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action

alinnea

Accelerating energy storage for decarbonisation and electrification

Key considerations for drawing up a roadmap for the sector

October 2026



alinnea has been an active player in Spain's climate action ecosystem since mid-2024. It forms part of the IE Foundation, is spearheaded by IE University and is supported by the European Climate Foundation. **alinnea** is an organisation specialising in comparative analysis and the search for solutions to coordinate climate action measures involving different sectors from both the public and private spheres, as well as civil society.

Within a multi-stakeholder dialogue and action research framework, it aims to provide solutions to the barriers hindering progress on climate action, in a way that is socially just, economically prosperous and beneficial to the environment and the protection of biodiversity.

Between April and July 2026, **alinnea** held four working sessions with more than fifty key stakeholders — from the public and private sectors, financial institutions, the social sector and academia — with the aim of accelerating the roll-out of energy storage in Spain. This process made it possible to gather highly relevant critical analyses and practical experience. This report has been drawn up on the basis of this dialogue; it provides a detailed analysis of the main challenges facing energy storage in Spain and sets out recommendations to accelerate its development as a key element in ensuring the flexibility of the electricity system, electrification and the decarbonisation of the economy.

This report has been drawn up by the following team of professionals:

Coordination and drafting of the report:

- Ana Belén Sánchez, Director, **alinnea**
- Raúl García Posada, Director, ASEALEN
- Gemma Bedia, Senior Project Manager, Climate Change, **alinnea**
- Patricia Pascau, Head of Communications, **alinnea**

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01 Executive Summary

Energy storage has become an essential component in supporting the transformation of the electricity system. The growth in renewable generation, the electrification of the economy and the need to strengthen the system's security and resilience are driving up demand for resources capable of providing flexibility, shifting energy over time, reducing curtailment and optimising the use of the grids. Spain is in a favourable position: the PNIEC forecasts that around **81 per cent of electricity generation will come from renewable sources by 2030** and sets a target of **22.5 GW of storage capacity** by the end of the decade.

However, high investor interest alone does not guarantee that the projects will go ahead. The working group identifies barriers relating to grid access and connection, infrastructure planning and management, regulatory fragmentation, coordination between public authorities, market signals that are still insufficient, the limited integration of flexible demand and distributed resources, the lack of real-time observability, external dependence on technologies and components, a shortage of specialised talent, industrial safety and cybersecurity challenges, technical standardisation, regional and social acceptance, and limited revenue visibility and access to funding.

To tackle these challenges, the report proposes a **roadmap structured around four broad areas and three timeframes — short, medium and long term** —. In the context of **enabling conditions**, it is recommended to move towards more dynamic management of the network and access, to complete and simplify the regulatory framework, to strengthen financial viability through more predictable revenue models and risk-hedging instruments, to adapt taxation to the specific nature of storage, and to consolidate a robust framework for industrial safety and cybersecurity.

Secondly, the **integration of storage into the electricity system** requires the development of markets capable of providing adequate remuneration for firmness, flexibility, duration and other technical services; the completion of the framework for independent aggregation; and the facilitation of participation by demand response, self-consumption, electric mobility and distributed resources; improving

the digitalisation, observability and interoperability of information systems; and consolidating a planning framework that incorporates storage as a structural resource, with a diversified technology mix tailored to the system's actual needs.

Thirdly, the **industry and skills** dimension requires strengthening a competitive European value chain, promoting innovation, standardisation and the scaling up of new technologies, developing a specialised financial ecosystem, and adapting training and professional skills to the sector's needs. Finally, with regard to **governance and territory**, the aim is to improve coordination between public authorities, integrate energy, industrial, environmental and spatial planning, strengthen early public involvement and public information, and promote mechanisms for local benefits and the creation of shared value that facilitate social acceptance of projects.

As part of this roadmap, the report sets out three priority actions in greater detail. The first is a **comprehensive reform of the taxation of storage**, including the permanent abolition of the IVPEE, adjustments to the IEE, the IAE, VAT and regional and local taxation, as well as stable incentives for investments that deliver flexibility, renewable integration or industrial decarbonisation. The second involves **rapidly deploying the capacity mechanism**, setting it up as a stable source of revenue linked to availability and clearly distinguishing between firmness, flexibility and duration, in a manner compatible with *revenue stacking* and with the participation of aggregated demand and resources.

The third proposal suggests **establishing a functional and technologically neutral framework for long-duration storage**, using discharge hours as the main criterion — with eight hours as the initial benchmark — and requiring that performance be maintained in a verifiable manner throughout the contract period. This definition should be incorporated into planning, capacity, flexibility, innovation and funding frameworks, enabling different technologies to compete on the basis of the service they provide rather than their technological nature.

Overall, the report concludes that the main challenge is no longer simply to increase installed capacity, but **to create the conditions for transforming the high level of interest into viable, financeable projects that are integrated into the system and the local area**. To achieve this, it will be necessary to take coordinated action across networks, regulation, markets, taxation, funding, technology, industry, talent, security and governance.



02 Introduction

This report sets out the main conclusions of the working group on **Energy Storage and Electricity System Flexibility**, set up by **alinnea** to analyse the key challenges associated with the development of energy storage in Spain and to make progress in identifying measures to facilitate its roll-out.

Energy storage is a strategic element of the energy transition. Its development is essential for integrating a higher share of renewable energy, providing flexibility to the electricity system, strengthening security of supply and moving towards a more competitive, resilient and decarbonised energy model. At the same time, it represents an opportunity to strengthen Spain's industrial capacity, foster new value chains and improve the economy's competitiveness against a backdrop of increasing electrification.

Despite the technological potential and regulatory progress made in recent years, regulatory, economic, financial, technological, industrial, regional and social barriers remain, hindering the roll-out of new projects and limiting the ability to capitalise on the benefits that storage can bring to the energy system.

To tackle these challenges, **alinnea** launched a multi-stakeholder dialogue process structured around four working sessions, involving representatives from public administrations, businesses, sectoral associations, financial institutions, system operators, technology centres and independent experts. The sessions provided an opportunity to jointly analyse the role of storage in the electricity system, the technological and industrial challenges, regulatory and market requirements, financing conditions and business models, as well as the regional and social dimensions of its implementation.

The conclusions of this process are organised into three main sections: an assessment of the current state of energy storage in Spain, the identification of the main bottlenecks hindering its development, and a set of recommendations for action.

The working group received technical support from Raúl García Posada, director of ASEALEN, and Florent Marcellesi, an energy and climate expert, on issues relating to a Just Transition and its territorial and social dimensions. Sergio Soler, specialist in Public Policy and International Relations helped to identify participants' profiles and draft the minutes of the working sessions.

We would also like to thank all the individuals and organisations that have taken part in this working

group for sharing their knowledge, experience and time, thereby making the production of this document possible.

2.1 Objectives of the working group

The working group set itself three main objectives: **to analyse the current situation regarding energy storage and flexibility in Spain; to identify the main bottlenecks hindering its roll-out; and to draw up recommendations that will help to create a more stable and predictable framework for its development and integration into the energy system.**

The analysis is based on Spain's significant potential, stemming from its renewable resources, its industrial capacity and the targets set out in the Integrated National Energy and Climate Plan (PNIEC), and takes a comprehensive approach to the regulatory, market, financial, technological, industrial, territorial and social conditions that determine whether new investments materialise.

The ultimate aim is to help ensure that energy storage can play its full part in the integration of renewable energy, the stability and security of supply, the reduction of curtailment, the optimisation of grids, the electrification of the economy and the improvement of the competitiveness of the productive sector.

2.2 Methodology

The methodology used to produce this report was based on a multi-stakeholder dialogue process conducted under the Chatham House Rules, which combined presentations by experts, discussion amongst participants and a joint review of the findings. Between April and June 2026, three thematic sessions were held, followed in July by a fourth session aimed at reviewing and validating the report's main content, key points and recommendations.

The sessions were organised as follows:

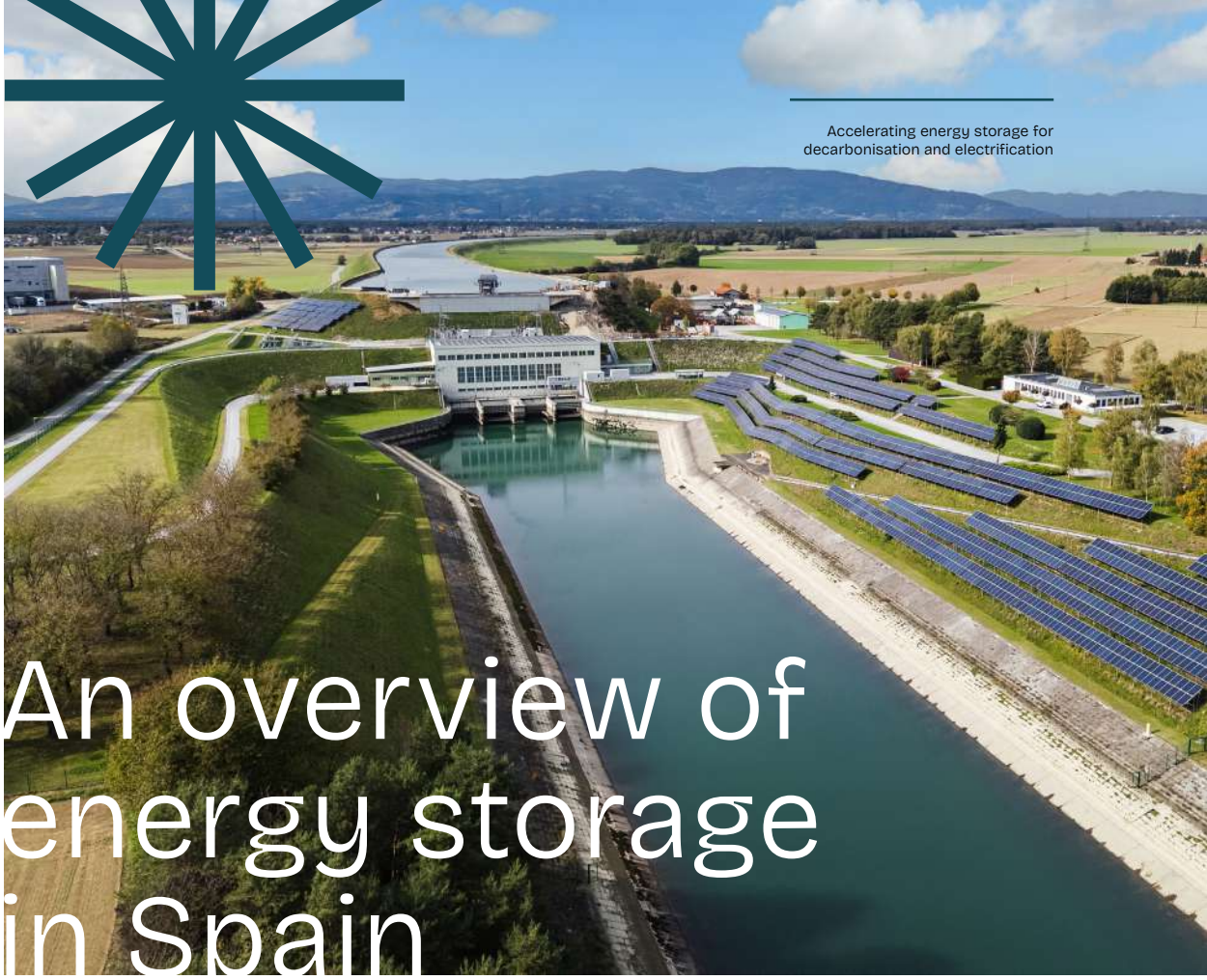
- **Session 1.** Regulatory framework and developments in grid storage and flexibility
- **Session 2.** Storage technologies, flexibility applications and the territorial dimension
- **Session 3.** Financing and business models for storage and flexibility



- **Session 4:** Joint review of the report's content

During these sessions, presentations were given by the following organisations on the following topics; we also thank them for their time and effort.

- **Overview of the sector, current situation, context and challenges.** Raúl García Posada, director of ASEALEN, contributor to alinnea.
- **AEPIBAL's views on key issues facing the sector (cybersecurity, the need for dialogue with local authorities).** Luis Marquina, President of AEPIBAL.
- **ENTRA's view on the role of aggregation and flexibility.** Alicia Carrasco, Executive Director of ENTRA, Aggregation and Flexibility.
- **The technological need for storage in the electricity system and industrial safety.**
  - Raúl García Posada, director of ASEALEN, contributor to **alinnea**
  - Carmen Longás, Head of the Grid Access Department, Red Eléctrica
  - Elena García, Head of Department at the Directorate-General for Industry and SMEs, Sub-Directorate-General for Quality and Industrial Safety, Ministry of Industry and Tourism
- **The social and territorial dimensions of storage projects.** Florent Marcellesi, a contributor to **alinnea** and an expert on energy and climate.
- **The impact of the new capacity mechanism and the sector's outlook,** Raúl García Posada, director of ASEALEN, contributor to **alinnea**.
- **Revenue and profitability of hybrid renewable energy generation and storage projects.** Borja Dalmau, UNEF
- **Market and business model for storage projects.** David Pérez, Agere
- **Financial institutions' perspective on the financing of storage projects.**
  - Patrício Peixoto, European Investment Bank
  - Rubén Martínez, Banco Sabadell
- **Taxation of energy storage.** Emilio Rodríguez, Partner in charge of the Energy Sector at PwC Tax & Legal.



03 An overview of energy storage in Spain

The expansion of renewable energy, the advance of electrification and the growing need for security and resilience are shaping an energy system in which storage and flexibility resources are becoming increasingly important.

The expansion of renewable energy, the advance of electrification and the growing need for security and resilience are shaping an energy system in which storage and flexibility resources are becoming increasingly important.

Energy storage makes it possible to shift energy over time, reduce renewable curtailment, make better use of the electricity grids and help balance generation and demand. In addition to these functions, there is their economic and industrial dimension, linked to the development of new value chains, the attraction of investment and the strengthening of Spain's competitiveness (European Commission, 2023; MITECO, 2021).

Spain also benefits from factors that promote its development: an abundance of renewable resources, ambitious electrification targets set out in the PNIEC, and significant industrial capacity. Whether this potential is realised will, however, depend on the regulatory, market, financial, technological and territorial conditions surrounding investment decisions.

