voltage regulation and provision of synthetic inertia, these systems enable more stable operation of isolated grids, rural microgrids and interconnected systems with high renewable variability. In practice, this opens the door to reducing reliance on backup fossil power plants and accelerating the transition to cleaner, more flexible and safer electrical systems.

## 3.2. Mechanical storage

Mechanical storage is about harnessing kinetic or gravitational energy to store and release electricity efficiently. In Latin America and the Caribbean, these technologies are being explored in various applications.

#### Types of mechanical storage

• Hydraulic pumped storage: It is based on the pumping of water to an upper reservoir when there is surplus energy and its release to generate electricity at times of high demand.

- Flywheels: Systems that store energy in a high-speed rotating disk, allowing rapid delivery of energy when it is needed.
- Gravitational storage: Emerging technology that uses the lifting and lowering of heavy masses to store and release energy efficiently.

### 3.2.1. Pumped storage hydropower (PSH)

Pumped Storage Hydropower (PSH) is one of the most mature and widespread technologies for large-scale energy storage. It works by pumping water from a lower reservoir to an upper reservoir when there is surplus energy in the network. Subsequently, when demand increases, water is released and flows through generating turbines, producing electricity. It is a configuration of two reservoirs of water at different heights that can generate energy as the water descends from one to the other (discharge), passing through a turbine. The system also requires energy to pump water back to the upper reservoir (recharge). PSHs work similarly to a giant battery, as it can store energy and then release it when needed.

#### 3.2.2. Flywheel storage.

Flywheel storage, also known as rotational or kinetic energy storage, is a technology that allows electrical energy to be accumulated and released by rotating a disc or cylinder at high speed. This type of system converts electricity into kinetic energy through an electric motor that accelerates the steering wheel, and then reconverts that energy into electricity when the steering wheel decelerates, using the same motor acting as a generator.

Although it does not reach the storage capacities of other technologies such as batteries or hydraulic pumping, flywheels offer very high efficiency, almost instantaneous response times and an extensive useful life, which makes them especially useful in applications that require short-term stability and regulation of the power grid.

#### 3.2.3. Gravitational storage.

Gravitational storage is an emerging technology based on a simple physical principle: the use of potential energy generated by raising a mass and its subsequent conversion into electrical energy by lowering it. This type of storage converts electrical energy into gravitational potential energy during periods of low demand, lifting large solid or liquid blocks, and then releases that energy when the mass descends and drives a generator.

Unlike pumped storage, which requires large volumes of water and specific geographical

conditions, gravitational storage uses solid materials (such as concrete or steel), so it can be installed in more diverse locations, including urban, industrial, or mining environments.

The system consists of a platform or crane that uses electrical energy to lift a set of heavy masses to a certain height. When energy is required, the masses descend in a controlled manner, operating an electric generator. The energy stored depends on three factors: the high mass, the height of the displacement and gravity.

## 3.3. Thermal storage

Thermal storage consists of the accumulation of energy in the form of heat for later use. Materials such as molten salts, hot water, and phase change materials are used to store thermal energy and release it when needed.

Thermal storage offers multiple advantages: it allows you to use energy at times of lower demand and lower cost to release it when needed, reducing consumption during peak hours and, with it, the electricity bill, by taking advantage of lower rates and avoiding the installation of additional generation systems at times of peak demand. In addition, by storing heat or cold, the performance of equipment

such as boilers, heat pumps or air conditioning systems is optimized, favoring the integration of renewable sources - such as solar thermal - and reducing the use of fossil fuels, which contributes to sustainability. It also provides reliability and backup, as it can serve as an alternative source in the event of power failures or outages, improving grid stability when used on a large scale. Its versatility allows it to be applied in building air conditioning, industrial processes, solar thermal power plants or refrigeration, and, if combined with renewable energies, it has a very low environmental footprint.

#### 3.3.1. Carnot Batteries

Carnot batteries are an emerging technology of long-lasting thermal storage, which converts electricity into heat using heat pumps, stores it in low-cost materials (molten salts, concrete or rocks) and reconverts it to electricity through thermodynamic cycles. They offer storage scales of tens to hundreds of hours, with efficiencies of 40–70% [IEA, 2022]. Compared to electrochemical

batteries, they stand out for their low potential cost, the use of abundant materials and the option of integrating with industrial heat. Germany and Switzerland lead with pilots, while in China and the US laboratory projects predominate. Even without commercial deployment, they are projected as a key for seasonal storage and support for systems with high renewable penetration.

## 3.4. Chemical storage (hydrogen, green ammonia)

Chemical energy storage, in particular through green hydrogen and green ammonia, is an alternative with great potential to decarbonize industrial and energy sectors in Latin America and the Caribbean. These compounds make it possible to store renewable energy in the form of sustainable fuels that can be used in electricity generation, transport and heavy industries.

#### 3.4.1. Green hydrogen

Green hydrogen is produced by electrolysis of water using renewable energy, allowing energy to be stored in the form of hydrogen for later use in fuel cells or turbines, generating electricity without carbon emissions. Its advantages include zero pollutant emissions, as it does not produce CO<sub>2</sub> or greenhouse gases in its

production or use; it is an abundant source of energy as it comes from water, with even greater potential if technological advances allow seawater to be used; it solves the problem of the intermittency of solar and wind energy by storing their surpluses; it offers great versatility of use as a fuel for vehicles, heating, industrial

processes, and electricity generation; and it represents a viable alternative for sectors that

are difficult to decarbonize, such as steel and heavy transport.

#### 3.4.2. Green ammonia

Green ammonia is a renewable energy carrier produced from green hydrogen and nitrogen in the air, mainly used in the manufacture of fertilizers and also considered as a clean fuel for maritime transport and electricity generation. Its advantages include zero net carbon emissions, since it does not produce CO<sub>2</sub> in its manufacture if green hydrogen is used, thus replacing gray ammonia in agriculture and industry; its storage and

transport are simpler than those of pure hydrogen, since at moderate temperature and pressure it can be transported in existing tanks and ships; it has a high energy content by volume, which makes it attractive as fuel for ships, trains or electricity generation; and its versatility of use allows it to be used as an agricultural fertilizer, direct fuel or raw material for the chemical industry.

## 3.5. Levelized Cost of Storage LCOS

The growth of storage would have its fundamental basis in the reduction of costs. According to information from IRENA between 2010 and 2023, the costs of battery storage projects decreased by 89%, from USD 2511/kWh to USD 273/kWh, due to the expansion of manufacturing, the improvement of material efficiency and the optimization of manufacturing processes. By 2030, total installation costs could be reduced by 50% to 60% (and battery cell costs, even more), thanks to optimized manufacturing facilities, along with better combinations and lower

material use. Battery life and performance will also continue to improve, helping to reduce the cost of services provided. The cost of lithium-ion batteries for stationary applications is already in some cases less than USD 200 per kilowatt-hour.

One parameter that contributes to the analysis is the Levelized Cost of Storage (LCOS), an indicator that calculates the average cost for each megawatt-hour (MWh) of energy stored and shipped over the life of a storage system.

Table 3 Storage Technologies

	Technology	Typical Duration	Efficiency (%)	Estimated LCOS (USD/MWh)
9	Batteries (Li-ion)	2 – 8 hours	85 – 95%	140 – 300
E	Hydraulic pumping (PHS)	6 – 20 hours (some >100h)	70 – 85%	50 – 150
Ā	Thermal storage	4 – 15 hours	35 – 70%	30 - 100
0	Flywheels	Seconds – 1 hour	85 – 95%	200 – 400
	Gravitational	4 – 10 hours (some >20h)	70 – 80%	150 – 250
<b>=</b>	Green hydrogen	Days – months	25 – 45%	200 – 500
(4)	Green ammonia	Weeks – months	20 – 40%	250 – 600

Source: Own preparation.

Note: LCOS ranges may vary based on factors such as geographic location, system size, financing costs, and expected lifespan.

#### Factors influencing LCOS:

- Cost of Investment: Investment costs (materials, equipment, construction) represent a significant portion of LCOS.
- Operation and maintenance cost: The management, maintenance and repair of storage systems contribute to LCOS.
- System Lifespan and Efficiency: The lifecycle and efficiency of storage technology also impact LCOS.
- Charge prices (charging energy): If the storage is powered by renewable energy, the LCOS is affected by the prices of energy sources.

Lithium Ion (Li-ion) Batteries are currently the most widely used option for short term storage due to their high efficiency and decreasing costs. However, their LCOS may be higher in long-lasting applications.

On the other hand, Pumped Hydro Storage (PHS) is the most mature storage technology with the lowest cost per MWh, ideal for large-scale and long-lasting storage. Very applicable in countries in the region that have hydroelectric resources for new developments, or hydroelectric power plant infrastructure that can adapt and implement this system.

## 4. Regulatory framework and standards

## 4.1. Battery Storage System (BESS) Standards

The development and implementation of battery storage systems (BESS), which is the most developed technology in the region, requires the adoption of regulatory technical standards that ensure their safety, interoperability and performance under diverse operating conditions. These standards establish mandatory criteria and recommend good practices that cover the entire life cycle of the systems, including design, manufacture, installation, operation, maintenance, monitoring and final disposal of the batteries.

At the international level, bodies such as the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineers (IEEE) and Underwriters Laboratories (UL) have defined standards that regulate critical aspects such as: electrical and fire safety, electromagnetic compatibility, battery management systems (BMS), capacity and life cycle test procedures, communication protocols and recycling requirements. These standards constitute the baseline that countries must adopt or adapt to their national regulatory

frameworks, ensuring technical homogeneity and facilitating the integration of projects into electricity markets.

The BESS standardization landscape is relatively recent, but has evolved significantly since approximately 2016-2017, when key system- and facility-level standards were published.

#### Layered approach to standards:

BESS security is based on standards that cover different components and aspects of the system:

At the cell level: Focuses on the fundamental unit of the battery. Key standards include IEC/EN 62619 (lithium-ion industrial safety), ANSI/CAN/UL 1973 (US and Canada safety) and IEC/EN 62620 (performance). Chemical regulations, such as the EU Battery Directive, are also relevant.

Package/Module Level: Addresses the safety of assembled battery units. Relevant standards include the IEC 62933 series.

IEC/EN 62619, ANSI/CAN/UL 1973 and regional guides such as VDE-AR-N 2510-50 (Germany). The functional safety of control systems (such as BMS) is fundamental and is covered in standards such as IEC 60730-1 Annex H, IEC 61508 and UL 991+UL 1998. Electromagnetic compatibility (EMC) is addressed in the IEC/EN 61000-6 series.

At the PCS level: It covers the inverters/converters used with BESS. The main safety standards include EN 62477-1 and UL 1741. Network connection compliance usually refers to IEEE 1547/1547.1, EN 50549 or AS/NZS 4777.2.

At the system level: It covers the entire integrated BESS. The IEC 62933 series is fundamental in this case, together with UL 9540 (system security in USA /Canada). Fire safety testing methods are detailed in UL 9540A, along with Hazard Mitigation Analysis (HMA), to ensure identified risks are adequately addressed.

## The IEC 62933 series (Electric Energy Storage Systems):

This key IEC series focuses specifically on aspects of the ESS system. Its main sections include Part 1: Terminology, Part 2: Unit Parameters and Test Methods, Part 3: Planning and Installation (which provides essential guidelines for planning, design, installation, operation and maintenance, and system integration), Part 4: Environmental Aspects, and Part 5: Safety Considerations, which is of paramount importance and includes several elements:

- IEC 62933-5-1 (General Safety): Covers hazard identification, risk assessment methodology (likelihood and severity assessment, tolerable risk determination), mitigation requirements, validation/testing and documentation for network integrated systems. Requires a calculated design of overcurrent protection based on fault levels, conductor capacity, etc., with reference to IEC 60364-4-43.
- IEC 62933-5-2 (Safety of Electrochemical Systems): Specifies the detailed safety requirements for battery safety electrochemical systems (BESS) (e.g. lithium ions). Key areas

include hazard identification (electrical, mechanical, chemical and environmental); protection against electrical hazards (overvoltage, short circuit); critical thermal management to prevent thermal leakage; chemical hazard control (leaks, gases); fire safety (detection and suppression); system control/monitoring (voltage, temperature, system status); protection against mechanical hazards; safe installation and maintenance procedures (personnel safety, LOTO); and environmental robustness.

- IEC 62933-5-3 (Unplanned modification): Addresses safety when making unplanned modifications.
- IEC 62933-5-4 (Lithium-Ion Test Methods Draft): Will provide specific safety test methods for lithium-ion systems.

Battery specific safety: Standards such as IEC 62619 (industrial lithium ions) and IEC 63056 (specific lithium ions for energy storage systems [ESS]) define intrinsic safety requirements. UL 1973 is the North American equivalent.

Installation Standards: Beyond product/ system certification, specific installation standards are crucial for safety in location, design, construction, commissioning, and maintenance. Featured examples include NFPA 855 (US), AS/NZS 5139 (AU/NZ), VDE-AR-E 2510-50 (Germany) and TR 77 (Singapore). IEC 62485-2 also addresses the safety of secondary battery installation. Protection and mitigation systems: Effective safety relies on integrated systems such as BMS for monitoring and control, thermal management systems (TMS) and appropriately designed protection against overcurrent, faults and environmental factors. Advanced safety designs typically incorporate multi-level protection strategies (cell, module, rack, system), including measures for thermal leak prevention/ mitigation, explosion protection (ventilation, suppression), and fire suppression.

The importance of the application of standards in Latin America and the Caribbean In the case of Latin America and the Caribbean, harmonization with international

standards is essential to avoid technical barriers, reduce implementation costs and give confidence to investors. The correct application of these standards also allows the BESS to participate in critical services of the electrical system - such as frequency regulation, voltage control and contingency

backup - under verifiable safety conditions and with measurable performance. Therefore, the establishment of standards for BESS is a prerequisite for its safe, efficient and sustainable deployment in the regional energy transition.

## 4.2. Characteristics of leading storage countries

The countries with the greatest development in energy storage in the region stand out for having a relevant installed capacity, flagship projects in operation or new initiatives underway. Its progress is supported by regulatory frameworks that recognize storage as its own asset, integrate it into energy planning and guide it to improve the management of renewable intermittency. reduce discharges and strengthen the reliability of the system. These conditions, together with economic incentives, available financing and a long-term strategic vision, have made it possible to attract investment and

position them as regional leaders in the field.

An essential element in these cases is regulatory stability, which generates confidence for the execution of large-scale projects and encourages the arrival of private and multilateral capital, consolidating a favorable environment for its sustained expansion.

Among the main elements that characterize the countries with the highest level of development in storage, the following can be considered:

Figure 5 Essential Regulatory Elements



#### Clear Legal **Definition**

- · It recognizes storage as its own asset with specific functions.
- · Avoids barriers like grid double billing or taxes.



#### **Market Participation** and Remuneration

- Allow BESS to participate in:
- Energy market (arbitrage)
- · Payments for capacity/availability
- · Complementary services (frequency, voltage, reserve)
- · Compensation for reduction of discharges



#### Tendering and **Auction Schemes**

- · Designed to accelerate deployment:
- · Dedicated capacity/flexibility products
- · Hybrid tenders (Renewable+storage). · Long-term contracts (10-20 years)
- · Clear performance requirements



#### Integration into **Energy Planning**

- · Recognizes storage as a strategic resource:
- · MW/MWh targets in national plans
- · Priority areas with congestion/renewables · Coordination with generation and transmission
- Connection with climate policies



#### Adapted Interconnection Rules

- · Bidirectional recognition (loading + unloading)
- · Specific technical evaluation
- · Simplified procedures
- · Coordination with the system operator



#### **Differential Rate Treatment**

- · Avoid double billing for grid use
- Differentiated hourly rates (valley/peak incentive).
- Fixed income by capacity.
- Reduced charges.



#### Regulatory stability and investment signals

- Consistency in rules + respect for acquired rights.
- Chile: legal definition + capacity payments.
- Brazil: roadmaps and tariff discussions
- Mexico: new provisions for markets.
- Dominican Republic, Argentina, Honduras: tenders

### 4.3. Clear legal definition of storage

The regulations recognize storage as an own asset with specific functions (not only

as consumption or generation), which avoids barriers in charges for network use or taxes.

Table 4 Legal definition of storage in leading countries

Country	Main legal framework	Legal definition	Practical implications
<b>Chile</b>	General Electrical Services Law; Decree 70/2024	It explicitly recognizes storage facilities as a type of independent electrical installation, with its own rights and obligations.	It allows for capacity remuneration, participation in energy and ancillary services markets, and integration into energy planning.
<b>⊚</b> Brazil	Mme/ANEEL guidelines; PPB (2024)	Consider storage as a standalone asset, not just consumption or generation.	Preparation of specific rules for remuneration, access to capacity auctio and participation in free and regulated markets.
<b>■•</b> Mexico	General Administrative Provisions (DACG) 2025	It defines storage as an independent resource within the National Electrical System.	It enables interconnection and operatio in the SEN, participation in markets and obligation of integration in renewables i certain cases.
Argentina	Disperse regulation (Res. SE 67/2025 for tenders with storage)	Recognizes storage within the framework of tenders and hybrid projects.	It allows its inclusion in renewable and storage auctions, although without a unified framework yet.
Honduras	Initial framework for tender (2025)	Includes storage in tender bases for hybrid projects.	Enables the award of large-scale BESS projects in the regulated market.

Source: Own elaboration

## 4.4. Market participation and remuneration for services

In the countries of the region that are leading the development of energy storage, one of the regulatory pillars is to allow storage systems to actively participate in the electricity markets and receive remuneration for the different services they provide. This is not limited to the sale of energy, but encompasses a basket of diversified revenues ("revenue stacking") that improves the financial viability of the projects. Main forms of remuneration

#### Energy market (arbitrage)

Storage buys energy at times of low price (valley) and sells it at times of high price (peak).

It is essential that the regulation allows storage to participate on an equal footing with other generation units.

#### · Payments for capacity or availability

Economic recognition for providing firm

power to the system, contributing to security of supply.