This chapter analyses the state of energy storage in Spain from these different perspectives. The report examines their role in the electricity system, developments in the sector, the European and national regulatory frameworks, the main technologies and business models, and their industrial, regional and social dimensions. This analysis helps to put the issues identified by the working group and the recommendations subsequently drawn up into context.

3.1 The need for storage in the energy transition

The increase in renewable energy generation and in electricity demand associated with electrification is creating new requirements in terms of management and flexibility. As discussed below, these requirements stem from the far-reaching transformation of the electricity system and the new challenges associated with a model characterised by a greater share of renewable generation and electrified consumption.

3.1.1 An electricity system undergoing transformation

The European electricity system is undergoing an unprecedented transformation. The accelerated roll-out of renewable energy, the electrification of sectors traditionally reliant on fossil fuels, and climate neutrality targets are changing the way electricity is generated, transmitted and consumed. This new energy model offers significant opportunities to reduce emissions and boost competitiveness, but it also presents new challenges in ensuring the stability and efficient operation of the electricity system (European Commission, 2025a).

Spain is one of the European countries with the greatest potential to lead this transformation (International Energy Agency [IEA], 2021; Elsner et al., 2026). In recent years, installed renewable generation capacity has grown steadily, particularly in solar photovoltaic and wind power (Red Eléctrica, 2026b), a trend that will continue over the next decade, driven by the targets of the PNIEC, which forecasts that nearly **81 per cent of electricity generation will come from renewable sources by 2030**. At the same time, the electrification of transport, industry, buildings and other end-uses will significantly increase demand for electricity and alter traditional consumption patterns (MITECO, 2024a).

This new scenario represents a paradigm shift from the conventional electricity system. Whilst thermal power technologies were able to adapt their output to changes in demand, variable renewable energy sources depend on the availability of the natural resource. As a result, the system must be capable of managing greater variability in both generation and consumption, whilst maintaining a balance between supply and demand at all times.

3.1.2 Storage and flexibility as the cornerstones of the energy system

In this context, flexibility becomes an essential prerequisite for the functioning of the electricity system. Its aim is to enable generation, consumption, grids and storage to adapt dynamically to the system's needs across different time scales, ranging from seconds to weeks (European Commission, 2023, 2025d).

Energy storage plays a particularly important role because it allows electricity generation and consumption to be decoupled over time. Thanks to this capability, the energy produced during periods of high renewable generation can be used later when demand rises or output falls, helping to reduce the curtailment of renewable energy, optimise the use of electricity infrastructure and strengthen security of supply.

Spain is one of the European countries with the greatest potential to lead the transformation of the European electricity system.

However, storage is only one part of a broader concept: system flexibility. Alongside storage, these resources include active demand management, consumer aggregation, self-consumption, hybridisation of renewable energy installations, electric mobility, thermal storage, renewable hydrogen and new digital solutions that enable the intelligent management of energy production and consumption (ACER, 2025).

For this reason, the role of storage should not be analysed solely from the perspective of a specific technology, but rather as one of the key enablers of a more flexible, efficient and resilient electricity system.

3.1.3 Strategic infrastructure for competitiveness

Beyond its technical function, storage has become a strategic element of European energy and industrial policy. Its development will make it possible to integrate greater volumes of renewable generation, reduce dependence on external energy supplies, improve the utilisation of electricity grids and facilitate the electrification of the economy (European Commission, 2025c).

At the same time, energy storage presents an opportunity to develop new industrial value chains linked to battery manufacturing, power electronics, engineering, software, aggregation, digitalisation and the operation of energy infrastructure. The growing importance that the European Union attaches to these technologies, as reflected in initiatives such as the **Net-Zero Industry Act** or the **Clean Industrial Deal**, places energy storage amongst the technologies considered strategic for strengthening European energy autonomy and industrial competitiveness (European Commission, 2025b; European Parliament and Council of the European Union, 2024a).

Consequently, the challenge is no longer simply to deploy more storage capacity, but to create the regulatory, economic, industrial and territorial conditions that will enable its development to be accelerated and maximise its contribution to the energy transition.

3.2 The state of energy storage in Spain

Energy storage in Spain is currently undergoing a period of expansion, characterised by growing investor interest, the emergence of new projects and the diversification of technological solutions. The following section analyses currently available capacity, the targets set for the coming years, market trends and Spain's position within the European context.

3.2.1 Installed capacity and storage technologies

Spain is heading into the next decade with great potential to become one of Europe's leading energy storage markets. The rapid expansion of renewable energy generation, the projected growth in electricity demand and the electrification of the economy make it necessary to incorporate new resources capable of providing flexibility to the electricity system.

At present, energy storage in Spain continues to be dominated by pumped-storage hydroelectricity, which is the main large-scale storage technology installed in the electricity system. These facilities, developed primarily to manage the operation of the electricity system, provide long-duration storage capacity and continue to play a vital role in ensuring security of supply (Granell Ninot et al., 2023).

However, in recent years there has been an acceleration in the development of new technologies, particularly electrochemical batteries, both as stand-alone systems and integrated with renewable energy plants through hybridisation schemes. At the same time, other solutions such as thermal storage (Acideka, 2026; Brenmiller Energy, 2025; EnergyNest, 2026; IDAE, 2024; MITECO, 2025a), renewable hydrogen (Iberdrola Spain, 2026b; Moeve, 2026; Reolum, 2026; Repsol, 2025) and flexible demand management are beginning to establish themselves as complementary resources for meeting specific needs of the energy system (ENTRA Aggregation and Flexibility, 2025; Red Eléctrica, 2026a; Spain, 2026a).

The growing diversification of technology is a response to the fact that flexibility requirements are also becoming increasingly diverse (ACER, 2025). Whilst some applications require virtually instantaneous responses to ensure system stability, others need to shift energy over several hours or even several days, optimise the operation of renewable energy installations or facilitate the electrification of industrial processes.

3.2.2 Objectives of the PNIEC and prospects for development

The PNIEC identifies energy storage as one of the key elements for achieving the decarbonisation targets set for 2030. In its update, it sets a target of **22.5 GW of storage capacity** by the end of the decade, combining different technologies and operational time scales. This development aims to support the strong growth forecast for renewable energy

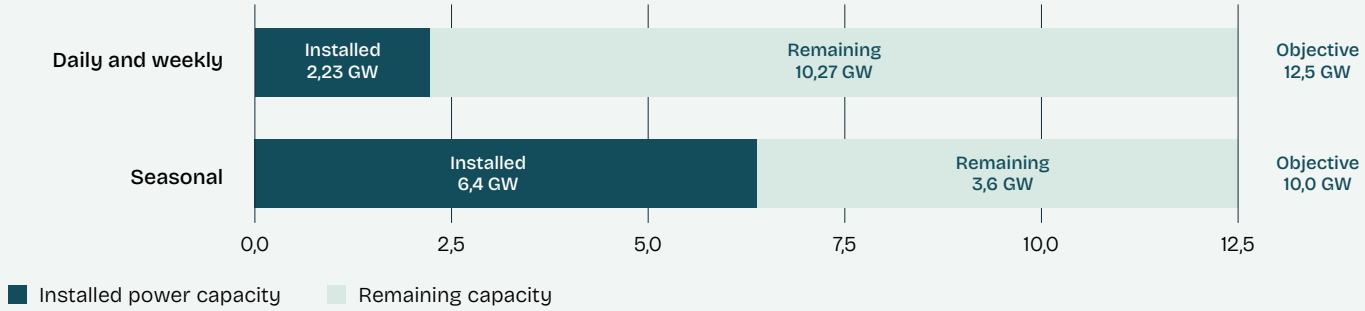


Figure 1. PNIEC 2030 storage targets and capacity already installed

Estimated progress by time frame

Reference installed power capacity versus the remaining capacity needed to meet each target

22,5 GW
overall objective



Basis for calculating installed power capacity

- Daily and weekly: 0.26 GW of utility-scale batteries, 0.87 GW of concentrated solar power (CSP) and 1.1 GW of behind-the-meter storage.
- Seasonal: 6.4 GW of pumped hydro storage.

Note: The allocation by technology is indicative. The NECP does not break down its targets by technology. Of the 1.6 GW of behind-the-meter storage projected for 2030, 1.1 GW is considered already installed and is included in the calculation of progress towards the daily and weekly targets.

Sources: Authors' calculations based on MITECO, NECP 2023–2030 (2024) and Annual Statistics on Self-Consumption and Storage 2024; Red Eléctrica, Installed Capacity (August 2026). Protermosolar, firm capacity of the 18 concentrated solar power (CSP) plants with storage (0.87 GW).

generation, ensure the efficient integration of new installations and reduce the constraints arising from the variability of solar and wind power generation.

Storage is thus no longer seen as a complement to renewable generation, but has become an essential part of the infrastructure required for the operation of the electricity system as a whole. Their roll-out will help to reduce renewable energy curtailment, optimise grid utilisation, improve security of supply and facilitate the electrification of new industrial, residential and transport applications (MITECO, 2024a).

In addition to the PNIEC, the Energy Storage Strategy had already identified the need to develop storage solutions with varying durations, tailored both to the day-to-day management of the system and to seasonal requirements arising from high renewable energy penetration (MITECO, 2021).

3.2.3 Projects currently under development and market trends

Investor interest in energy storage has grown significantly in recent years. The trend in applications for access and connection shows that the sector has

Investor interest in energy storage has grown significantly in recent years.

moved from its early stages to become one of the most dynamic segments within the Spanish electricity system.

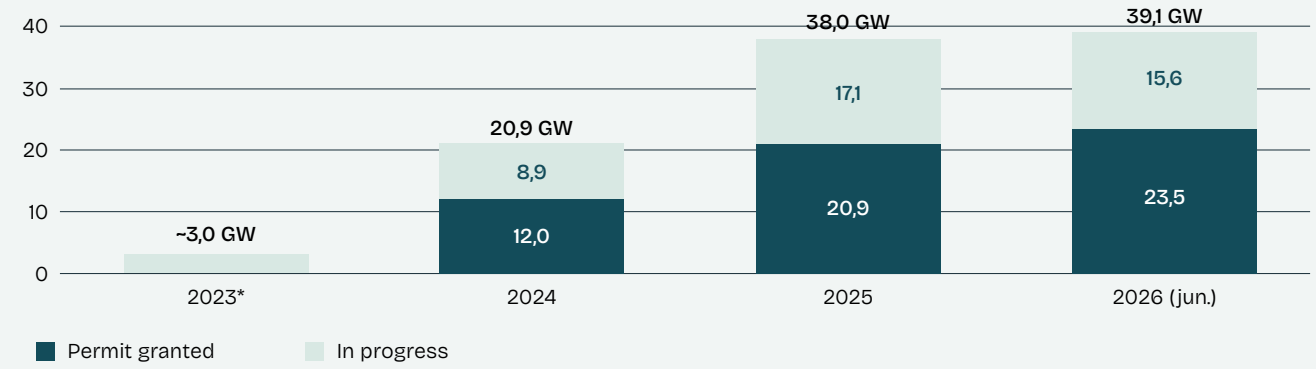
This growth is driven mainly by the development of battery projects, both in connection with new renewable energy plants and as stand-alone installations. The integration of solar and wind farms has established itself as one of the key strategies for improving the profitability of renewable energy installations, optimising the use of connection points and enhancing the manageability of generation.

At the same time, pumped-storage hydroelectric projects continue to be developed (MITECO, 2024b, 2026b, 2026c, 2026d; Iberdrola Spain, 2026a; Ayuso Santamaría, 2026), particularly those linked to the utilisation of existing infrastructure, as well as new initiatives relating to thermal storage (IDAE, 2025; Pacheco, 2026), industrial flexibility, demand

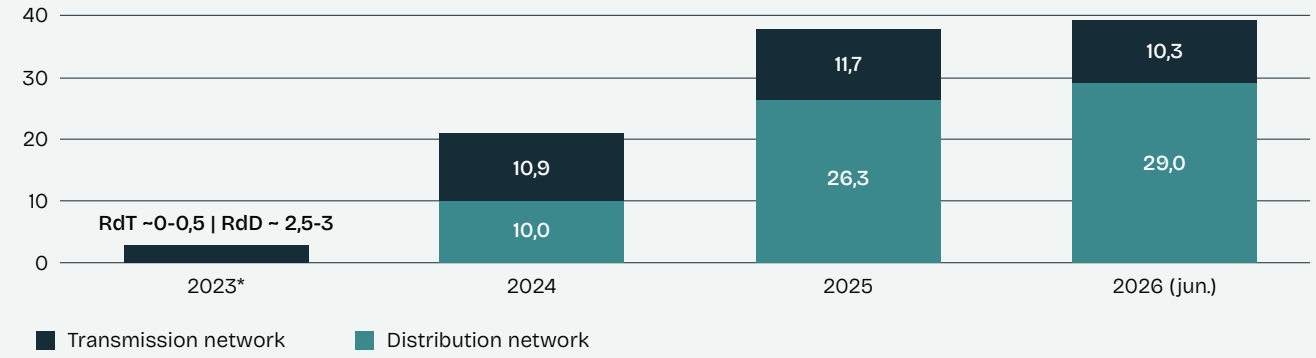
Figure 2. Storage grid access and connection applications

Cumulative requested capacity increased from approximately 3 GW in 2023 to 39.1 GW in June 2026.

Evolution by application status



Evolution by connection network



*The 2023 figures are approximate. The ranges for the transmission and distribution networks are represented by their midpoints.

Source: ASEALEN's own calculations based on data from Red Eléctrica and distribution system operators.

aggregation and energy communities (MITECO, 2025b).