Very relevant in systems with high renewable penetration, where backup power is scarce.

#### Complementary or ancillary services

Remuneration for services such as primary/secondary frequency regulation, voltage control, rolling stock and rapid response.

BESS are particularly competitive in these markets for their speed and accuracy of response.

### Compensation for reduction of spills

Some countries allow storage to be remunerated when it avoids the loss of renewable energy that would otherwise be wasted by congestion or oversupply.

Table 5 Market share and remuneration for services in leading countries

Country	Enabled markets	Methods of remuneration	Remarks
Chile	Spot energy market, capacity payments (Decree 70/2024), complementary services.	Energy arbitration, fixed payment for availability, revenue from frequency regulation and other ancillary services.	It allows to combine income from energy, capacit and services; growing interest in remuneration for reduction of discharges
Srazil	Capacity reserve auctions in preparation, ancillary services market under ONS.	Capacity payments, energy arbitrage, remuneration for systemic services.	Design for stable entry and participation in both regulated and free markets.
<b>■</b> ∗ <b>■</b> Mexico	Participation in the Wholesale Electricity Market (MEM) as an independent resource (DACG 2025).	Sale of energy and capacity, provision of related services, demand response programs.	Diversified income with potential for long-term contracts in capacity and services.
Argentina	Renewable+storage hybrid tenders.	Payments for energy and capacity implicit in PPA contracts; yet no ancillary market developed for BESS.	Model based on bilateral contracts or specific auctions.
Honduras	Tender 75 MW/300 MWh with contract for availability.	Fixed income due to availability, possible remuneration for network support and frequency control.	Initial focus on regulated market with potential for expansion to additional services.

In all these cases, the common principle is that storage is not limited to a single revenue stream, but is recognized for its multifunctional value in the electrical system. This diversity of remuneration sources is necessary to attract private investment and close long-term financing.

## 4.5. Specific tendering schemes or auctions

In the countries in the region that are leading the deployment of storage systems, competitive tendering and auction processes have been essential tools to accelerate the incorporation of this technology, ensure stable revenues and generate clear signals to investors. These schemes allow storage to compete or be contracted under conditions adapted to its technical and economic nature, preventing it from being at a disadvantage compared to other technologies such as thermal generation.

## Common features of schemes in leading countries

#### Dedicated product design

Capacity or flexibility auctions that create a specific product for storage, separate from renewable energy or conventional generation.

Prevents storage from competing for a single price against technologies with different cost structures.

#### Integration into hybrid tenders

Requirements that demand or reward the incorporation of storage in renewable projects (solar or wind), to improve their firmness and delivery time profile.

#### Long-term contracts

Typical durations of 10–20 years, with fixed payments for availability or for power delivered, which ensures certainty for financing.

#### Performance requirements and KPIs

Clear criteria on minimum availability, response time, unloading duration, efficiency and operational capacity in contingencies.

Table 6 Tendering schemes - storage auctions in leading countries

Country	Type of tender/auction	Integration with renewables	Contractual modality	Current status
Chile	Incipient integration of storage in supply tenders and complementary services.	Evaluation of specific products for BESS in future auctions.	Mainly merchant or associated with renewables; auctions could include capacity and flexibility.	Under evaluation
<b>⊘</b> Brazil	Design of reserve capacity auction with product dedicated to storage.	Participation in regulated auctions and free market contracts.	Specific product for BESS with capacity payment.	In preparation
■• Mexico	DACG 2025 enables BESS participation in long-term auctions and MEM	Potential to integrate BESS into renewable tenders.	Long-term contract for energy and capacity; no exclusive BESS product yet.	Enabling framework
Argentina	Resolution SE 67/2025 for renewable+storage hybrid tenders.	Prioritize firm delivery and a stable time profile.	PPA contract with implicit energy and capacity payments.	Operational
Honduras	2025 tender for 75 MW / 300 MWh exclusively for storage.	Contract for availability with fixed payments.	Exclusive BESS product with clear availability and response KPIs.	Operational

### 4.6. Integration into energy planning

In the countries of the region that are leading the development of storage systems, energy planning is not limited to identifying generation and transmission needs, but explicitly incorporates storage as a strategic resource for the operation and expansion of the electricity system. This implies that authorities and network operators consider storage as a tool for flexibility, security and optimization of infrastructure investments.

## Common features of integration in leading countries

#### Quantitative targets

They set storage capacity targets in MW/MWh within national plans or sector strategies, with short, medium and long-term horizons.

#### · Identification of priority areas

Location of projects in regions with high renewable penetration, transmission congestion or low resilience, to maximize systemic impact.

## Generation-transmission-storage coordination

Use of storage as an alternative to new lines or network reinforcements ("non-wires alternatives"), optimizing investments and execution times.

#### Incorporation into planning scenarios

Models that simulate the storage operation to cover demand ramps, absorb renewable surpluses and provide auxiliary services

#### Linkage with climate and energy transition policies

Storage is presented as an enabler to achieve renewable energy and decarbonization goals.

Table 7 Integration in Energy Planning in leading countries

Country	Planning document/scope	Quantitative targets (MW/MWh)	Priority Areas/ Locational Criteria	Role of storage in planning	Status
<b>C</b> hile	Sector strategy/planning; integration in transmission expansion	Target 2 GW BESS to 2030; Atacama Oasis megaproject (~11 GWh) in pipeline	Norte Grande (high solar, spills) and critical driveshafts	Flexibility, reduction of discharges, capacity support and complementary services; generation-transmission -storage coordination	Operational /Explicit targets
<b>♦</b> Brasil	Ten-year Plan of Energy Expansion (PDE) and guidelines MME/ANEEL	Indicative objectives linked to capacity products (in design)	Areas with congestion and high renewable penetration; regional pilots	Support for renewables, deferral of networks (non-wires alternatives) and provision of systemic services	In Implementation / Rules in Preparation
<b>■•</b> México	PRODESEN 2025–2039 and CENACE criteria for integration of resources	Scenarios with BESS to increase reliability and solar/wind penetration	Strategic nodes with congestion and steep ramps	Arbitration, capacity and related services; support for safe operation and congestion reduction	Enabling framework /Scenario integration
- Argentina	Planning of renewable+storage (SE) hybrid tenders	No unified target; firmness/schedule requirements in bidding bases	Regions with higher intermittency and network restrictions	Delivery profiling, capacity backup and congestion relief	Operational (tenders) /Evolving framework
Honduras	Expansion plan with 75 MW / 300 MWh project as key infrastructure	Implicit objective: cover peaks and improve system reliability	Island systems and critical nodes of the SIN	Contract for availability, reliability support and peak cost reduction	Operational (award) /Integrated in plannir

In these countries, the integration of storage into energy planning sends a clear signal to investors and operators: it is not an optional resource, but an essential piece to achieve the energy transition, improve system reliability and optimize the use of existing infrastructure.

## 4.7. Adapted interconnection rules

In the region's leading energy storage countries, interconnection rules have been adjusted or designed specifically to reflect the dual nature of storage: the ability to consume and generate energy. An adapted interconnection framework reduces technical barriers, streamline paperwork, and ensures that a BESS's connection is evaluated against criteria consistent with its actual operation.

#### Common features:

## Recognition of storage as a two-way resource

The regulation stipulates that charging and discharging flows must be recorded separately, preventing the storage system from being treated solely as generation or consumption.

#### Specific technical evaluation

Connection studies that consider operation profiles, fast ramps, nominal discharge

power and energy absorption capacity at off-peak hours.

#### Simplified procedures

Shorter timeframes for processing applications, integration with hybrid renewable processes and reduction of redundant requirements.

#### Coordination with the system operator

Definition of clear protocols for dispatch, frequency, voltage and reserve control, maximizing the contribution of storage to the stability of the grid.

## Tariff treatment linked to interconnection

Applying network connection and usage charges that avoid double charging and reflect the systemic value of storage.

Table 8 Interconnection rules adapted in leading countries

Country	Regulatory framework	Interconnection mode	Key technical aspects
Chile	General Electrical Service Law; Decree 70/2024	Renewable hybrids +BESS with a single connection point and integrated control; two-way recognition.	Studies consider rapid response and reduction of discharges; deadlines coordinated with renewable projects.
<b>◆</b> Brazil	ANEEL/ONS standards in development	Flexibility for stand-alone and associated renewables; planned bidirectional treatment.	Definition of technical parameters for connection; integration into capacity auctions.
<b>■</b> • Mexico	DACG 2025 – CENACE technical criteria	Evaluation of loading/unloading profiles and related services; independent resource.	Adapted procedures; coordination with demand response programs.
Argentina	Hybrid tender bases SE 67/2025	Connected storage under the same point as renewable plant.	Optimize time profile and firm delivery; rules focused on hybrid projects.
Honduras	Tendering bases 75 MW/300 MWh (2025)	Technical specifications and protocols with national operator.	Designed to maximize reliability and network support; contract for availability.

In these countries, tailored interconnection rules not only facilitate the technical connection of storage, but also shorten development times,

improve operational integration, and reduce uncertainty for investors-critical factors for driving large-scale projects.

#### 4.8. Differential rate treatment

In the countries of the region that have made the most progress in energy storage, a fundamental element within the regulatory framework is the application of differentiated tariff treatments that recognize the operational particularities of storage systems. The main objective is to eliminate economic barriers that could discourage its deployment and, at the same time, optimize its use for the management of the electrical system.

A central aspect is to avoid double charging for network use. Since storage is connected to both charge and discharge energy, in a traditional scheme it could be subject to transmission and distribution charges in both operations, which would artificially make its operation more expensive. Leading countries have modified their rules so that charging is done only in one of the phases or with reduced rates, so that storage is not penalized by its double condition of charging and generation. Another common measure is to offer differentiated hourly rates that encourage charging in periods of low demand and low cost - for example, night hours or with high

renewable production - and discharge in peak periods, when energy is more expensive or scarce. This not only improves the profitability of the projects, but also contributes to the balance and stability of the grid.

In Chile, although the specific tariff scheme for BESS is still evolving, Decree 70/2024 and capacity recognition allow these systems to receive fixed availability revenues, which partially compensates for the absence of a consolidated differentiated network charge.

In Brazil, regulatory adjustments are discussed so that BESS pay reduced network usage fees, especially when providing systemic services such as frequency regulation or fast backup.

In Mexico, the General Administrative Provisions (2025) open the door to preferential charging schemes and participation in demand response programs, which can translate into lower access costs and greater commercial flexibility for storage operators.

Table 9 Differentiated tariff treatment in leading countries

Country	Framework/ current status	Tariff measures	Expected impact
Chile	In evolution; Decree 70/2024 recognizes capacity and allows fixed income due to availability.	It seeks to avoid double charging for network use; there is no consolidated differentiated rate yet, but payments for capacity and complementary services do exist.	Provides stable revenue and promotes operation in support of renewable integration.
Srazil	Regulatory discussion led by MME/ANEEL to adjust network usage rates.	Proposed reduced fees for BESS providing systemic services or participating in capacity auctions.	Reduces operating costs and improves competitiveness against thermal generation.
<b>■</b> • Mexico	2025 General Administrative Provisions (DACG).	Possibility of preferential charges in network access and demand response programs.	It allows optimizing the profitability of projects and encourages operational flexibility.
Argentina	There is no specific tariff scheme yet.	Hybrid projects can indirectly benefit from incentives to renewables.	Storage does not have a direct differentiated rate, limiting its deployment.
Honduras	Initial framework for tendering (2025) includes recognition of storage in bases.	There is no differentiated rate defined, but incentives are expected to be incorporated into awarded contracts.	It could stimulate BESS on a large scale if tariff benefits are integrated into future tenders.

This special tariff treatment not only improves the economic viability of the projects, but sends a clear energy policy signal: storage is a strategic asset for the energy transition

and must be incentivized to play an active role in the integration of renewables, demand management and the resilience of the electricity system.

## 4.9. Regulatory stability and investment signals

It is the consistency, predictability and continuity of the rules that govern storage over time. In practice, it means that legal definitions, remuneration mechanisms and connection/operation processes do not change abruptly, contemplate transitional regimes and respect the acquired right of the projects (grandfathering). This stability reduces regulatory risk and lowers the cost of capital.

What it looks like in leading countries in the region (indicative examples)

• **Chile:** legal definition and payment for already operational capacity; expansion of complementary services and planning that internalizes the role of storage against dumping.

- **Brazil:** guidelines for capacity products and tariff discussion/network use; institutionality (MME/ANEEL/ONS) with consultations and roadmaps.
- **Mexico:** recent technical rules to recognize storage as an independent resource, opening market participation and demand response schemes.
- **Dominican Republic:** explicit goals and hybrid renewable+storage tenders in preparation with a focus on reliability.
- **Argentina/Honduras:** tendering bases with storage that begin to standardize contracts and trigger portfolios.

## 4.10. Operational checklist for a country analysis

To analyze the conditions that a country presents for the successful incorporation of

storage systems, the following questionnaire can be tested:

#### Operational checklist for a country analysis

Is there a legal definition of storage as an own asset?
What income is enabled (energy, capacity, ancillary, resilience)?
With what contractual horizon? Are there auctions/RFPs with standardized specifications and contracts?
Do grid access and charges prevent double billing and give time signals?
Does the planning spell out MW/MWh targets and priority locations? What guarantees/indices protect the investor (inflation, FX, off-taker solvency)?
How predictable are regulatory decisions (public consultations, timelines, case law)?

With these elements, you can quickly assess the quality of the investment environment and explain why certain countries have managed to close large-scale projects while others are still in the pilot phase.

## 5. Investment and financing in the sector

Access to finance is a determining factor for the expansion of energy storage. Development banks and international agencies are promoting investments in sustainable energy infrastructure.

The expansion of energy storage in Latin America and the Caribbean requires not

only technological and regulatory advances, but also sustainable investment models and financing mechanisms adapted to the needs of each country. Since many of the storage solutions still have high capital costs, especially compared to conventional technologies, access to finance is a decisive factor for their large-scale deployment.

## 5.1. Current Investment landscape

In the region, investment in energy storage has been mostly concentrated in pilot projects or international cooperation initiatives, with limited participation of private capital. Some elements that characterize the current landscape are:

- Projects financed by multilateral organizations such as the Inter-American Development Bank (IDB), the World Bank, CAF and the Green Climate Fund.
- Participation in bilateral cooperation (such as USAID, GIZ, JICA, AECID) in rural, island or vulnerable area initiatives.

- Private investment is still incipient, due to lack of clear business models, regulatory risks and poorly defined returns.
- Predominance of electrochemical technologies (batteries), due to their lower technological risk compared to other solutions (green hydrogen, gravitational or thermal storage).

## 5.2. Most used funding sources

The main sources of funding identified in the region include:

- Multilateral agencies: finance projects through concessional loans, grants and climate development funds.
- National development banks: offer lines of credit or guarantees for clean energy and storage projects.
- International climate funds: such as the Green Climate Fund, the Clean Technology

Fund (CTF) and the Adaptation Fund, which prioritize projects with environmental and social co-benefits.

- Public-Private Partnerships (PPPs): Some countries have explored co-investment models between governments, local businesses, and international developers.
- Community or cooperative financing: especially in rural areas, where local associations have co-financed battery-backed microgrids.

## 5.3. Barriers to attracting investment

Despite the growing interest, barriers persist that limit the flow of capital into the storage sector:

Figure 6 Barriers to attracting investment

### **Barriers to attracting investment:**

Despite the growing interest, barriers persist that limit the flow of capital into the storage sector:



#### Lack of regulatory certainty:

the absence of stable and predictable regulatory frameworks increases the risk perceived by investors.



## Lack of knowledge of viable business models:

many financial actors still do not understand the technical and economic value of storage, making it difficult to structure profitable projects.



#### High capital costs (CAPEX):

especially in emerging technologies or when equipment import is required.



## Weak institutional capacity to structure bankable projects:

many governments lack the experience to develop technically robust and financially viable proposals.



Limited access to reliable technical data - preventing proper risk assessments and effective mitigation schemes.

## 5.4. Recommendations to strengthen investment

To improve the financial environment of the sector, it is recommended to:

- Establish clear and stable regulatory frameworks that recognize storage as an asset eligible for public and private financing.
- Create innovative financial instruments: green bonds, climate investment funds, insurance schemes and performance guarantees.
- Encourage the participation of national banks and sovereign wealth funds in

strategic projects.

- Promote regional co-financing programs, supported by multilateral agencies, which reduce the cost of capital and encourage cross-border cooperation.
- Strengthen the capacities of local governments and companies to design, structure and manage bankable projects.
- Include social and environmental impact criteria to facilitate access to green funds and align with global climate goals.

## 5.5. Projections

Energy storage is emerging as a strategic sector for energy transformation in Latin America and the Caribbean. With the rise of renewables, the need for climate resilience, and the digitization of grids, storage is becoming established as a necessary tool to ensure reliable, flexible, and sustainable supply. The studies coincide in projecting accelerated growth in the region, both in installed capacity and in technological diversification and regulatory adaptation.

In terms of technologies, lithium-ion batteries will continue to dominate, but interest will grow in flow and sodium-ion batteries for long-term storage, thermal solutions in the industry, green hydrogen as a high-volume carrier and, to a lesser extent, hydraulic pumping in hydroelectric plants. At the same time, small-scale distributed storage - residential, community and commercial - will expand strongly, with more than 30% of residential solar systems estimated to incorporate batteries by 2035, boosting distributed generation with local backup.

At the regulatory level, most countries in the region are expected to have specific frameworks in place by 2030, incorporating tariff schemes, participation in ancillary services and flexibility remuneration mechanisms. These conditions, together with green financing and international cooperation, will allow the necessary financing to support its growth.

#### Growth in installed capacity

At the end of 2024, the COP29 Energy Storage and Grids Commitment set out to increase global energy storage capacity sixfold above 2022 levels, reaching 1,500 GW by 2030. This goal was set based on estimates made by the International Energy Agency, IEA.