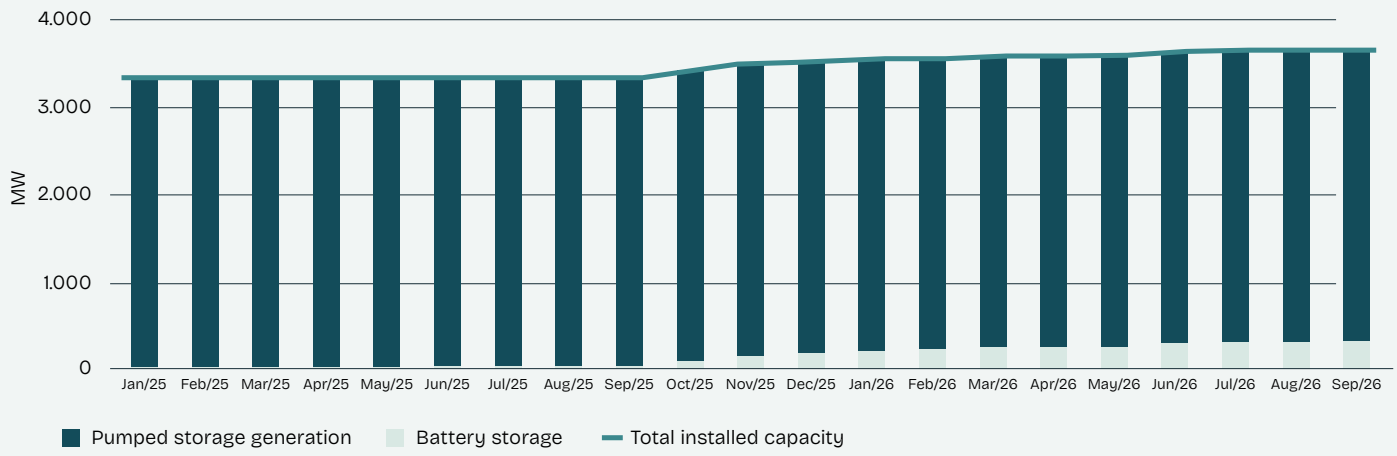
However, the large number of projects currently in the planning stage does not necessarily mean that all of them will actually be built. The market's development will depend on regulatory, economic and financial factors, as well as on the system's ability to generate sufficiently stable investment signals.

3.2.4 Spain in the European context

Spain offers some of the most favourable conditions in Europe for the development of energy storage. Its abundant supply of renewable resources, the strong growth forecast for solar photovoltaic energy and the need to electrify a significant part of the economy place the country amongst the markets with the greatest growth potential over the next decade.

The very development of European energy policy reinforces this position. The reform of the electricity market, the **Net-Zero Industry Act**, the **Clean Industrial Deal** and the new flexibility planning mechanisms recognise storage as a strategic infrastructure for ensuring industrial competitiveness, energy autonomy and security of supply (ACER, 2025; European Commission, 2025b; European Parliament and Council of the European Union, 2024a, 2024b).

Figure 3. Installed storage capacity in Spain | Electric National System



Source: Red Eléctrica (2026b), Installed capacity, data accessed in September 2026.

At the same time, other European countries are also stepping up their investment in storage, both through public support schemes and through regulatory reforms designed to facilitate the integration of these technologies into the various electricity markets. In this context, Spain's ability to realise its potential will depend not only on its renewable resources, but also on how quickly it manages to develop a regulatory, financial and industrial framework capable of supporting the sector's projected growth (European Commission, 2024; Ofgem, 2026; Terna, 2025).

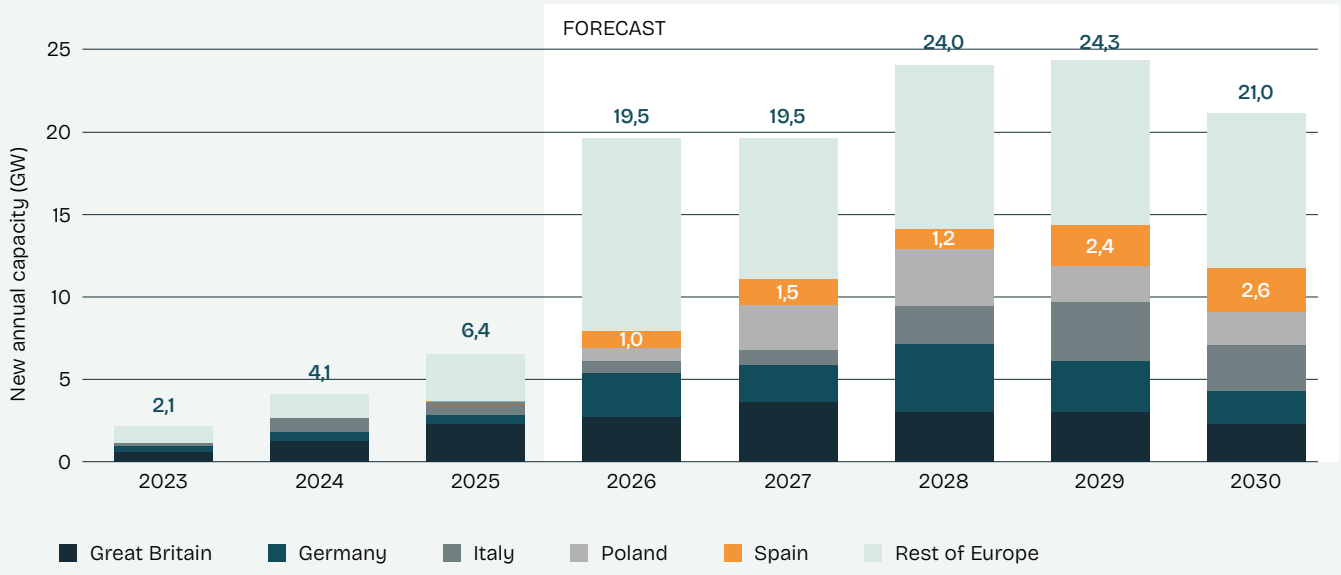
3.3 Regulatory framework and planning

The development of energy storage depends to a large extent on changes to the regulatory framework and on the planning of the electricity system. In recent years, both the European Union and Spain have promoted reforms aimed at integrating storage and flexibility resources into the functioning of the electricity market and into energy planning. This section summarises the key regulatory developments and the instruments that will shape the sector's development over the next decade.



Figure 4. Projected new utility-scale battery capacity in Europe

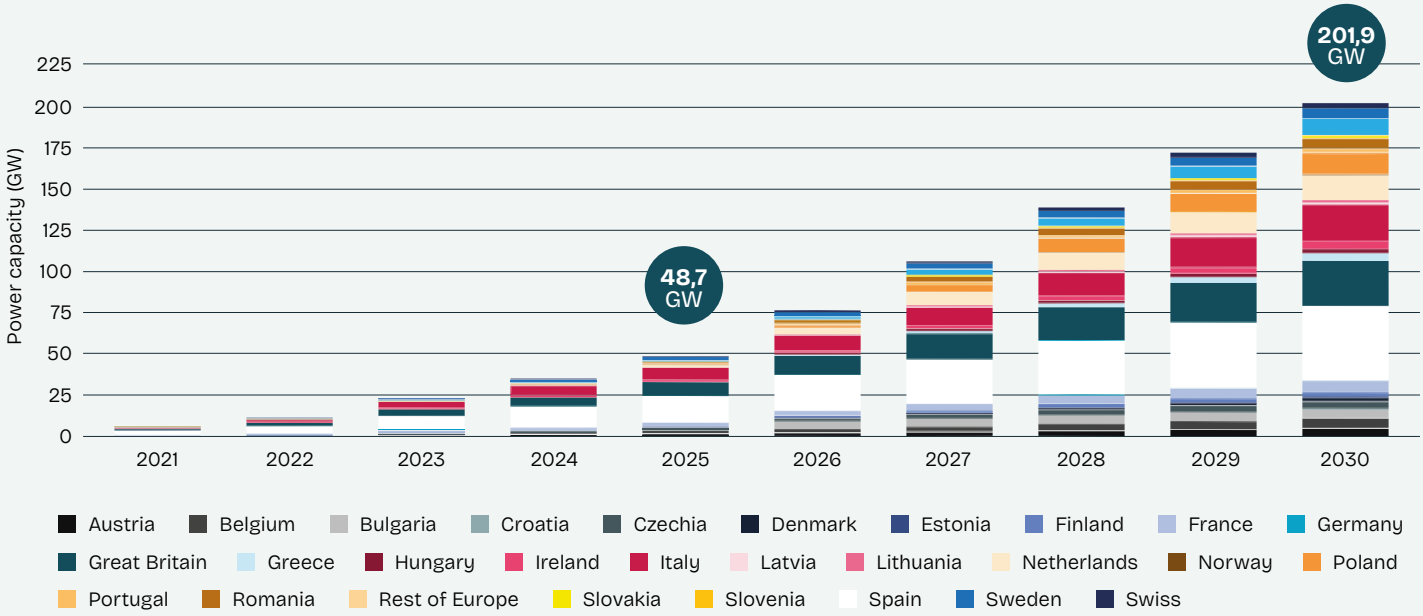
Spain is projected to rank among the top five markets by installed capacity in 2030.



EMMES forecasts that Europe's installed front-of-the-meter (FoM) storage capacity will exceed 120 GW/360 GWh by the end of 2030.

Source: compiled by the author based on LCP Delta and Energy Storage Europe (2026), *European Market Monitor on Energy Storage 10.0*, slide 11

Figure 5. Cumulative installed power capacity by country



Source: LCP Delta and Energy Storage Europe (2026), *European Market Monitor on Energy Storage 10.0*, https://energystorageeurope.eu/publication/emmes-10-0-june-2026-2/

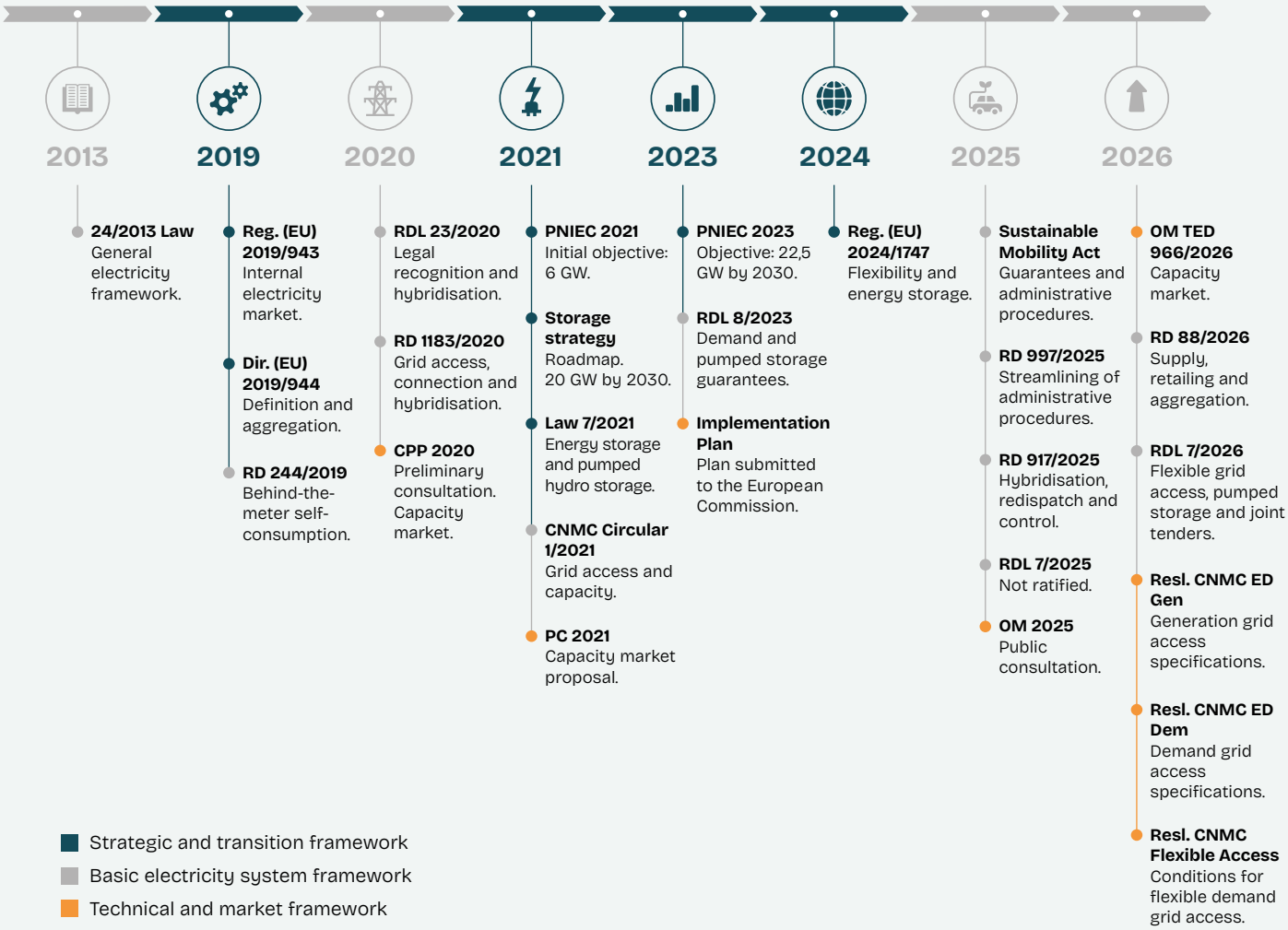
3.3.1 Developments in the European framework

In recent years, the European Union has identified energy storage and flexibility resources as key elements in the transition to a decarbonised, competitive and resilient energy system. The accelerated roll-out of renewable energy, together with the consequences of the energy crisis resulting from the Russian invasion of Ukraine, has reinforced the need for an electricity system capable of integrating large volumes of renewable generation whilst ensuring security of supply (European Commission, 2022, 2023).

In response, European energy policy has evolved from an approach focused primarily on renewable generation towards a broader vision, in which storage, demand management, smart grids and electrification play an equally strategic role. This development is reflected both in the reform of the European electricity market and in industrial initiatives such as the **Net-Zero Industry Act**, and the **Clean Industrial Deal**, as well as in the **REPowerEU** plan, which regard storage as a strategic technology for strengthening European energy autonomy and industrial competitiveness (European Commission, 2022, 2025b; European Parliament and Council of the European Union, 2024a, 2024b).

As well as facilitating the integration of renewables, these initiatives aim to strengthen European industrial value chains, reduce dependence on foreign technology and accelerate the roll-out of clean technologies considered essential for achieving climate neutrality.