According to the IEA outlook, in the STEPS scenario (under established policies) the share of wind and solar in the global electricity matrix increases from 12% today to 30% in 2030 and to 54% in 2050. In the NZE carbon neutrality scenario, installed renewable energy capacity is projected to triple by 2030 reaching a share of 40% and 71% by 2050.

Regarding storage, the IEA estimates that, globally, compared to a 3x growth in installed capacity in renewables, storage capacity should have a 6x growth.

The International Energy Agency (IEA) projections mean in quantitative terms that,

to reach 10,500 GW of installed renewable capacity by 2030, the world will require 1,500 GW of storage. This implies that, compared to the increase of 7,000 GW in renewables (from 3,500 to 10,500 GW), it will be necessary to

add 1,250 GW in storage (from 250 to 1,500 GW), which is equivalent to an overall ratio of 0.18 GW of storage for each renewable GW incorporated (18%).

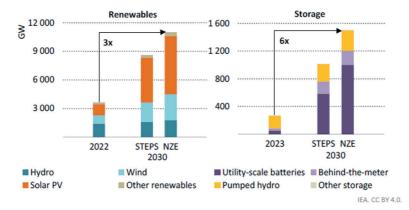


Figure 7 IEA - Global Renewable Energy and Energy Storage Installed Capacity by Scenario, 2022 and 2030

In Latin America and the Caribbean (LAC), projections should be adjusted to the regional reality. According to OLADE, solar and wind capacity should grow by 241 GW by 2030 and 460 GW by 2035; if hydroelectric capacity is included, the increase would reach 285 GW and 538 GW respectively. Directly applying the IEA benchmark rate (18%) would result in needs between 43 and 51 GW of storage by 2030, and between 83 and 97 GW by 2035. However, these figures do not reflect

the particular situation of the region, where: i) current storage capacity is just 2.5 GW (1.5 GW in batteries), ii) renewables already account for 70% of the matrix (well above the global average of 30%), and iii) the high hydropower share provides natural flexibility.

Table 10 Projected LAC Storage Capacity

#### **LAC STORAGE CAPACITY - PROJECTED**

YEAR	2030	2035
Installed Capacity (GW) Storage capacity (GWh) INVESTMENT (MMUSD)	24 96 <b>24.000</b>	46 184 <b>46.000</b>
Average Cost	250	USD/kWh

Source: Own elaboration

Based on these factors, preliminary estimates by OLADE - under review in the Storage OTG - suggest needs that, although they can be considered optimistic, are more realistic than those of the IEA: around 24 GW by 2030 and 46 GW in 2035 including the different technologies (BESS, pumping, thermal, chemical, among others). This would

imply investments of approximately USD 24 billion in 2030 and USD 46 billion in 2035, figures achievable through mixed schemes that combine public and private financing, international cooperation and climate funds, within the framework of a just transition.

## 6. Case studies

### 6.1. CHILE: Consolidated case

Chile has positioned itself as the regional leader in energy storage. To date (July 2025), it reports 66% of the installed capacity in battery systems at the regional level, and 41% of the total storage capacity. It also stands out for its regulatory approach, its clear goals and the rapid incorporation of projects into its matrix. In 2023, the country launched the National Energy Storage Strategy 2023-2030, a pioneering document in the region that links this development with decarbonization and electricity supply security. This strategy is articulated with the growing penetration of variable renewable energies, especially solar in the north and wind in the south, which has created the need for systems that manage intermittency and optimize the use of existing infrastructure. The National Energy Policy includes the goal of developing 2 GW in energy storage systems in the SEN by 2030 and 6 GW by 2050.

The Chilean regulatory framework is also an example for the region. In recent years, reforms have been approved that allow storage systems to participate directly in the electricity market, access remuneration schemes for the complementary services they provide and be considered in generation and transmission expansion plans. This has created an attractive environment for private investment, which is reflected in a portfolio of more than 80 storage projects at different stages of development, several of them combined with photovoltaic and hybrid solar plants.

Chile has established a comprehensive and coherent framework to boost energy storage through a set of standards:

- Law 21.505 (2022) introduces legal recognition and remuneration in the market.
- Supreme Decrees 70 (2024) and 125 (2025) guarantee technical and operational visibility in planning and dispatch.
- Technical Instruction RGR 06/2024 ensures that BESS are implemented in a safe and standardized manner.
- Public consultation (2025) to amend the Small Distributed Generation Facilities (SDGF) regulation aims to expand its use in distributed generation.

In addition, Chile has been a pioneer in integrating storage into its long-term energy planning, guaranteeing certainty to investors and favoring technological competition between lithium-ion batteries, hydraulic pumping systems and emerging solutions such as green hydrogen.

### How did Chile do it?

1) Clear and pro-competition legal framework. Chile took a decisive step by explicitly recognizing storage within its electricity legislation (e.g., promoting

"renewable plants with storage capacity" and enabling stand-alone projects). This cleared ambiguities (generation, consumption or own asset?), opened the door to their market share and reduced frictions such as double charging for network use.

- 2) Market rules that pay for the actual value of storage. The Chilean scheme allows capturing multiple revenues (revenue stacking): energy arbitrage (valley-peak), payments for sufficiency/ capacity, and complementary services (frequency regulation, voltage control, fast reserve). By remunerating what storage effectively delivers flexibility and firmness it improves bankability and lowers the cost of capital.
- **3) Planning that integrates storage as a system resource.** In long-term energy planning and in the studies of the National Electrical Coordinator, storage appears as a tool to: (i) reduce solar/wind discharges in the north, (ii) manage ramps and contingencies, and (iii) defer transmission investments as a "non-wires" alternative. This visibility into plans and scenarios sends credible signals to investors.
- 4) Demand signals and tenders that reward flexibility. Supply tenders for regulated customers with time blocks and the expansion of corporate PPAs push firm delivery profiles; that incentivizes hybrid solutions (solar/wind + BESS) and stand-alone BESS projects located where they provide the most systemic value.
- **5) Technical standardization and connection processes.** Technical guidelines, safety requirements and interconnection procedures adapted to bidirectional resources have shortened deadlines, reduced uncertainty and facilitated coordinated operation (dispatch, frequency/voltage control, rapid response). In parallel, the adoption of grid-forming inverters in recent projects improves stability in low-inertia networks.
- **6) Robust portfolio and sustained execution.** Chile combines hundreds of MW already operational with a pipeline

of several GW at different stages (environmental approval, construction and testing), including hybrid plants in areas of high irradiance and nodes with congestion. The repetition of bankable cases creates learning curves for promoters, funders and authorities.

### 7) Institutionality and certainty.

Coordination between the Ministry of Energy, regulator and Electricity Coordinator, coupled with public consultations and roadmaps, reduces regulatory risk. That stability - plus a relatively predictable macro environment - explains the inflow of international capital and corporate offtakers.

8) Visible systemic outcomes. Storage deployment already contributes to: (i) lowering renewable discharges, (ii) smoothing net ramps, (iii) improving reliability at critical hours, and (iv) containing operating costs by replacing more expensive/polluting peak generation.

Chile combines legal definition, market rules that pay for flexibility, explicit integration in planning, tenders that demand firm profiles, clear technical standards and predictable institutionality. That "complete package" aligns technical, regulatory and financial incentives, and makes it the regional benchmark for scaling storage with real impact on reliability, costs and decarbonization. Chilean experience shows that storage can become a central axis of the energy transition in Latin America, ensuring reliability, emission reduction and sustainable economic development.

Table 11 Main actions implemented by Chile



# Essential aspects that Chile has implemented for the development of energy storage

Pillar	Key Aspects Implemented	Detail
Regulatory	Legal definition of storage as an energy resource	Amendments to the General Electrical Services Law (2022) and the Coordination and Operation Regulations (2023) incorporated storage as an actor of the electrical system.
Market and remuneration	Enabling energy income and ancillary services	The BESS can participate in the spot market, provide frequency control services, reserve power and black-start. Progress is made in schemes to avoid double charging for network use.
Planning	Inclusion of explicit targets	The National Storage Strategy (2023) set 2 GW by 2030 and long-term targets (multi-hour and seasonal scale). The 2023 Transmission Expansion Plan already incorporates storage as an investment alternative.
Incentives and economic signals	Auctions and specific financing	The Small Media Distributed Generation (PMG/PMGD) Program enables hybrid projects with storage. Auctions dedicated to storage are being explored as part of the Coal Retirement Plans.
Transmission and flexibility	Recognition of storage as supporting infrastructure	In the Transmission Planning process, the National Electrical Coordinator may propose projects with storage to relieve congestion and increase system safety.
Innovation and pilot projects	Demonstration Projects and Escalation	Projects such as Solar+Storage in northern Chile (photovoltaic hybrids + BESS) and thermal and gravitational storage pilots supported by CORFO and universities.
Governance and transparency	National strategy with public consultations	The design of the National Storage Strategy included public consultations, defined schedules and multisectoral participation, granting regulatory certainty.
Recent tenders and contracts	Key contracts for large-scale renewable support	Codelco awarded PPAs for 1.5 TWh/year from 2026, with Generadora Metropolitana and GR Power Chile, which include BESS as an integral part of the system.

Source: Own elaboration

## Installed capacity and ongoing projects.

As of June 2025, Chile reports 1,105 MW of installed capacity in storage and aspires to meet the goal of 2,000 MW in October 2025. According to the "Report on Construction and Investment Projects in the Energy Sector for the month of July 2025" of the Ministry

of Energy, the goal of 6,000 MW of Storage Systems by 2050 will be met in 2027. As of July 31, 2025, there are 6 storage systems in the testing phase, with 652 MW of installed capacity and 2,328 MWh of stored energy.

Table 12 Most recent energy	y storage projects in Chile
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		Conneity	
Project	Location	Capacity (MW/MWh)	Description
Desert BESS (Atlas)	Antofagasta – María Elena	200 MW / 800 MWh (standalone)	Opened in April 2025, it is LATAM's largest independent battery plant.
Diego de Almagro Sur (Colbún)	Atacama	228 MW / 912 MWh	Colbún awarded supply to Canadian Solar e-Storage; construction will begin in June 2025 and operation in December 2026.
Remanso (Orion Power)	Rancagua, Liberator O'Higgins	150 MW / 750 MWh	Project entered into the Environmental Impact Assessment System (SEIA). Investment \$165 million, 30 years of estimated operation.
Sungrow BESS (New Almonte Well)	Tarapacá – Almonte Well	762 MWh (grid-connected)	Independent BESS system (Li-FePO <sub>4</sub> ), with 220 kV line for integration.
Solar Radal + BESS (Eurus)	Valparaiso / Metropolitan	200 MW / 1,101 MWh	Solar project plus storage, under environmental assessment.
AES Andes Projects (Pampas + Cristales)	Antofagasta	1.3 GW solar+wind / 2.2 GWH storage	Construction began; it combines solar, wind, and storage for more than USD 1.1 billion.
Atacama Oasis (Grenergy)	Norte de Chi <b>l</b> e	Up to 11 GWh (pipeline)	Multiphase project: 2 GW solar + 11 GWh BESS (current 1 GW solar and 4.1 GWh BESS

Fuente: Elaboración Propia

## 6.2. BRAZIL: expanding market.

Brazil has established itself as one of the most advanced countries in the region in terms of energy storage, thanks to a strategy that combines regulatory vision, long-term planning and expanding pilot projects. In 2024, the Ten-year Plan of Energy Expansion 2034 (PDE 2034) prepared by the Ministry of Mines and Energy (MME) and the Energy Research Company (EPE) explicitly incorporated storage as a key resource for the reliability of the system. This plan recognizes the role of batteries (BESS) and hybrid solutions (solar + storage, wind + storage), in addition to maintaining the traditional relevance of hydraulic storage through dams and reversible pumping stations.

In the regulatory sphere, Brazil has developed a process that is underway. ANEEL (Agência

Nacional de Energia Elétrica) launched a public consultation on distributed storage in 2022. To date, there are no complete and current regulatory resolutions that fully enable BESS' participation in the Brazilian electricity market. Resolution 1.111/2024 and Technical Note 13/2025 represent first structural advances, but are still in the consultation phase and have not been implemented. The final regulation is on its way and is expected to form the basis for future regulation, probably in stages, between 2025 and 2028.

Although it is not a regulation, the E2Brasil program, developed jointly between the MME and GIZ of Germany, provides technical support and institutional capacity to promote and structure public policies, technical analysis and conditions necessary for the

integration of storage technologies in isolated and connected networks.

In practical terms, Brazil already has outstanding experiences: from hybrid photovoltaic projects with BESS in the Northeast, which seek to mitigate solar variability, to the integration of storage in isolated systems in the Amazon, reducing dependence on diesel. Reversible hydraulic pumping projects are also being evaluated in Minas Gerais and Paraná, which reinforces technological diversification.

Table 13 Main actions implemented by Brazil



# Essential aspects that BRAZIL has implemented for the development of energy storage

Pillar	Key Aspects Implemented	Detail
Regulatory	Initial Regulatory Recognition of Storage	The ANEEL issued resolutions (ex. ANEEL 954/2021 and 1.059/2023) that allow the registration of storage projects and their participation in the market as generation or grid resources. The publication of the regulation on energy storage systems is expected.
Market and remuneration	Wholesale market participation	Storage systems are enabled to offer in the short-term energy market and to provide ancillary services (frequency control, voltage modulation, dispatch reliability).
Planning	Inclusion of storage in official planning	The Ten-Year Energy Expansion Plan (PDE 2032) and the National Energy Plan (PNE 2050) integrate storage as a key technology to integrate renewables and defer investments in transmission. The expansion plan considers the incorporation of 800 MW by 2034.
Incentives and economic signals	"Mais Armazenamento" programme	Launched by the Mme in 2022, it seeks to stimulate the national storage production chain, promote R&D and create conditions for capacity auctions with storage.
Transmission and flexibility	Use of storage as a regulated asset	ANEEL studies mechanisms to recognize storage as a transmission asset, enabling its use to relieve congestion and postpone reinforcements in the network. Projects such as ISA CTEEP already operate BESS as a non-wires alternative
Innovation and pilot projects	Demonstration and large-scale projects	Lithium battery pilots in the SIN (Ex.: Roraima and Manaus for stability of isolated systems), in addition to hybrid projects with solar and storage in new energy auctions.
Governance and transparency	Regulatory processes with public consultations	ANEEL and MME have opened regular public consultations on defining the role of storage, remunerating services and creating specific auction frameworks.
Recent tenders and contracts	Launch of first BESS auction and investment estimate	The first specific tender (LRCAP) for 2025, with 10-year contracts and availability payments, has been cancelled creating uncertainty in the market

Source: Own elaboration

In short, Brazil is an emerging success story because it combines regulatory advancement, inclusion in national planning, a government program ("Mais Armazenamento") and a pilot project in operation, positioning itself as one of the most dynamic markets in the region.

# 6.3. MEXICO: progressive integration.

Mexico has become one of the most promising players in the region in terms of energy storage, with recent regulatory and strategic advances that place it at the forefront. In March 2025, the National Energy Commission (CNE) published

Agreement A/113/2024, incorporating for the first time a regulatory framework for the integration of Energy Storage Systems (ESS) into the National Electric System (SEN).

This regulation defines five storage modalities -including systems associated with renewable plants, load centers and independent solutions - and gives them recognition similar to that of generators, with interconnection rights, permits and the possibility of participating in energy markets and complementary services

In line with this, the Government announced in March 2025 a new obligation for all solar

and wind plants to include battery systems equivalent to 30% of their installed capacity, with a minimum discharge autonomy of three hours, aiming to add 574 MW of BESS by 2028. This measure, unprecedented in the region, creates a solid and coherent regulatory impulse for the integration of storage with renewable generation.

Table 14 Main actions implemented by Mexico



# **Essential aspects that MEXICO has implemented** for the development of energy storage

Pillar	Key Aspects Implemented	Detail
Regulatory	Mandate of storage in renewable plants	In early March, Mexico introduced administrative provisions regulating the integration of energy storage systems into the National Electric System. The regulation requires new renewable projects to incorporate BESS equivalent to 30% of its capacity with at least 3 hours of backup.
Market and remuneration	Participation in the Wholesale Electricity Market (MEM)	Storage can participate indirectly in the energy and power market, as well as in related services (rolling stock, primary regulation, frequency control). However, there is not yet a specific payment mechanism for storage.
Planning	Inclusion in the planning of the electricity sector.	The planning of the electricity sector c onsiders an incorporation of 950 MW in storage capacity until 2030, to which 741 MW can be added as capacity associated with wind projects that are under analysis.
Incentives and economic signals	Pilots and international cooperation	Mexico has promoted pilot projects with support from multilateral organizations (World Bank, IDB) and cooperation programs (e.g. photovoltaic + battery hybrid projects in Baja California Sur). There are no dedicated storage auctions yet.
Transmission and flexibility	Studies to integrate storage into the network	The CFE has evaluated the use of batteries as strategic assets in areas with weak transmission (e.g. Yucatan Peninsula and Baja California), where batteries help stabilize frequency and reduce outages.
Innovation and pilot projects	Relevant projects in operation	Installations of lithium batteries up to 20 MW / 20 MWh in Baja California Sur and hybrid projects with photovoltaic. Advances in community distributed storage projects.
Governance and transparency	Processes in consultation	There are public consultations by CRE and SENER to define clearer rules on storage participation, although regulatory gaps and lack of regulatory certainty persist.
Recent tenders and contracts	CFE hiring pilot	Puerto Peñasco Phase II will be awarded through a tender led by CFE, with the explicit inclusion of BESS as an integral part of the system (300 MW solar + 60 MW BESS with 3 hours of backup).

Source: Own elaboration

In terms of planning, the National Electricity System Development Program (PRODESEN 2024-2038) identifies a strategic role for storage, estimating that around 8.4 GW of ESS will be required by 2038, to guarantee the stability of the SEN in the face of the increasing integration of intermittent energies.