Figure 6. Major regulatory developements 2013 - 2026



3.3.2 The reform of the European electricity market

One of the key regulatory developments has been the approval, in 2024, of the reform of the European electricity market design. This reform introduces a significant change to the planning of the electricity system by recognising that, in addition to ensuring sufficient generation capacity, it is essential to have resources capable of providing flexibility across different time scales (European Parliament and Council of the European Union, 2019, arts. 20–25; 2024b).

For the first time, European legislation introduces an obligation to specifically assess the flexibility requirements of each electricity system, distinguishing these from traditional analyses of adequacy or security of supply. This new approach recognises that a system with a high level of renewable energy penetration requires resources capable of managing the variability of generation, shifting energy over time, responding to changes in demand and alleviating congestion on electricity grids. (European Parliament and Council of the European Union, 2019, arts. 19f–19i; ACER, 2025

In this context, energy storage, active demand management, the aggregation of distributed resources and other flexibility solutions are now explicitly incorporated into Member States' energy planning. The reform also provides for the possibility of developing specific mechanisms to support flexibility where market signals prove insufficient to mobilise the necessary investment.

This new approach represents a significant shift from previous models, as it recognises that the energy transition does not depend solely on installing more renewable capacity, but also on equipping the system with the tools needed to manage it efficiently.

3.3.3 The Spanish regulatory framework

Spain has gradually adapted its regulations to incorporate energy storage as a new component of the electricity system. A turning point was **Royal Decree-Law 23/2020**, which legally recognised storage facilities and introduced new concepts such as independent aggregation and the hybridisation of renewable energy facilities (Spain, 2020b).

Subsequently, **Royal Decree 1183/2020**, concerning access to and connection to electricity grids, established the framework for the processing of storage projects, allowing them to be developed both as stand-alone installations and as part of renewable generation systems (Spain, 2020a).

This regulatory process has encouraged growing investor interest in storage, although there are still issues to be developed and implemented relating to participation in certain markets, the definition of specific mechanisms for remunerating flexibility, the regulation of distributed storage, and the integration of new business models associated with aggregation and active demand management (Spain, 2026a).

At the same time, various public support programmes, funded largely through the Recovery, Transformation and Resilience Plan and, in particular, the Renewable Energy PERTE, Renewable Hydrogen and Storage, as well as other European funding instruments, have helped to drive forward the first commercial energy storage projects in Spain (Government of Spain, 2021; MITECO, 2025a).

> **Energy storage, active demand management, the aggregation of distributed resources and other flexibility solutions are now explicitly incorporated into Member States' energy planning.**

3.3.4 Energy planning and grid development

Spain's energy planning recognises energy storage as an essential piece of infrastructure for achieving the decarbonisation targets set out in the PNIEC. The planned roll-out of renewable energy generation over the next decade requires the integration of new flexibility resources capable of ensuring the balance of the electricity system and optimising the use of the grids.

In this context, storage planning is closely linked to the planning of transmission and distribution networks. In certain areas, the introduction of storage can help to manage congestion, reduce curtailment of renewable generation and facilitate the connection of new electricity consumers, complementing planned investments in grid infrastructure (European Commission, 2023; FutuRed, 2023).

Furthermore, the growing electrification of industry, transport, buildings and other sectors will increase the need to coordinate the development of energy storage with the expansion of electricity grids, the digitalisation of the system and the integration of new distributed flexibility resources.



Future planning must therefore take an integrated approach to the development of renewable generation, grids, storage and demand, so that all these elements collectively contribute to a more secure, efficient and competitive electricity system (MITECO, 2025c; Red Eléctrica, 2025).

3.4 Storage technologies and models

Energy storage encompasses a diverse range of technologies capable of meeting a wide variety of needs within the electricity system. Each of these has different characteristics, scopes of application and levels of maturity, which means that a combination of solutions is required to meet the growing need for flexibility. This section provides an overview of the main technologies and the roles they play within the energy system.

3.4.1 A rapidly evolving technological ecosystem

Energy storage is not a single technology, but rather a range of solutions with very different technical characteristics, scales and applications. Each of these technologies addresses specific needs of the electricity system; consequently, there is no single technology capable of fulfilling, on its own, all the functions required by a system with a high level of renewable energy penetration (MITECO, 2021).

The growing electrification of the economy is driving the simultaneous development of various storage technologies, the use of which will depend on the length of time they need to store energy, the required response time, their location within the electricity system and the service they are required to provide.

In this context, the challenge lies not merely in deploying more storage capacity, but in efficiently combining different technologies capable of meeting a wide range of needs, from instantaneous system regulation to the storage of energy over several days or even seasons.

3.4.2 Key storage technologies

At present, energy storage in Spain relies on several families of technologies, each at different stages of maturity and development.

Pumped-storage hydroelectricity remains the technology with the largest installed capacity. Its main advantage lies in its ability to store large amounts of energy over long periods, making it a particularly valuable resource for electricity system management and the integration of renewable energy sources.

Electrochemical batteries, particularly those based on lithium-ion technology, are the fastest-growing technology. Their rapid response time, modular design and steadily falling costs are encouraging their deployment both in stand-alone installations and in conjunction with renewable energy plants or industrial consumers.

Alongside these technologies, other solutions with high growth potential are beginning to be developed, such as **thermal storage**, which is particularly

relevant for the decarbonisation of industrial processes and heat networks; new generations of batteries, such as sodium or flow batteries; and other long-duration storage technologies designed to meet needs lasting more than several hours or days.

For its part, **renewable hydrogen** is a complementary energy carrier which, although it has different characteristics to conventional electrical storage, can help to provide flexibility to the energy system by storing energy over long periods and subsequently utilising it in industrial, transport or electricity generation applications.

The coexistence of all these technologies will make it possible to tailor storage solutions to the system's various requirements, thereby avoiding reliance on a single technological option.

3.4.3 Applications of energy storage

The value of storage does not depend solely on the technology used, but on the role it plays within the energy system. Its main applications are summarised below (European Commission, 2023; MITECO, 2021).

In the field of renewable energy generation, energy storage makes it possible to shift production to times of peak demand, reduce energy curtailment and improve the manageability of solar and wind power plants.

In electricity networks, it can help to manage congestion, improve system stability and optimise the use of existing infrastructure, thereby reducing the need for new investment in the network in certain cases (FutuRed, 2023).

In industry, energy storage facilitates the electrification of production processes, improves the energy management of facilities and reduces exposure to volatility in electricity prices (European Commission, 2025c).

In the residential and commercial sectors, when combined with self-consumption, it enables greater use to be made of locally generated energy, improves energy resilience and reduces electricity bills.

The coexistence of technologies will make it possible to tailor storage solutions to the system's various requirements, thereby avoiding reliance on a single technological option.

Finally, storage will play an increasingly important role in electric mobility, both through charging infrastructure and through the future development of smart charging solutions and bidirectional technologies capable of interacting with the electricity grid.

3.4.4 System flexibility and demand management

Although storage is one of the main sources of flexibility, it is not the only one. The energy transition is driving the development of a wider range of solutions capable of adapting electricity consumption or generation to the system's needs.

These include, in particular, active demand management, which enables certain consumption to be shifted to times when renewable energy is most readily available; the aggregation of distributed resources, which coordinates multiple small consumers or installations to act collectively in the electricity markets; energy communities, self-consumption, smart electric mobility and the various digital solutions that enable the system's operation to be optimised in real time (European Commission, 2026).

Taken together, these resources form a new model for an electricity system that is far more decentralised, digitalised and participatory, in which consumers, producers and operators come to play a more active role in energy management.

3.5 Markets, business models and financing

The viability of energy storage depends not only on technological developments, but also on the existence of business models capable of ensuring a return on investment. Participation in the various electricity markets, the provision of flexibility services and the availability of appropriate funding mechanisms will be key factors in accelerating the sector's roll-out. This section analyses the main sources of income and the factors that influence its economic development.

3.5.1 The economic value of storage

The development of energy storage depends both on technological progress and on the existence of business models capable of ensuring the economic viability of investments. Unlike other energy infrastructure, whose profitability is usually based on a single activity, energy storage can generate value by simultaneously providing various services to the

electricity system (Agere Energy & Infrastructure Partners, 2025; Yusta et al., 2026).

These include temporal energy shifting (*energy shifting*), participation in wholesale electricity markets, the provision of balancing and adjustment services, the resolution of technical constraints, the integration of renewable generation, and the optimisation of consumption by large electricity consumers. This diversity makes storage a particularly versatile asset, but it also means that its profitability depends on multiple sources of revenue that evolve dynamically.

As the penetration of renewable energy increases, the economic value of flexibility is becoming increasingly important to the operation of the electricity system. However, many of these functions do not yet have fully developed or sufficiently stable remuneration mechanisms to facilitate long-term investment decisions.

3.5.2 Participation in electricity markets

Different storage technologies can play a part in different segments of the electricity market, depending on their technical characteristics and the services they are able to provide.

In addition to the day-ahead and intraday electricity markets, storage can add value in the balancing and adjustment markets managed by Red Eléctrica, by providing services designed to maintain the instantaneous balance between generation and demand and ensure the stability of the system (CNMC, 2020, 2024a, 2024b; Red Eléctrica, n.d.).

Furthermore, storage can help to manage technical constraints at certain points in the grid, facilitate the integration of renewable generation, or improve the utilisation of existing electricity infrastructure (CNMC, 2024b). In the future, the gradual introduction of new mechanisms linked to flexibility will make it possible to expand the opportunities for these technologies to be utilised.

The development of these markets is particularly significant because it will determine many of the economic indicators that will shape the pace of storage deployment over the coming years.

3.5.3 Funding and investment models

The development of energy storage requires capital-intensive investment and has relatively long payback periods. In this context, the availability of funding depends to a large extent on regulatory stability, the predictability of income and the perception of risk on the part of lenders and investors.

In recent years, European funding programmes, the Recovery, Transformation and Resilience Plan and various public calls for proposals have helped to drive forward the first commercial energy storage projects. However, the expected growth in the sector will require a much greater mobilisation of private investment.

To this end, it is essential to have sufficiently robust business models that enable the combination of different sources of revenue and reduce the uncertainty associated with future developments in the electricity markets. In this regard, the establishment of stable mechanisms for remunerating flexibility and the development of new financial tools will be key factors in accelerating the roll-out of storage in Spain.

3.6 Industrial, regional and social dimensions

Energy storage goes beyond the strictly technological sphere and also presents an opportunity to boost industrial competitiveness, generate new production capacity and promote territorial cohesion. At the same time, its roll-out presents challenges relating to social acceptance, integration into the local community and the development of new professional skills. This section addresses these aspects, which are essential for ensuring the sector's sustainable and balanced growth.

3.6.1 An opportunity for industrial development

Energy storage presents an opportunity to strengthen Spain's industrial competitiveness and develop new value chains linked to the energy transition. The growing demand for storage solutions is driving activity in the fields of battery manufacturing, power electronics, control systems, engineering, digitalisation, and the operation and maintenance of facilities, as well as new energy services linked to system flexibility (IDAE, 2026).

Spain has significant assets that enable it to participate in this process. Its industrial capacity, the projected growth of the domestic market, the availability of renewable resources and the presence of companies with expertise in sectors such as the automotive industry, the manufacture of electrical components and energy engineering place the

Figure 7. How does energy storage create value?

A combination of revenues, savings and avoided costs



STAND-ALONE
Grid-connected installation



HYBRIDISED WITH GENERATION
Joint operation with generation



BEHIND THE METER
Industry, businesses and households

REVENUE FROM PARTICIPATION IN MARKETS AND SERVICES

Depending on configuration, authorisation and grid access conditions; directly or through aggregation

Energy
- Day-ahead and intraday markets
- Arbitrage between time periods

Balancing and operation
Balancing services and technical constraints

Capacity and other services
Capacity mechanisms and grid flexibility, where enabled

ADDITIONAL VALUE BY APPLICATION



Asset optimisation
Using available power and energy capacity to combine compatible services.

Better utilisation of the installation



Generation integration
Shifting generation, reducing curtailment and managing imbalances.

Increasing the value of the energy generated



Consumption management
- Self-consumption, time-of-use management and peak shaving.
- Backup during outages.

Savings and avoided costs for consumers

COMBINING AND STRUCTURING REVENUE STREAMS

Market exposure • Optimisation or tolling agreements • Availability payments
The contractual structure determines how revenues and risks are allocated.

Not all value streams can be combined: this depends on the technology, regulation and operational commitments.

Contracts channel or stabilise value; they are not an additional source of revenue and should not be double-counted.

Source: Produced in-house.

From the territorial perspective, energy storage faces some of the same challenges that have already been encountered in the roll-out of other energy infrastructures.

country in a favourable position to attract new investment and develop its own industrial capabilities.

In this context, European industrial policy reinforces this opportunity. Initiatives such as the **Net-Zero Industry Act** and the **Clean Industrial Deal** aim to strengthen the manufacturing of clean technologies within the European Union, reduce external dependence and consolidate strategic supply chains. Energy storage forms part of this set of technologies considered essential for European competitiveness (European Commission, 2025b; European Parliament and Council of the European Union, 2024a).

However, to take full advantage of this opportunity, it will be necessary to establish a stable regulatory framework, facilitate industrial investment and strengthen capacity in the areas of innovation, training and technological development.

3.6.2 Territorial integration and social acceptance

The roll-out of energy storage also poses significant challenges from a regional perspective. Although these infrastructure projects contribute to the energy transition and the integration of renewable energy, they are being implemented in specific areas where different land uses, economic activities and social sensitivities coexist.

Social acceptance of projects will depend to a large extent on the quality of the planning processes, on transparency throughout their implementation, and on the ability to take proper account of local needs. Factors such as the location of facilities, compatibility with other uses, environmental protection and the distribution of economic benefits are becoming increasingly important as the number of projects rises.

In this respect, energy storage faces some of the same challenges that have already been encountered in the roll-out of other energy infrastructures. Proactive planning, coordination between public authorities and the involvement of local stakeholders will be crucial in facilitating the sector's balanced development. This approach is also beginning to be incorporated into public policy through the development of standards and labels of social, territorial and environmental excellence applicable, amongst other things, to energy storage projects, which are currently being drawn up by UNE (Spain, 2026b; MITECO, 2026a).

3.6.3 Capabilities, innovation and industrial safety

The development of energy storage also requires strengthening the technical and industrial capabilities needed to support the sector's projected growth. The expansion of new technologies will increase demand for specialists in engineering, electronics, digitalisation, energy systems operation, maintenance, cybersecurity and data management (EOI, 2026; Extremadura New Energies, n.d.).