This set - specific regulation, mandatory self-generation mandate with support and long-term planning - positions Mexico as an emerging case of success in energy storage, showing how the convergence between regulations, national plans and technological vision can accelerate an inclusive and resilient energy transition.

## 6.4. ARGENTINA: emerging case underway

Argentina has taken a significant step in strengthening its electricity system through the historic AlmaGBA tender, aimed at installing 500 MW of battery storage (BESS) in critical nodes of the Buenos Aires Metropolitan Area (AMBA). The opening of envelopes in July 2025 revealed strong private sector interest with 15 companies and 27 projects totaling 1,347 MW

and an estimated investment commitment of more than US\$1 billion. On September 1, 2025, the Ministry of Energy reported on the award of 667 MW, with the possibility of incorporating an additional 222 MW. The investment of the awarded block exceeds 540 million dollars and is expected to be operational in a period between 12 and 18 months.

Table 15 Main actions implemented by Argentina



# Essential aspects that ARGENTINA has implemented for the development of energy storage

Pillar	Key Aspects Implemented	Detail
Regulatory	Framework under construction	There is still no legal definition of storage as an own asset in the Electricity Law. However, the Ministry of Energy has opened consultations on its incorporation into planning and technical standards.
Market and remuneration	Indirect participation	Storage may implicitly participate in the market as part of hybrid plants (e.g. solar + battery) under supply contracts. There is no specific remuneration scheme or dedicated ancillary services.
Planning	Recognition in RenovAr and PERMER	Within the framework of programs such as RenovAr and PERMER, storage has been included for rural electrification and intermittent renewable support, mainly in isolated communities.
Incentives and economic signals	Internationally funded pilots	Mini-grid projects with batteries have been developed in provinces such as Jujuy and Catamarca, with support from the IDB and the World Bank, and hybrid projects (solar + storage) in non-interconnected areas.
Transmission and flexibility	Initial Studies	Transmission bottlenecks have been identified that could be mitigated with storage, especially in the Northwest (NOA) with high solar penetration and in Patagonia with wind.
Innovation and pilot projects	Renewable hybrid experiences	Solar projects with small-scale batteries in Jujuy (e.g. Cauchari Solar + pilot storage) and in isolated systems in the north and south of the country.
Governance and transparency	Preliminary processes	The Federal Energy Council has discussed the incorporation of storage into energy planning, but there is still no defined regulatory schedule or systematic public consultations as in Chile or Brazil.
Recent tenders and contracts	First national BESS tender (AlmaGBA) in progress	The AlmaGBA tender in Amba launched in February 2025, sought to award 500 MW BESS, to reinforce the electrical infrastructure of the Buenos Aires Metropolitan Area. The call has been successful. The power finally awarded exceeds the initial target, reaching a total of 667 MW with the possibility of incorporating an additional 222 MW. The awarded projects must begin operating within a period of between 12 and 18 months from the date of award.

Source: Own elaboration

This project, part of the Contingency Plan promoted by the National Government, seeks to restore electricity reliability in the region after years of divestment, facing peaks in demand and frequent outages. The contracts, concluded with the distributors Edenor and Edesur and backed by CAMMESA as guarantor of last resort, will have a duration of up to 15 years, with differentiated rates for

available power and energy supplied.

In addition, this pilot effort works as a replicable model in other provinces, encouraging similar tenders in vulnerable nodes identified by CAMMESA.

Although Argentina has not yet developed a comprehensive regulatory framework for

storage, this tender represents a concrete and valuable experience. It demonstrates the country's ability to structure operational market mechanisms, long-term contracts, institutional guarantees and financial support for BESS, marking an important step towards its consolidation as a strategic tool for the energy transition.

## 6.5. HONDURAS: Emerging case with tenders

Honduras is emerging as a benchmark in Central America in terms of energy storage, thanks to concrete efforts to strengthen the reliability of the electricity system. In 2024, the Empresa Nacional de Energía Eléctrica (ENEE) launched the tender LPI-001 - ENEE - UEPER-2024, aimed at installing a grid-connected battery storage system (BESS). This project includes 75 MW with 300 MWh of capacity, to be installed in the Amarateca substation, in the department of Francisco Morazán, with the aim of improving the stability of the electricity supply in times of high demand.

In March 2025, the Chinese-Honduran Windey-Equinsa consortium was awarded the contract for USD 50.2 million, leading this initiative that is expected to be the largest storage facility in the Central American

electricity system. This project is designed to begin construction in April and enter into operation before the end of the year.

In addition, Honduras launched a historic tender for 1,500 MW, in which 65% must come from renewable sources accompanied by storage. The plan includes progressive deployment: 800 MW in 2027, 300 MW in 2028 and 400 MW in 2030

The 75 MW/300 MWh project, due to its scale and successful award, is positioned as a turning point for Honduras. Not only does it represent the first major public storage contract in Central America, but it also provides visibility to the sector and can catalyze future auctions and more robust regulatory frameworks.

Table 16 Main actions implemented by Honduras



# Aspectos esenciales que HONDURAS ha implementado para el desarrollo del almacenamiento de energía

Pillar	Key Aspects Implemented	Detail
Regulatory	Initial recognition	The General Law of the Electricity Industry (2014) does not yet include a legal definition of storage. However, the CREE (Electricity Regulatory Commission) has initiated discussions to allow its integration into the electricity market and hybrid projects.
Market and remuneration	Participation in hybrids	Storage is being incorporated as part of solar and hybrid plants in generation contracts. There is still no specific market for ancillary services or remuneration for flexibility.
Planning	Recognition in electrification and resilience	The Generation Expansion Plan recognizes storage as a tool to improve reliability in weak networks and for rural electrification in isolated communities.
Incentives and economic signals	International support	Projects have been implemented with international cooperation (IDB, USAID, GIZ), especially in microgrids with batteries for rural areas and community photovoltaic solar projects.
Transmission and flexibility	Use for grid stability	The National Electric Energy Company (ENEE) has identified the need for storage in isolated systems (Islands and rural communities) and in the reinforcement of the interconnected grid in the face of increasing solar penetration.
Innovation and pilot projects	Microgrids and climate resilience	Pilot projects of microgrids with batteries in the Mosquitia and in isolated communities, designed for resilience to hurricanes and storms Also hybrid pilots (solar + batteries) in non-interconnected areas.
Governance and transparency	Processes under construction	CREE has shown openness to incipient public consultations on storage although there is still no consolidated regulatory framework or clear timelines for its full implementation.
Recent tenders and contracts	First regional scale tender	ENEE awarded a \$50.2 million contract to a Chinese-Honduran consort (Windey-Equinsa) for a 75 MW / 300 MWh BESS connected in Amarated substation, which will be the largest in the isthmus.

Source: Own elaboration

With this, Honduras demonstrates how Central American countries can bet on emerging technological solutions, ordered in transparent

bidding processes, to transform their energy matrix and improve service quality.

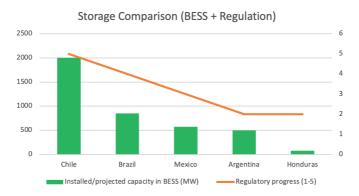


Figure 8 Comparative Inst/Projected Capacity - Regulation

NOTE: Regulatory progress is graded with a score of 1-5 based on developmental level.

The graph shows a comparison between the installed/projected capacity in BESS systems and the level of regulatory progress in five Latin American countries. The relationship

shows that the deployment of BESS is closely linked to regulatory development.

# 7. Challenges and Barriers to Energy Storage Development

Energy storage is a strategic component for the transition to more sustainable, resilient and renewable-based electricity systems. Its ability to stabilize grids, exploit surpluses, manage intermittency and reduce dependence on fossil fuels makes it a very useful tool for 21st century energy security. However, in Latin America and the Caribbean (LAC), its massive adoption faces multiple technical, economic, institutional and social barriers that limit its effective deployment.

### Costs and economic viability:

High cost remains the main barrier to storage in LAC. Although lithium-ion battery prices have fallen, large-scale projects still require investments of 200 to 500 USD/kWh. OPEX is low, but specialized maintenance and

replenishment of batteries every 5 to 15 years affect profitability. The lack of remuneration schemes for ancillary services and limited access to financing prolong return deadlines. Without supportive policies and clear market rules, economic viability remains constrained.

### Energy regulations and policies:

In most countries, storage lacks a legal definition, which generates uncertainty about its role in the system and limits its participation in tenders or programs. Electricity laws remain focused on conventional generation, without incorporating digitization or smart grids. Developments in Chile and Brazil show that clear legal frameworks and appropriate incentives are key to attracting investment.

### Infrastructure and access to technologies:

LAC's electricity grids are lagging behind: high losses, low digitalization and poor two-way management capacity. The dependence on imports in batteries, software and components increases costs and vulnerability. In rural areas, access to modern technologies is limited, making decentralized solutions such as microgrids difficult.

### Sustainability and recycling:

The massive deployment of batteries poses environmental risks due to the extraction of lithium, cobalt and nickel, as well as the lack of regulations for proper recycling. The region lacks infrastructure to process depleted batteries, which implies risks of contamination and waste of valuable materials.