At the same time, the large-scale roll-out of new facilities makes it necessary to establish a robust industrial safety framework that ensures high standards of design, manufacture, installation and operation. The technological diversity of energy storage requires procedures tailored to the specific characteristics of each solution, as well as the ongoing updating of technical standards and certification schemes (BatteryPlat, 2025).

Innovation will also play a key role in the coming years. In addition to developments in storage technologies (BEPA, 2024), the sector will continue to make progress in areas such as digitalisation, the aggregation of distributed resources, smart grids, artificial intelligence applied to energy management and new flexibility models (European Commission, 2026).

Taken together, the development of industrial capabilities, the promotion of innovation and the strengthening of industrial safety will be decisive factors in consolidating a competitive ecosystem capable of supporting the roll-out of energy storage in Spain.

3.7 Conclusion

Overall, the assessment shows that Spain is in a particularly favourable position to make progress in the development of energy storage. The high potential for renewable energy, electrification targets, the existence of a significant industrial base and growing investor interest all combine to create a favourable environment for energy storage to play an increasingly important role in the energy system. Its development will be crucial to integrating greater volumes of renewable generation, providing

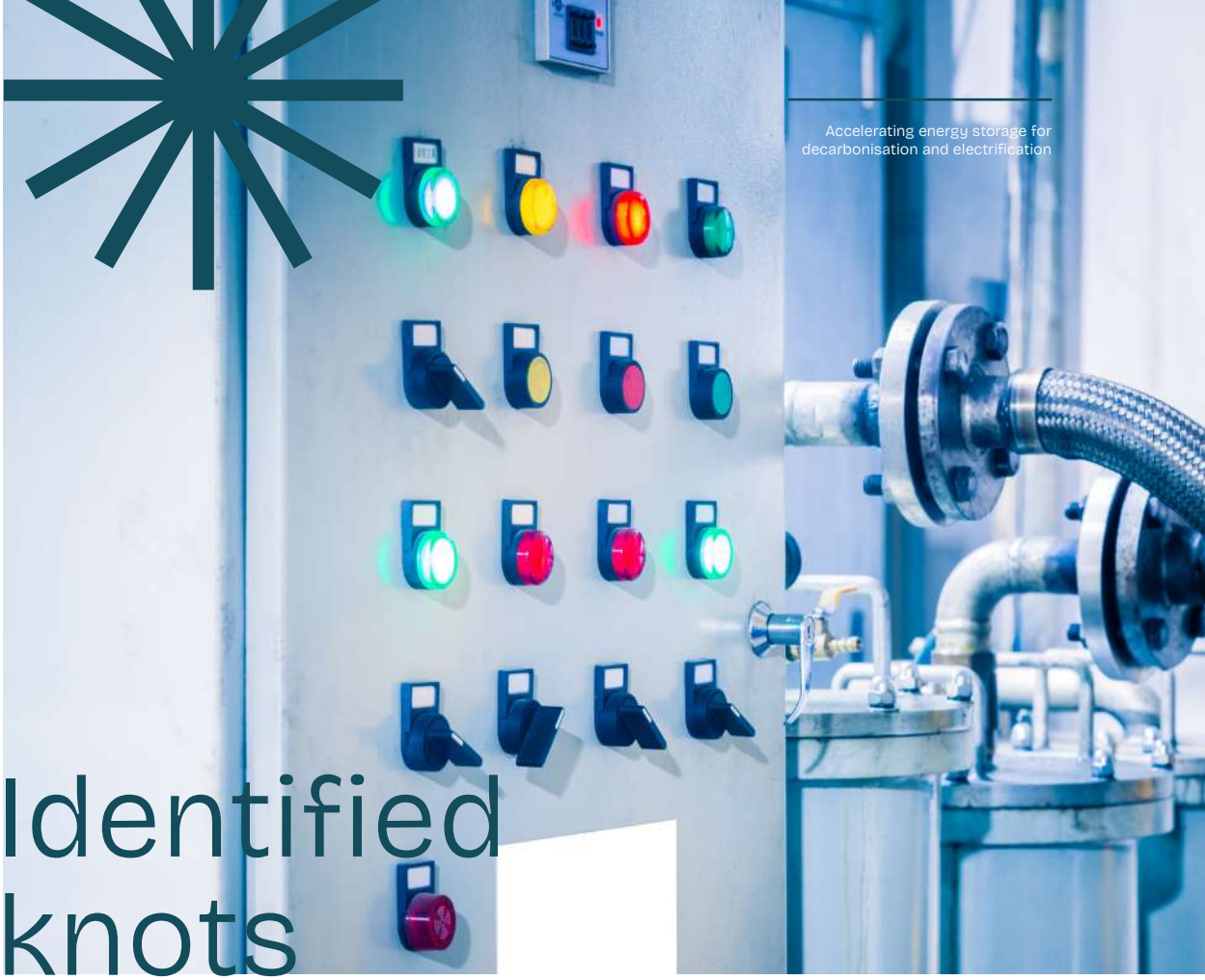
flexibility, reducing curtailment, optimising the use of the grids and helping to ensure the security and competitiveness of the electricity supply.

However, realising this potential will require a sustained increase in installed capacity, which will in turn necessitate coordinated progress in adapting the regulatory and planning framework, developing markets capable of adequately remunerating the various services provided by storage, the consolidation of viable business models, and the deployment of a combination of technologies and flexibility resources tailored to the system's varying needs. Added to this is the need to strengthen the industrial value chain, technical and professional capabilities, industrial safety, and the territorial and social integration of projects.

The challenge, therefore, is to move from a situation characterised by high potential and growing interest in energy storage to a framework that enables that interest to be transformed into viable projects and an effective contribution to the functioning of the energy system.

The challenge is to move from a situation characterised by high potential and growing interest in energy storage to a framework that enables that interest to be transformed into viable projects.

The following chapters set out the main challenges identified during the working group's dialogue process and the recommendations for action proposed to address them, with the aim of accelerating the roll-out of energy storage and maximising its contribution to the electrification, decarbonisation and competitiveness of the Spanish economy.



04 Identified knots

As part of the dialogue organised by **alinnea** within the Working Group on Energy Storage, **bottlenecks** are defined as those regulatory, technological, economic, industrial or social obstacles that hinder the development of energy storage and limit its ability to contribute to a more flexible, resilient and decarbonised electricity system.

The bottlenecks identified are not the result of isolated problems, but rather of interrelated factors that affect the entire storage value chain. Resolving these issues requires coordinated action between public authorities, regulators, system operators, industry, the financial sector and other relevant stakeholders.

4.1 Network, access and system operation

4.1.1 Limited access to the electricity grid

Limited access to and connection with the electricity grid continues to hamper the roll-out of energy storage and the electrification of industry, particularly at those nodes experiencing the highest levels of congestion.

4.1.2 Limited flexibility in network management

The management of transmission and distribution networks does not yet fully harness the potential of mechanisms such as flexibility and flexible connections, thereby limiting the efficient integration of storage, renewable energy and new electricity demand.

4.1.3 Inefficiencies in the access and connection system (*permitting*)

The growing gap between authorised capacity and that actually brought into service, together with the accumulation of permits for projects that are never carried out, makes it difficult to make efficient use of the available capacity.

4.1.4 Network planning that is not dynamic enough

The planning of electricity infrastructure and capacity allocation mechanisms is evolving at a slower pace than the transformation of the energy system, making it difficult for the grid to adapt to the system's new requirements.

4.2 Regulation and institutional framework

4.2.1 Regulatory complexity

The development of storage continues to be hampered by a fragmented, complex and constantly evolving regulatory framework, which makes it difficult to plan investments and develop projects.

4.2.2 Lack of coordination between government departments

The implementation of projects is hampered by a lack of coordination between public authorities, the inconsistent application of regulations and a lack of alignment between different public policies.

4.2.3 Pending regulatory developments

The development of aggregation, flexibility and other new business models continues to be constrained by pending regulatory developments and by the difficulty of translating regulatory recognition into effective implementation.

4.2.4 Administrative procedures are only partially adapted to innovation

The rapid technological evolution of storage stands in contrast to inflexible administrative and regulatory procedures, making it difficult to incorporate technological improvements during the development of projects.

4.2.5 Regulatory mismatch in the face of regional specificities

The regulatory framework does not take sufficient account of the specific characteristics of non-mainland electricity systems, where isolation and smaller scale make energy storage a particularly critical resource for ensuring security of supply and the integration of renewable energy.

4.3 System design and market signals

4.3.1 Inadequate definition of the role of storage

The lack of a clear definition of the functions that storage should fulfil makes it difficult to design regulatory instruments and capacity mechanisms tailored to the system's needs.

4.3.2 A market design that reduces the profitability of storage

Electricity markets do not yet allow the full value of all the services provided by energy storage to be captured, thereby limiting its profitability and the development of new business models.

4.3.3 Weak regulatory and economic signals for long-duration storage

Technologies capable of providing flexibility over extended periods still lack regulatory and economic incentives that adequately recognise their contribution to the system.

4.4 Demand flexibility and aggregation

4.4.1 Barriers to distributed storage

Distributed storage and behind-the-meter resources continue to face regulatory and market barriers that hinder their deployment and recognition as system assets.

4.4.2 Limited integration of flexible demand

Active participation on the demand side continues to be constrained by the lack of adequate economic signals, specific markets and sufficiently developed aggregation mechanisms.

4.4.3 Insufficient digitalisation and observability (lack of real-time information)

Insufficient observability – understood as a lack of real-time information on the status and operation of distributed resources, such as self-consumption – limits the efficient planning and operation of the system and hinders the development of new flexibility services.

4.5 Industry, the value chain and strategic autonomy

4.5.1 External dependence on technologies and components

The development of energy storage continues to be hampered by a high degree of reliance on external suppliers for certain technologies, such as batteries, and strategic components.

4.5.2 Incomplete development of the European value chain

The development of domestic industrial capabilities continues to be hampered by the lack of a sufficiently developed value chain at national and European level.



4.5.3 Lack of coordination in deployment and industrialisation

The pace of deployment of storage facilities is not keeping step with the strengthening of industrial capabilities and Europe's strategic autonomy.

4.6 Talent, skills and sectoral organisation

4.6.1 Shortage of specialist talent

Growth in the sector continues to be hampered by a shortage of professionals specialising in the various stages of the storage value chain.

4.6.2 The need to strengthen training and reskilling in the sector

The transformation of the sector requires us to speed up professional reskilling and adapt technical and university education to the new requirements of energy storage.

4.7 Security and cybersecurity

4.7.1 Inadequate development of the industrial safety framework

The roll-out of storage continues to be hampered by the need to develop specific technical and regulatory standards in Spain to ensure the safety of the facilities, particularly those based on technologies that are less widely adopted.

4.7.2 Increasing exposure to cybersecurity risks

The digitalisation of storage infrastructure makes it all the more important to strengthen cybersecurity and reduce the vulnerabilities associated with critical components.

4.7.3 Perception of risk and limited acceptance of certain technologies

The uptake of certain storage technologies continues to be influenced by perceptions of risk and by the need to improve public information and build confidence in security standards.

4.8 Technology, roll-out and sector maturity

4.8.1 Uneven development of storage technologies

Different technologies have varying levels of maturity, development times and capabilities, which calls for a differentiated approach in public policy.

4.8.2 Insufficient technical standardisation

The lack of common standards, as well as the incomplete adoption of new international standards, continues to hamper the design, construction and operation of storage projects.

4.8.3 Complexity in project delivery

The implementation of projects continues to be hampered by the technical, logistical, contractual and operational complexities of these facilities.

4.8.4 Limited recognition of technological diversity

The regulatory and market framework does not yet fully reflect the diversity of services that different storage technologies can provide.

4.9 Governance and the territorial dimension

4.9.1 Limited territorial governance

The implementation of projects continues to be hampered by shortcomings in institutional coordination and by complex administrative procedures.

4.9.2 Growing territorial disputes

The rise in social and territorial conflicts surrounding certain projects highlights the need to improve public participation and the early-stage management of projects.

4.9.3 Misinformation and a lack of communication

Acceptance of energy storage continues to be hampered by the spread of misinformation and by the need to improve transparency, communication and public education.

4.10 Economic model, investment and financing

4.10.1 Limited bankability of projects

The limited visibility and stability of revenue continue to hamper the mobilisation of investment and the financing of energy storage.

4.10.2 Uncertainty regarding revenue mechanisms

Changes in the design of capacity mechanisms and other markets are creating uncertainty regarding the future profitability of investments.

4.10.3 Difficulties in accessing finance

Smaller-scale projects and certain technologies continue to face greater difficulties in accessing funding tailored to their specific needs.

4.10.4 Mismatch between the fiscal framework and the specific characteristics of storage

The tax regime for energy storage continues to be based on categories designed for conventional generation and consumption, leading to economic and tax distortions for different technologies and business models.



Accelerating energy storage for decarbonisation and electrification

05 Roadmap

Based on the issues identified during the dialogue process, **alinnea** proposes a roadmap to guide the development of energy storage in Spain. The aim is to translate the findings into a set of priorities that will enable their roll-out to be accelerated and strengthen their contribution to the energy transition, industrial competitiveness and the security of the electricity system.

The roadmap organises these priorities into **three time horizons — short, medium and long term** — distinguishing between actions aimed at removing the most immediate barriers (short term), those aimed at scaling up the sector through new markets, capacities and instruments (medium term), and those designed to fully integrate storage into the planning and operation of the electricity system (long term).

The priorities are grouped into four areas: **enabling conditions (1), integration into the system (2), industry and capabilities (3), and governance and territory (4)**. These areas encompass regulatory, economic and fiscal reforms; developments in the markets and the functioning of the system; the strengthening of the value chain, innovation and talent; and institutional, regional and social coordination.

Furthermore, each priority is classified according to its **strategic relevance**, distinguishing between **high, medium and low priorities**, based on the importance assigned to them during the participatory process and their potential to accelerate the development of energy storage.

The roadmap is not a fixed action plan, but rather a strategic framework that identifies the priorities shared by the participating stakeholders and provides an integrated vision of the transformation required for energy storage to play its full part in a more flexible, resilient, competitive and decarbonised electricity system.