### Financing:

Projects face high upfront costs, perceived risk and lack of specific financial instruments. There are no lines of credit adapted to storage, whose return depends on emerging markets. The absence of sovereign guarantees limits bankability and accentuates the gaps between urban and rural areas.

### Technical training:

The human talent gap is critical: educational programs rarely include content about storage or hydrogen. This forces dependence on external consultants and makes projects more expensive. The lack of practical training in rural communities hinders local ownership and sustainable operation of systems.

#### **Critical materials:**

Although LAC concentrates reserves of lithium and other minerals, a large part of the value chain -processing and manufacturing-is located outside the region, generating dependence and volatility. To avoid being only an exporter of raw materials, it is necessary to advance in industrialization and resource governance.

### Safety and environmental risks:

Storage technologies involve risks: fires in lithium-ion batteries, hydrogen flammability and waste toxicity. The absence of installation, operation and final disposal regulations increases risks and can generate social rejection.

### Scalability and lifecycle:

Many projects in LAC remain in pilot phase. Lack of standardization and technological degradation limit its scalability. Incorporating a life cycle vision - from manufacturing to recycling - is important to ensure sustainability and reduce obsolescence.

### Social and cultural acceptance

The social perception of storage remains weak, associated with risks or ignorance. In indigenous and rural communities, the lack of prior consultation generates resistance. Clear communication processes and community inclusion are essential to ensure legitimacy. Microgrids and distributed solutions can become engines of energy autonomy and climate justice if they have local ownership.

Figure 9 LAC Storage Challenges

# Challenges for the massification of storage in Latin America and the Caribbean:



### Costs and economic viability

- High CAPEX (200–500 USD/kWh).
- Replacement every 5-15 years.
- Absence of remuneration and financing schemes limits profitability.



### **Energy regulations and policies**

- · Lack of legal definition in most countries.
- Regulatory frameworks still focused on conventional generation.



### Infrastructure and access to technologies

- High losses and low digitalization in grids.
- Dependence on imports in batteries and software.
- · Limitations in rural areas for microgrids.



#### Sustainability and recycling

- · Impacts from lithium, cobalt and nickel mining.
- Lack of battery recycling regulations.
- Risk of contamination and loss of valuable materials.



### **Financing**

- · Lack of adapted credit lines.
- · High perception of risk and absence of guarantees.
- · Greater gap between urban and rural projects.



### Technician training

- Deficit of specialized human talent.
- Lack of training in universities and communities.
- Dependence on external consultants makes projects more expensive.



### Safety and environmental risks

- Fires in lithium-ion batteries.
- Hydrogen flammability.
- Lack of final disposition regulations increases social rejection.



### **Critical materials**

- LAC has lithium reserves, but...
- Processing and manufacturing outside the region.
- Risk of being only an exporter of raw materials.



#### Scalability and social acceptance

- Many projects are still in the pilot phase.
- Technological degradation and lack of standardization.
- Weak social perception: resistance in communities without prior consultation.

# 8. Recommendations and strategies for the future

Energy storage is emerging as a strategic piece to accelerate the energy transition in Latin America and the Caribbean. However, its consolidation requires overcoming regulatory gaps, promoting adequate incentives, strengthening institutional and technical capacities, and fostering innovation and cooperation between the public and private sectors. The main lines of action that countries in the region should prioritize are highlighted below.

### Clear regulatory frameworks and policies

A fundamental first step is the development of regulatory frameworks that explicitly recognize storage within the electrical system. In many countries there is still no legal definition that integrates it as part of the energy chain. This generates uncertainty about its role: whether it is considered a generator, a consumer, an auxiliary service or, ideally, a category of its own. A clear definition will make it possible to guide investments, design remuneration schemes and avoid regulatory conflicts.

Likewise, it is essential to create rules that enable its participation in the electricity markets and guarantee remuneration for the multiple services it can offer, from grid stabilization to frequency control or deferred dispatch. Similarly, technical safety and operating standards must be established for batteries, thermal systems and hydrogen, which ensures both the reliability of the electrical system and the protection of users. Including storage in national energy plans and defining clear responsibilities between ministries, regulatory agencies and grid operators is necessary to move forward with order and coherence.

### **Economic and financial incentives**

The high upfront cost of storage still represents a significant barrier to deployment. Therefore, it is strategic to design economic and financial incentive schemes that reduce risks and attract private and community investment. Among the most relevant are tax exemptions,

access to green financing and preferential credits, as well as subsidies and public funds for pilot projects.

Beyond lowering costs, incentives play a decisive role in creating emerging markets, opening up to new business models and strengthening energy resilience in urban and rural contexts. To maximize their impact, they must be aligned with sustainable development goals, tailored to national realities, and designed with an inclusive approach that promotes the participation of vulnerable communities.

#### Innovation and research

The region faces the challenge of not only remaining a consumer of imported technologies. For this, investment in research and development is essential. Promoting local innovation will allow solutions to be adapted to their own climatic, technical and social conditions, strengthen technological autonomy and stimulate green industrialization.

This requires increasing public and private funds in R&D, fostering cooperation between universities, research centers, companies and governments, and creating national and regional consortia that work on concrete solutions. The training of researchers, the creation of innovation funds and participation in global knowledge networks are basic requirements to position Latin America and the Caribbean as an active actor in the development of new storage technologies, such as flow batteries, thermal systems or green hydrogen.

### Infrastructure and smart grids

Storage can only be fully deployed if the region's power grids are modernized. Many of them were designed for a centralized and unidirectional model based on fossil fuels, so they must evolve towards flexible, intelligent and resilient systems.

In this sense, it is a priority to invest in networks capable of interacting in real time with storage systems, incorporate storage as a strategic infrastructure in electricity expansion plans, and promote the development of microgrids in rural, island and isolated areas. Technological interoperability, digitalization and training of technical personnel are determining factors to ensure that networks can absorb and maximize the potential of storage.

### Human talent and institutional capacities

The energy transition will not be possible without qualified human resources. The training of technical and professional talent in storage technologies is a central enabling condition. Specialized programs, public-private partnerships that combine theory and practice, and inclusion strategies are required so that women, youth, and vulnerable communities can actively participate in this sector. In addition, universities, technical centers and cooperation agencies must take a leading role in building regional capacities, strengthening institutions and taking advantage of international cooperation to exchange knowledge and train specialists in emerging technologies.

### **Public-private partnerships**

Energy storage requires mobilizing large volumes of investment, and public-private partnerships (PPPs) offer an effective avenue to share risks and accelerate project implementation. However, these partnerships

must be structured on clear legal frameworks, mutual trust and shared objectives.

Experience shows that, when well designed, PPPs can catalyze strategic projects in essential sectors such as rural electrification, urban resilience or the integration of renewables. Governments can facilitate this process by establishing co-financing schemes, tax incentives and risk guarantees, as well as promoting spaces for dialogue between institutions, companies and local communities.

### Distributed storage and microgrids

Finally, distributed storage and microgrids are consolidated as transformative tools to ensure reliable and sustainable access to energy in areas with low coverage or fragile networks. These decentralized solutions not only reduce dependence on fossil fuels, but democratize energy management and strengthen the autonomy of local communities.

To promote them, countries must explicitly recognize these solutions in their plans and regulatory frameworks, establish differentiated incentives in rural or isolated territories, and simplify administrative processes for their implementation. Involvement of local governments, cooperatives, and community organizations is essential to ensure that benefits reach those in need directly.

## 9. Conclusions

As energy storage gains prominence in Latin America and the Caribbean, it is consolidated as a strategic and inevitable pillar for the energy transition. In a region abundant in renewable resources, but still marked by access gaps in isolated areas and the need to strengthen resilience to the impacts of climate change, storage is not only a technological solution, but a structural tool to build more sustainable, inclusive and robust systems.

Technologies such as pumped storage, battery systems (BESS), thermal storage, and green hydrogen are proving to be viable solutions, and several countries are already making progress in implementing regulatory frameworks and pilot projects that lay the groundwork for replicating these experiences across the region. However, significant challenges remain: fragmented regulatory frameworks, high initial investment costs, weaknesses in electrical infrastructure, low investment in research and development, and scarce training of specialized human talent.

Faced with these limitations, opportunities also arise that must be considered: the

development of hybrid projects that combine renewables and storage, the expansion of microgrids in non-interconnected areas, technological diversification with different storage options, and the creation of local innovation ecosystems capable of generating value chains, employment and new opportunities for communities, in particular for the young population.

To take advantage of these opportunities, it is essential to make progress in: strengthening regulatory frameworks; designing effective financial incentives; investing steadily in R&D; modernizing electrical and digital infrastructure; training technicians and professionals; promoting distributed storage and community microgrids; and fostering public-private partnerships and active international cooperation.

The future of storage will depend on the regional capacity to articulate actions in these pillars and, in particular, on reaching joint agreements to guide national policies, attract investment, access green financing and accelerate the energy transition.

Storage should not only be seen as a technical complement to renewable energies, but as a strategic tool to transform Latin American and Caribbean electricity systems into more sustainable, inclusive and resilient structures. Its incorporation into national and regional agendas, taking into account the particular conditions and needs of each system, is an essential task to guarantee a fairer, safer and more sustainable energy future

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