Roadmap for the Development of Energy Storage

	SHORT TERM 0-2 years | Unlock	MEDIUM TERM 2-4 years | Scale up	LONG TERM 4+ years | Transform
Enabling conditions	Active grid management and flexible connections Complete regulation and simplify procedures Reduce revenue uncertainty and strengthen public funding Correct tax distortions Standardise industrial safety and cybersecurity	Dynamic, observable grid planning Consistent and flexible regulatory framework Diversified business models and risk hedging Taxation adapted to different applications Safety integrated across the life cycle	Grid adapted to a flexible, electrified system Stable and predictable regulatory framework Financing on a par with other infrastructure Taxation aligned with the system's evolution Fully consolidated safety framework
Integration into the system	Remove barriers to market access and participation Facilitate aggregation and active demand Improve observability and information exchange Gear technologies to immediate needs	Remunerate firmness, flexibility and capacity Consolidate aggregation and distributed resources Active and predictive grid management Diversify the portfolio and drive long-duration storage	Markets that recognise the value of storage Fully integrated demand and distributed resources Smart, automated and coordinated system Storage integrated into planning and operation
Industry and capabilities	Strengthen industrial capabilities and the value chain Applied innovation, pilots and common standards Improve financial valuation methodologies Identify and train critical profiles	Industrial scale-up and less external dependence Scale up promising and long-duration technologies Consolidate specialised financing Training ecosystem connected to industry	Competitive European value chain Technology market with harmonised standards Mature financial ecosystem Solid base of talent and technical capabilities
Governance and territory	Administrative coordination and common criteria Public information and early participation Anticipate territorial conflicts	Permanent coordination and monitoring mechanisms Stable models of local participation and returns	Integrated energy and territorial governance Social licence and balanced distribution of benefits

Strategic priority: High Medium Low

5.1 Enabling conditions

The development of energy storage requires a regulatory, economic and institutional framework that provides stability and certainty for investment. To this end, it is essential to take action in **five priority areas: network access and management**, the development of the **regulatory framework**, the **bankability** of projects, the adaptation of the **tax framework** and the strengthening of **industrial safety** and **cybersecurity**.

The development of these enabling conditions is the first step towards establishing storage as an essential piece of infrastructure for the energy transition, industrial competitiveness and security of supply.

5.1.1 Network access and the evolution of the network management model

The transition to a highly renewable electricity system requires a fundamental transformation of the way in which electricity networks are planned, managed and used. In this new context, access to the grid is no longer merely an administrative requirement but has become one of the key factors determining the roll-out of energy storage and, consequently, the system's ability to integrate new renewable energy sources, provide flexibility and ensure security of supply.

Although there have been significant advances in recent years in the planning and regulation of energy storage, including most recently **Royal Decree-Law 7/2026**, of 20 March, which introduces new regulation for demand access, and **Royal Decree 88/2026**, which develops the regulatory framework for independent aggregation, the model still largely responds to a logic designed for an electricity system based on conventional generation technologies. Access capacity continues to be allocated in an essentially static manner, and infrastructure planning is carried out over long time horizons, making it necessary to move towards a more dynamic model, capable of optimising the use of existing infrastructure and adapting more quickly to the growing penetration of renewable energy and flexibility resources.

One of the main challenges is the gap between the access capacity allocated and that actually utilised. The existence of capacity tied up by projects that have not been implemented or are under-utilised limits the development of new initiatives and makes it necessary to move towards mechanisms that allow it to be reallocated or shared more efficiently, thereby preventing it from remaining tied up by projects that never go ahead or that make only limited use of the network.

In this context, energy storage is a strategic tool for maximising the use of existing capacity. Its ability to shift energy over time, reduce congestion and provide flexibility makes it possible to increase the effective utilisation of infrastructure without the need for further investment in the grid. To this end, it will be necessary to move towards active management models based on flexible connections, real-time network monitoring and digital tools that dynamically optimise the use of available capacity.

This development must be accompanied by more dynamic grid planning that is better aligned with changes in demand, the electrification of the economy and the roll-out of new technologies. Rather than a model based on periodic reviews with long-term timeframes, it will be necessary to move towards continuous planning, underpinned by actual data on grid usage, which incorporates scenarios for growth in demand and storage, periodically reviews capacity requirements and coordinates infrastructure development with energy, industrial and spatial planning.

Furthermore, this development must take into account the specific characteristics of non-peninsular systems, where storage is particularly valuable for improving the integration of renewable energy, strengthening security of supply and reducing dependence on conventional technologies. To this end, it will be necessary to adopt a specific regulatory framework that defines the role of storage in system planning and operation, establishes appropriate remuneration for the services it provides, adapts the criteria for access and connection, and streamlines project authorisation, thereby providing a stable regulatory environment that encourages investment and accelerates its roll-out.

The transformation of the network access and management model should be carried out gradually:

SHORT TERM	To improve the utilisation of existing capacity by implementing active grid management mechanisms, developing flexible connections, ensuring greater transparency regarding available capacity, and promoting tools that facilitate the integration of storage into system planning.
MEDIUM TERM	To consolidate a more dynamic planning model, underpinned by greater digitalisation and observability of the networks and closer coordination between planning, operations and the development of electricity demand.

LONG TERM	To have a grid that is fully adapted to a decarbonised, highly electrified and flexibility-based electricity system, in which storage plays a key role in optimising the use of infrastructure and ensuring safe, efficient and resilient operation.

5.1.2 Development of the regulatory framework for storage

In just a few years, energy storage has gone from being a technology that was virtually non-existent in the regulatory framework to becoming an essential component of the energy transition. However, the development of the legislation has taken place through a series of amendments designed to address specific needs, resulting in a fragmented regulatory framework which can sometimes make it difficult to implement.

At the same time, rapid technological change and the emergence of new business models, hybrid set-ups and distributed solutions call for more flexible and adaptable regulation. A framework that is overly rigid or based on closed technological categories may stifle innovation and delay the adoption of new solutions. To meet this challenge, it will be necessary to put in place procedures that allow for the updating of technologies or the introduction of non-substantial technical modifications to projects that have already been authorised, without having to restart the entire administrative process from scratch.

Alongside this regulatory reform, one of the main challenges remains the simplification of the administrative procedures associated with project development. The existence of differing interpretation criteria across different authorities, the lack of coordination between energy, environmental and town-planning regulations, and the difficulty in incorporating technological changes into projects that have already been authorised all increase uncertainty, prolong deadlines and hinder investment.

To address these challenges, it will be necessary to move towards more standardised and coordinated procedures, with common criteria for interpretation and mechanisms that allow for non-substantial technical amendments to be made without restarting the process, whilst ensuring legal certainty and environmental and social safeguards.

The consolidation of this regulatory framework must take into account the diversity of functions and configurations that storage can assume within the electricity system. The coexistence of stand-alone, hybrid, self-consumption-based and grid-integrated installations calls for technology-neutral regulation that is sufficiently flexible to accommodate new business models and facilitate the provision of multiple services to the system, whilst ensuring that the regulations are not tied to specific configurations that may quickly become obsolete.

The regulatory framework should evolve gradually:

SHORT TERM	To finalise the outstanding regulatory developments and simplify administrative procedures.
MEDIUM TERM	To establish a more consistent and flexible framework that facilitates the updating of projects and ensures the uniform application of the regulations throughout the country.
LONG TERM	To have an integrated, stable and predictable regulatory framework capable of adapting to developments in the electricity system and of providing the necessary conditions for storage to realise its full potential as a strategic infrastructure for decarbonisation, industrial competitiveness and the resilience of the energy system.

5.1.3 Bankability, financing and economic models

The development of energy storage no longer depends solely on technological maturity, but on the existence of an economic framework that enables the value it brings to the system to be translated into viable projects that are attractive to investors. Uncertainty over future revenue continues to hamper their financing and slow down the roll-out of new capacity, despite their contribution to the integration of renewable energy, flexibility and security of supply.

Unlike other energy infrastructure, energy storage often lacks a stable and predictable source of revenue. Its profitability depends on a combination of different services (*revenue stacking*), which makes it difficult to estimate cash flows and assess the risk of projects. Consequently, one of the main challenges is to consolidate business models with more stable revenue streams through instruments such as long-term contracts or mechanisms for remunerating capacity and flexibility, which can provide greater visibility regarding future revenue.

This uncertainty has a direct impact on the bankability of the projects. Although certain investments may prove profitable from a financial point of view, high exposure to *merchant* revenue, limited historical experience and the lack of established benchmarks make it difficult to access funding through *project finance* and to secure financing on competitive terms. To overcome these barriers, it will be necessary to develop risk hedging instruments, contractual models tailored to storage, and specific valuation methodologies that enable financial institutions to assess these investments more effectively.

During the early stages of the market's development, public funding should act as a catalyst, reducing perceived risk, facilitating initial transactions and mobilising private capital. In this context, the European Investment Bank and other national and European investment support instruments will be particularly important in accelerating the sector's development.

At the same time, it will be necessary to improve financial institutions' and investors' understanding of storage. The accumulation of experience and the availability of data on the technical and economic performance of these technologies will make it possible to improve risk assessment, reduce financing costs and establish storage as an asset class within the energy sector.

The development of bankability should take place gradually:

SHORT TERM	To reduce uncertainty regarding revenue and strengthen the role of public funding.
MEDIUM TERM	To consolidate more diversified business models, risk hedging instruments and greater involvement of the financial sector.
LONG TERM	To have a mature market in which energy storage can access funding on terms comparable to those for other strategic energy infrastructure.

5.1.4 Adjustment of the fiscal framework

Energy storage is becoming established as an essential part of the energy transition, but the tax framework has not kept pace. Tax legislation continues to be based on an electricity system characterised by the separation of generation, transmission, distribution and consumption, whilst storage plays a cross-cutting role. This failure to adapt creates distortions that reduce the competitiveness of certain technologies and limit the development of new business models.



One of the main challenges is to recognise the specific nature of storage within the tax system. At present, the tax system continues to apply categories designed for conventional generation and consumption, which leads to inconsistencies in the treatment of these facilities. Consequently, schemes such as the IVPEE, the IAE or certain levies may tax activities or facilities without adequately reflecting the systemic role of storage. Furthermore, the diversity of technologies — such as hydraulic pumping, batteries and thermal storage — requires a tax regime tailored to their different technical and operational characteristics, thereby preventing a single tax regime from being applied indiscriminately to very different situations.

It will also be necessary to review those tax measures that impose a disproportionate financial burden or are applied unevenly across different regions, such as the IAE or certain regional levies. Key priorities include clarifying the tax treatment of stored energy and adapting the applicable regime to facilities which, like energy storage systems, can consume, store and supply energy to the grid. At the same time, the tax system should incorporate incentives to encourage investment in storage projects — for example, through tax credits, deductions or more favourable tax treatment for infrastructure that provides flexibility services — recognising their contribution to decarbonisation, electrification and security of supply.

Changes to the fiscal framework should be introduced gradually:

SHORT TERM	To rectify the main tax distortions, clarify the tax treatment of different types of projects and move towards a more consistent application of the regulations.
MEDIUM TERM	To consolidate a tax framework tailored to the diverse applications of energy storage and aligned with the transformation of the electricity system.
LONG TERM	To have a tax system which, as well as removing barriers, encourages investment in storage infrastructure as a strategic factor for the competitiveness, resilience and decarbonisation of the energy system.

5.1.5 Industrial safety and cybersecurity

The large-scale roll-out of energy storage must be accompanied by a robust framework for industrial safety and cybersecurity that bolsters the confidence of public authorities, developers, investors and the public. The rapid expansion of these technologies and the diversity of their applications make it necessary to move towards standardised technical criteria that ensure safe implementation and promote the acceptance of projects.

Although there have been significant advances in recent years, such as the revision of the Low-Voltage Electrotechnical Regulations (REBT), the development of new Complementary Technical Instructions (ITC) for direct current, and the work to approve a specific ITC for high-voltage BESS systems, the regulatory framework must continue to evolve to keep pace with the rapid rate of innovation in the sector. The emergence of new technologies and configurations requires the criteria for design, installation, operation and maintenance to be continuously updated, incorporating technical advances without causing uncertainty during the project approval process.

The consolidation of the sector will also require strengthening the technical capabilities of public authorities, emergency services, inspection bodies, installers, operators and maintenance companies. Specialised training, the dissemination of best practice and the consistent application of safety requirements will help to reduce uncertainty and improve the management of these infrastructures throughout their entire life cycle.

Alongside industrial safety, the increasing digitalisation of the electricity system makes it essential to integrate cybersecurity from the very early stages of project design. The protection of equipment, communication systems and management platforms must be incorporated into technical standards to ensure the resilience and operational security of increasingly interconnected infrastructure.

Changes to the safety framework should be introduced gradually:

SHORT TERM	The priority will be to establish standardised technical criteria, finalise the regulatory framework and enhance training for the relevant stakeholders.
MEDIUM TERM	It will be necessary to integrate industrial safety and cybersecurity into all stages of the project life cycle and to ensure the consistent application of standards.

LONG TERM	The aim will be to establish a fully consolidated framework that combines innovation, high levels of safety, and institutional and social trust, thereby facilitating the roll-out of energy storage as a strategic infrastructure for the energy transition.

5.2 Integration of storage into the electricity system

The growing uptake of renewable energy, the electrification of the economy and the development of distributed energy resources are profoundly transforming the way the electricity system operates. In this new context, storage is no longer merely a supporting technology but has become a strategic resource that will provide flexibility, strengthen security of supply and ensure the efficient integration of renewable energy.

To realise this potential to the full, it will be necessary to move towards a more flexible, digitalised and smart electricity system, by adapting the design of the markets, promoting the involvement of demand-side management and distributed resources, incorporating new tools for system operation, and establishing storage as a strategic infrastructure for the energy transition.

5.2.1 Development of flexibility markets and the evolution of market design

The increased presence of variable renewable energy sources is transforming the needs of the electricity system and requires a market design capable of valuing not only energy, but also the system's flexibility, reliability and responsiveness. In this new context, storage is no longer merely a complementary technology but has become an essential resource for providing balancing services, managing congestion, helping to balance generation and demand, and strengthening security of supply.

The evolution of market design will need to recognise more accurately the value of the various services provided by storage. To this end, it will be necessary to develop flexibility markets that enable the remuneration of services such as primary response, the provision of inertia, the management of technical constraints in distribution networks, *black start* or short-circuit current, reflecting the value that these technologies bring to the operation of the system.

At the same time, the capacity mechanism must be established as a tool to facilitate an orderly transition towards a progressively non-fossil-based energy system, incentivising the storage durations that the system actually requires and ensuring that its design does not favour certain technologies over others. This development will require a clearer distinction to be made between firmness and flexibility, defining the roles played by each resource and establishing specific remuneration mechanisms for each service.

At the same time, it will be necessary to move towards a market design based on remuneration for the services that storage provides to the system, rather than solely on the energy supplied. To this end, economic signals must recognise the value of flexibility, security of supply, location and the duration of services, whilst market mechanisms must allow storage to participate simultaneously in the various markets and system services, thereby providing a more stable and predictable framework for investment.

These markets should evolve gradually.

SHORT TERM	To remove the main barriers to access and participation, to consolidate recognition of the value of flexibility, and to promote the development of the instruments already under development.
MEDIUM TERM	Establish a more stable and integrated framework, capable of providing certainty for investment and of consistently remunerating firmness, flexibility and capacity.
LONG TERM	To have an electricity system that is fully adapted to a decarbonised model, in which the markets effectively recognise the strategic value of storage and flexibility for the system as a whole.

5.2.2 Aggregation, demand and distributed energy resources

The growing electrification of the economy, the rise of self-consumption, energy communities and the roll-out of distributed storage are transforming the way the electricity system operates. Compared with a model based on a small number of large-scale generation facilities, the coordinated involvement of consumers and distributed energy resources is becoming increasingly important. In this way, demand ceases to play a passive role and becomes an active

element in the system's operation, helping to maintain a balance between generation and consumption.

The pooling of resources already provides a means of participating in certain markets and services within the system, through suppliers and other operators who manage portfolios of consumers. The challenge, therefore, is to increase this participation and ensure that a greater volume of demand, storage and distributed resources can effectively provide flexibility. To this end, it will be necessary to strengthen economic signals, promote sustainable business models and adapt participation and remuneration mechanisms to reflect the value that these resources bring to the system.

At the same time, the regulatory framework for the independent aggregator must be finalised, clearly defining its functions and its relationship with suppliers, distributors and the system operator. Its introduction will broaden the options available for facilitating consumer participation, without the development of flexibility being tied exclusively to this mechanism.

The development of this model will require enabling an ever-wider range of distributed resources to participate in the electricity markets and in the provision of services, regardless of their size, technology, voltage level or location. To this end, it will be necessary to establish uniform criteria for participation, ensure non-discriminatory access and set up coordination mechanisms between the parties involved. This will enable us to harness the flexibility provided by consumers, industry, storage, self-consumption and electric mobility, in both distribution and transmission networks, thereby contributing to efficiency, security of supply and the integration of renewable energy.

The roll-out of this model should proceed gradually:

SHORT TERM	Remove the barriers that limit the pooling of resources and active participation on the demand side.
MEDIUM TERM	Consolidate business models and remuneration mechanisms that enable an increase in the share of demand and distributed resources in the electricity markets and system services, through the various aggregation models available.
LONG TERM	To have an electricity system in which demand, storage and distributed resources play a fully integrated and coordinated role in providing services to the system, helping to maximise the efficiency, resilience and competitiveness of the energy system.

5.2.3 Digitalisation, observability and intelligent system operation

The integration of an increasing number of distributed resources requires greater capacity for monitoring, coordination and real-time decision-making. In this regard, digitalisation acts as an enabler for integrating storage and managing system flexibility more efficiently.

One of the main challenges is to improve the observability of distribution networks and the resources connected to them. To this end, it will be necessary to deploy remote metering and sensor systems, develop tools for dynamically calculating available capacity and digital network models (*digital twins*), and strengthen the exchange of information between distributors and the system operator. It will also be necessary to improve the interoperability of information systems in order to facilitate the exchange and use of available data. These capabilities will enable real-time monitoring of the grid's status, optimise the use of existing capacity and facilitate more efficient management of flexibility and the integration of renewable energy.

Digitalisation must be accompanied by changes to the system's operating models. To this end, it will be necessary to incorporate active network management systems (*Active Network Management*), advanced predictive analytics tools and coordination procedures between the system operator and the distribution network operators. This development will enable a shift from an operational model based on estimates and periodic reviews towards dynamic grid management supported by real-time information, capable of coordinating the use of demand, storage and other flexibility resources, as well as optimising existing infrastructure.

The transition to this new model should take place gradually:

SHORT TERM	Improve the observability of distribution networks, roll out digital tools and strengthen the exchange of information between the various operators.

MEDIUM TERM	Consolidate active and predictive grid management by fully integrating storage and other distributed resources into system operations and strengthening coordination between transmission and distribution networks.
LONG TERM	To have a smart, highly automated and coordinated electricity system in which demand, storage and grids can be managed jointly to maximise efficiency, resilience and security of supply.

5.2.4 Storage as a strategic component of the system's infrastructure

The transition to a highly renewable electricity system requires that energy storage cease to be regarded as a supporting technology and instead become an infrastructure that forms the foundation of the system. Its contribution is no longer limited to shifting energy over time; rather, it is essential for ensuring security of supply, integrating renewable energy, strengthening the system's resilience and optimising the operation of the grids. In this new context, the deployment of new capacity must meet the needs of the electricity system and form part of long-term energy planning.

Establishing storage as a strategic infrastructure will require the development of a diversified portfolio of technologies capable of meeting flexibility requirements of varying durations. Whilst batteries offer high responsiveness for short-term services, technologies such as hydraulic pumping or thermal storage will play an increasingly important role in meeting daily, weekly or seasonal needs. The planning of the system should capitalise on the comparative advantages of each technology, promoting their complementarity and avoiding excessive reliance on a single solution. The choice of technologies must be based on the system's operational requirements — response capacity, storage duration, location or required services — rather than on a preference for specific solutions.

At the same time, it will be necessary to promote the development of long-duration storage through a regulatory framework and economic incentives tailored to the characteristics of these technologies. Their contribution to security of supply, the management of prolonged periods of low renewable generation and the resilience of the system requires mechanisms that adequately recognise the value they provide, thereby encouraging their gradual roll-out as the needs of the electricity system evolve.



The transition to this new model should take place gradually:

SHORT TERM	Recognise the distinct roles played by the various storage technologies and gear their development towards the system's most immediate needs.
MEDIUM TERM	To consolidate a more diversified technology portfolio, driving the development of long-duration storage and strengthening its complementarity with other flexibility resources.
LONG TERM	To have an electricity system in which storage forms a fully integrated strategic infrastructure, underpinned by a balanced mix of technologies capable of ensuring flexibility, resilience and security of supply in a context of high levels of electrification and decarbonisation.

5.3 Industry and technical capabilities

The development of energy storage represents a strategic opportunity to boost the industrial competitiveness of Spain and Europe, foster new value chains and strengthen strategic autonomy in a key technology for the energy transition. Beyond its contribution to the electricity system, energy storage is a driving force for innovation, investment and industrial development.

To capitalise on this opportunity, we will need to accelerate the development of a competitive European value chain, drive innovation and the industrial scaling-up of the various technologies, consolidate a specialised financial ecosystem, and develop the necessary technical and professional skills. All of this will enable Europe to lead not only the way in the roll-out of energy storage, but also in the development, manufacture and funding of the technologies that will make it possible.

5.3.1 Development of a competitive industrial value chain

The rapid growth forecast for energy storage offers an opportunity to develop a competitive industrial value chain in Europe, capable of reducing strategic dependencies and strengthening Europe's leadership in key technologies for the energy transition. To capitalise on this potential, the industry will need to move away from a model focused primarily on project deployment towards an ecosystem capable of designing, manufacturing, integrating and maintaining the various storage technologies throughout their entire value chain.

One of the main challenges is to establish a robust industrial base, ranging from the supply of components and equipment to the manufacture, integration and operation of the various storage technologies. To this end, it will be necessary to strengthen industrial capabilities by developing specialised suppliers and new manufacturing capacities in Europe, to encourage the creation of higher value-added activities in areas such as engineering, systems integration, recycling and technology services, and to foster collaboration between manufacturers, technology centres, universities and industrial users to accelerate knowledge transfer, industrial upscaling and the commercialisation of new solutions, underpinned by sufficient demand to facilitate the establishment of a competitive value chain in Europe. This development will help to reduce external dependencies and strengthen the resilience of supply chains.

At the same time, it will be necessary to promote an industrial strategy based on technological diversification, encouraging the development of different storage solutions in line with the services required by the electricity system and avoiding excessive reliance on a single technology. To this end, it will be necessary to support industrial and demonstration projects in technologies such as batteries, hydraulic pumping and thermal storage, as well as to promote specialisation in those sectors where Europe has competitive advantages, such as engineering and systems integration, and hydraulic pumping. This strategy will enable us to meet the various needs of the electricity system, strengthen Europe's strategic autonomy and build a more resilient and competitive industrial base.

The transition to this model should take place gradually:

SHORT TERM	To strengthen existing industrial capabilities and promote the development of a European value chain in the sectors with the greatest growth potential.
MEDIUM TERM	To accelerate the industrial scale-up of the various storage technologies, thereby consolidating a competitive business ecosystem and reducing dependence on external suppliers.
LONG TERM	To have a fully integrated and internationally competitive value chain that positions Europe as a leader in the development, manufacture and integration of strategic storage technologies.

5.3.2 Innovation, standardisation and technological scaling

The competitiveness of the European storage industry will depend on its ability to transform technological knowledge into commercially viable solutions that are manufactured on an industrial and competitive scale. Although Europe has a robust research and innovation ecosystem, one of the main challenges is to accelerate the transfer of knowledge to the market and bridge the gap between technological development and its industrial deployment.

To this end, it will be necessary to strengthen the mechanisms that facilitate the scaling up of the most

promising technologies by promoting demonstration projects, pilot plants and first commercial installations, developing testing and validation infrastructure, the creation of specific programmes to support industrial scale-up, and the strengthening of collaboration between companies, technology centres and research organisations. This development will be particularly significant for long-duration storage technologies, such as reversible hydraulic pumping, thermal storage, compressed air energy storage (CAES), liquid air energy storage (LAES), CO_2-based developments and battery chemistries designed for long-duration storage, the deployment of which will enable the electricity system to meet future flexibility requirements. It will also be necessary to encourage technological diversification, by promoting the parallel development of different solutions and avoiding excessive reliance on a single technology.

Alongside technological development, it will be necessary to consolidate and build on the progress already made in the field of technical standardisation. In recent years, several international regulations and standards have been updated to bring safety requirements into line with technological advances in BESS systems (UL, NFPA, IEC, etc.); however, these have not yet been adopted by the Spanish sector. Consequently, efforts have been made to develop common standards and guidelines for the sector, as well as initiatives to strengthen industrial safety criteria, notably including work to develop a specific Complementary Technical Instruction (ITC) for high-voltage BESS systems and a nationally agreed document that standardises criteria on safety distances, fire protection and installation requirements. On this basis, it will be necessary to continue harmonising the technical criteria applicable to the design, construction, operation and decommissioning of facilities, to strengthen *safety compliance* and to clarify the division of responsibilities amongst the various stakeholders in the value chain. In this way, standardisation will be able to evolve in step with technological advances, reducing uncertainty and facilitating the sector's industrial scaling.

The transition to this model should take place gradually:

SHORT TERM	To strengthen applied innovation, promote pilot projects and make progress on the development of common technical standards.
MEDIUM TERM	To consolidate the industrial scaling-up of the most promising technologies, particularly those with a long lifespan, and to promote greater technological diversification.
LONG TERM	To have a fully developed market for the various storage technologies, underpinned by harmonised standards and an industrial ecosystem capable of developing, manufacturing and deploying competitive solutions on an international scale.

5.3.3 The maturing of the specialised financial ecosystem

The establishment of storage as a strategic infrastructure will also depend on the financial sector's ability to understand, value and finance this type of asset. Although investor interest has increased significantly in recent years, the storage sector continues to face challenges arising from limited experience in this field, the complexity of its business models and the lack of established methodologies for assessing its risk and profitability.

One of the main challenges is to **develop tools and methodologies** that will enable a more accurate assessment of the economic contribution of storage to the electricity system. To this end, it will be necessary to adopt models that take into account the value of flexibility, the simultaneous provision of different services to the system, and the expected revenue trends over the projects' lifetimes. A more comprehensive assessment will make it easier to compare technologies, improve risk assessment and lead to investment decisions that are better aligned with the system's needs.

At the same time, it will be necessary to establish a specialised financial ecosystem capable of responding to the specific characteristics of storage. To this end, it will be necessary to develop specific methodologies for *project finance*, broaden the expertise of financial institutions and investors in this type of asset, and promote financial instruments tailored to projects with different risk and revenue profiles, particularly in the case of emerging and long-term technologies. This development will help to reduce the cost of capital and speed up access to finance on competitive terms.

The transition to this model should take place gradually:

SHORT TERM	To develop common methodologies for the economic valuation of storage and to enhance financial institutions' and investors' understanding of the sector.
MEDIUM TERM	To consolidate a specialised financing market, promoting the development of instruments tailored to different technologies and business models.
LONG TERM	To have a fully mature financial ecosystem capable of financing storage on terms comparable to those of other strategic energy infrastructures and of supporting the large-scale roll-out of new capacity.

5.3.4 Talent and professional skills (technical training)

The development of a competitive energy storage industry will require professionals with the technical skills needed to design, manufacture, install, operate and maintain these technologies throughout their entire life cycle. The rapid evolution of the sector and the growing complexity of projects make it necessary to adapt the training provision and develop new professional profiles capable of meeting the needs of an expanding industry.

One of the main challenges is to strengthen specialised training at all educational and professional levels. To this end, it will be necessary to update vocational and university training programmes, promote specialisation and continuing professional development programmes, and strengthen collaboration between businesses, technology centres and universities in order to tailor training to the industry's actual needs. It will also be necessary to develop specific skills in areas such as engineering, systems integration, digitalisation, the operation and maintenance of facilities, industrial safety and the management of complex projects.

The consolidation of the sector will also require strengthening the technical capabilities of public authorities and the various stakeholders involved in the development of projects. Training for technical staff in government departments, inspection bodies, engineering firms, installers, operators and emergency services will help to standardise technical criteria, streamline administrative procedures and facilitate the safe and efficient roll-out of energy storage.

The transition to this model should take place gradually:

SHORT TERM	Identify the sector's talent needs and strengthen specialised training for the most in-demand roles.
MEDIUM TERM	To consolidate a training ecosystem tailored to technological developments in storage and to strengthen collaboration between the education system and industry.
LONG TERM	To have a solid foundation of talent and technical capabilities that will enable Europe to maintain its industrial leadership and support the widespread roll-out of storage technologies.

5.4 Governance and territory

The roll-out of energy storage will require a governance model capable of coordinating the actions of the various public authorities and ensuring the balanced integration of this infrastructure across the country. Beyond regulatory or technological considerations, its development will depend on the ability to incorporate the territorial dimension from the earliest stages of planning, to coordinate the actions of the various public authorities, to anticipate and manage any potential conflicts associated with its implementation, and to build trust amongst the various stakeholders involved.

To this end, it will be necessary to strengthen institutional coordination, promote models of early participation and ensure that the development of storage generates shared benefits for the regions where it is implemented. All of this will help to consolidate public support and recognise energy storage as a strategic piece of infrastructure for the energy transition, competitiveness and the resilience of the electricity system.

5.4.1 Governance and institutional coordination

The development of energy storage requires a governance framework capable of coordinating the actions of the various public authorities and

integrating energy, industrial, environmental and spatial planning policies. The cross-cutting nature of this infrastructure means it is necessary to move beyond sector-based approaches and towards more coordinated planning and decision-making models, which provide greater certainty for projects and enable a more agile response to the needs of the electricity system.

One of the main challenges is to strengthen coordination between the various authorities responsible for the planning, authorisation and monitoring of projects. To this end, it will be necessary to establish permanent coordination mechanisms between the central government, the autonomous communities and local authorities, through permanent working groups, common planning procedures and channels for exchanging information on project development, network planning and the future needs of the electricity system. Similarly, it will be necessary to integrate energy, industrial, environmental and spatial planning through coordinated planning and assessment processes that enable the early identification of infrastructure needs, reconcile the various land uses and align investment decisions with the objectives of decarbonisation, industrial development and territorial cohesion.

Improvements in governance must be accompanied by a more preventative approach to project management. To this end, it will be necessary to incorporate the territorial dimension from the earliest stages of planning, to identify potential technical, environmental and social constraints at an early stage, and to establish monitoring and evaluation mechanisms that enable planning to be adapted to the changing needs of the system and reduce the likelihood of conflicts arising during the implementation of projects.

The transition to this model should take place gradually:

SHORT TERM	To strengthen coordination between public authorities and move towards standardised criteria for the planning and processing of projects.
MEDIUM TERM	To consolidate permanent coordination and monitoring mechanisms that bring together the various public policies relating to energy storage.
LONG TERM	To have a fully integrated governance model capable of coordinating energy and spatial planning and of anticipating the system's needs through more agile, consistent and predictable decision-making processes.



5.4.2 Regional dialogue, participation and social licence

The roll-out of energy storage must be accompanied by a territorial integration strategy that enables it to be established as a strategic infrastructure for the energy transition. As the number of projects increases and their presence expands into different geographical areas, issues such as the perception of risk, the impact on the landscape, the lack of rigorous information or the perceived lack of benefits for the local area may become decisive factors in their development. In this context, social licence ceases to depend solely on the acceptance of individual projects and becomes a structural element of storage planning and governance.

One of the main challenges is to replace models of participation based on information provision or formal consultation with ongoing dialogue processes from the earliest stages of planning. To this end, it will be necessary to establish permanent forums for participation involving public authorities, developers, local authorities, social organisations, the business community and the general public, thereby facilitating the exchange of information, the early identification of concerns and the development of shared solutions. It will also be necessary to strengthen public information and education programmes, providing accurate, accessible and evidence-based information on how storage works, its safety and its contribution to the energy transition, whilst strengthening institutional capacity to counter disinformation campaigns.

The inclusion in the dialogue of the regions that are the recipients of investment must be accompanied by stable mechanisms for generating shared value for those regions. Beyond the economic impacts arising from the construction of the facilities, it will be necessary to develop models for local returns tailored to the specific characteristics of each project and each region, through mechanisms such as energy communities, lower-cost energy supply, public participation in project equity, or funds earmarked for the development of local services and infrastructure. It will also be necessary to make use of the tools provided for in **Royal Decree-Law 7/2026**, such as renewable energy acceleration zones, criteria of excellence and territorial returns, in order to strengthen the positive socio-economic impact of energy storage and consolidate its integration into the region.

The transition to this model should take place gradually:

SHORT TERM	Strengthen public information, incorporate participatory processes from the earliest stages of planning, and proactively manage territorial conflicts.
MEDIUM TERM	To consolidate stable models of local participation and return that strengthen the involvement of the various local stakeholders in the development of projects.
LONG TERM	To have a model in which storage is recognised as a strategic piece of infrastructure integrated into the local area, underpinned by a well-established social licence, participatory governance and a balanced distribution of the benefits associated with the energy transition.



06 Priority proposals

This section outlines the recommended actions that different stakeholder groups can take to accelerate the roll-out of energy storage.

6.1 Adapting the tax system to energy storage

What it involves

Energy storage fulfils a hybrid function that does not fit neatly into the traditional categories of the tax system. A single installation can act as a consumer during charging, as a producer when it feeds electricity back into the grid, and as a provider of flexibility, capacity or balancing services in both directions. As a result, it may be subject, in turn, to tax regimes designed for different activities, which affects the profitability and financing of projects. The adaptation of the fiscal framework must therefore remain a priority in order to accelerate the roll-out of storage.

One of the factors to be taken into account would be the treatment of electricity discharged for the purposes of the Tax on the Value of Electricity Production (IVPEE), the treatment of electricity used for charging as consumption for the purposes of the Special Tax on Electricity (IEE), the lack of a specific classification for batteries under the Tax on Economic Activities (IAE), and the uneven application of certain regional and local levies and taxes. Furthermore, the current framework does not distinguish sufficiently between stand-alone installations, hybrid projects, hydraulic pumping, storage linked to self-consumption, and solutions located either before or after the meter.

The recent adoption of Royal Decree-Law 18/2026 represents a significant step forward. The legislation reduces the IVPEE to 3.5 per cent for 2027 and sets a rate of 0 per cent from 1 January 2028, to remain in force indefinitely. The Congress of Deputies ratified the Royal Decree-Law on 23 July 2026 and agreed to proceed with it as a bill.

For projects with long payback periods, ensuring a stable and predictable tax regime that provides regulatory certainty for investment and financing decisions is a key factor. It is therefore advisable to clarify, in general terms, the specific tax treatment of storage operations within the tax framework.

The recommendation is therefore to move towards a comprehensive reform that recognises for tax

The recommendation is to move towards a comprehensive reform that recognises for tax purposes storage as a distinct activity and clarifies its treatment under the various tax regimes.

purposes storage as a distinct activity and clarifies its treatment under the various tax regimes. In particular, it would be advisable to make a regulatory distinction between storage operations – whether using batteries or hydraulic pumping – and conventional electricity generation for the purposes of the IVPEE, in line with their function of storing energy and subsequently feeding it back into the system.

The reform must avoid double taxation, adapt each tax regime to the actual function of the asset, and establish stable incentives that encourage investment without disproportionately passing on the costs to other consumers.

Objective

Establish a coherent and predictable fiscal framework that:

- recognise the specific nature of storage as a consumer, producer and service provider, and harmonise the tax treatment throughout the process (during the generation, charging and discharging phases);
- ensure regulatory certainty through a clear, stable and differentiated tax regime for storage operations, taking into account the various storage technologies available;
- distinguish between technologies, configurations and operating models;
- take into account the impact of taxes and levies on the operating costs and profitability of the facilities;
- facilitate funding and improve the profitability of projects;
- encourage investment that delivers flexibility, integration of renewable energy, security of supply and the decarbonisation of industry.

Measures

Comprehensive reform and institutional coordination

- **Set up a tax working group on energy storage**, involving the Ministry of Finance, the Ministry for Ecological Transition and the Demographic Challenge, the Directorate-General for Taxation, the Tax Agency, the CNMC, the autonomous communities, local authorities and industry representatives, as well as consumer organisations and other civil society organisations (environmental NGOs, trade unions and others) and academia.
- **Draw up a comprehensive tax map for energy storage** that identifies the national, regional and local tax regimes applicable to each technology and configuration, as well as any potential overlaps and their impact on operating costs, facility utilisation, profitability and the financial viability of projects.
- **To expressly recognise storage as a distinct activity in tax legislation**, thereby preventing it from being automatically classified under categories designed exclusively for generation or final consumption **and taking into account the specific characteristics of the various storage technologies.**
- To issue general administrative guidelines and criteria that reduce reliance on individual tax enquiries and prevent differing interpretations between tax authorities.

Clarification and stability of the treatment of storage in the IVPEE

- **To analyse the outcome of the framework established by Royal Decree-Law 18/2026**, with a rate of 3.5 per cent in 2027 and 0 per cent from 1 January 2028, and identify the necessary next steps to ensure the sector's progress.
- Clarificar expresamente en la normativa el tratamiento de las operaciones de almacenamiento dentro del IVPEE, diferenciando la actividad de almacenamiento —de las diferentes tecnologías de almacenamiento (baterías, bombeo hidráulico)— de la generación eléctrica convencional.
- To ensure that this policy is sufficiently stable and predictable, thereby avoiding any uncertainty that might affect investment in storage.

- To clarify the treatment of payments made exclusively in respect of availability, capacity, flexibility, voltage control, congestion management or other services not relating to the generation and supply of electricity.

- Coordinate any future changes to this scheme with the other taxes and charges applicable to storage, avoiding overlaps or equivalent burdens across different levels of government.

Adjustment to the Special Tax on Electricity

- To analyse the appropriateness of the current treatment of electricity used to charge storage facilities and subsequently fed back into the system, assessing whether its tax treatment adequately reflects the role these facilities play in the electricity system.

- Against a backdrop of increasing electrification and decarbonisation of demand, to initiate a discussion on the evolution of the Special Tax on Electricity and on the consistency of its design with electrification objectives.

- Define measurement and traceability systems that make it possible to distinguish between the energy supplied to the load, technical losses, auxiliary consumption and the electricity ultimately discharged.

- To clarify the treatment of *behind-the-meter* storage associated with self-consumption, distinguishing between electricity stored to optimise own consumption, energy purchased from the grid, and any surplus subsequently fed into the grid.

- To analyse the treatment of industrial facilities that incorporate storage to shift consumption, manage demand peaks or provide flexibility, taking into account the specific characteristics of these operating models and their contribution to system management.

- To assess whether the tax treatment applicable to the various industrial uses of electricity is consistent with the progressive electrification and decarbonisation of production processes.

Adaptation of the IAE

- To analyse the options and potential impacts, or potential consequences, of creating a specific category for energy storage, distinguishing it from conventional electricity generation.

- To analyse the impact on the system of proposing different rules for stand-alone batteries, hybrid projects, pumped storage, thermal storage and solutions relating to self-consumption.

- Review the current classification of stand-alone BESSs as electricity generation installations, so that their tax treatment reflects their role in storage and the provision of services.

- Review the current classification of hybrid projects, comprising battery storage and renewable energy installations.

- Adopt uniform criteria for application across the whole country, ensuring that classification or quotas do not depend on the local authority in which the project is located.

Clarification regarding VAT and transaction forms

- To draw up a tax guide on the VAT treatment of the various storage models, distinguishing between the sale and purchase of electricity,



arbitrage, balancing services, availability payments, capacity mechanisms, optimisation contracts, *tolling* agreements and PPAs.

- Clearly distinguish between revenue derived from the sale of energy and that received in return for flexibility, availability or management services, as the nature of each revenue stream determines its tax treatment.
- To clarify the treatment of self-consumption projects involving storage and of the solutions offered to industrial consumers through leases, energy service contracts or third-party financing.
- To expedite the refund or offset of input VAT incurred during the construction of projects (particularly relevant for capital-intensive projects), thereby alleviating cash flow pressures until the project becomes operational.
- To analyse the financial impact of VAT on industrial consumers who invest in storage, particularly where there are restrictions or delays in claiming a refund, ensuring that taxation does not reduce the incentives for electrification and flexibility.

Regional and local taxation

- To agree on common criteria with the autonomous communities and local authorities to ensure that storage facilities are not automatically subject to levies designed for conventional generation.
- Review the overlap between regional levies, local taxes and other central government charges.
- To clarify the treatment of BESS for the purposes of the IBI, property with special characteristics and the ICIO, using consistent and predictable criteria.
- To examine in detail the tax treatment of pumped storage, taking into account its role as a storage and flexibility technology and analysing the combined impact of the various taxes, levies and charges applicable to its operating costs and its use.
- Identify instances where state and regional charges overlap in relation to the same facility or on equivalent economic grounds, and propose alternatives.

Tax incentives for investment

- Propose possible tax deductions for investments in storage, linked to verifiable benefits such as the integration of renewables, the reduction of congestion, demand flexibility or industrial decarbonisation.
- Apply accelerated depreciation or flexible depreciation arrangements during the early stages of the sector's roll-out.
- To facilitate access to tax relief for research, development and technological innovation for pilot projects, first commercial installations and new storage technologies.
- Design specific incentives for long-term technologies and for *behind-the-meter* industrial solutions whose value is realised primarily through cost savings or reduced emissions.
- To establish temporary incentives that are measurable and compatible with the European framework for state aid, thereby reinforcing the fundamental role of storage in the path towards climate neutrality agreed by the European Union.

Monitoring and evaluation

- Publish a regular report on the financial status of storage facilities, broken down by technology, configuration, size and region.
- To assess the impact of the reforms on investment volumes, bankability, the cost of capital, capacity deployment and tax revenue.
- Review the framework every two years during the initial roll-out phase, avoiding retroactive amendments or sudden changes that would alter the financial conditions of projects that have already been funded, authorised or are under construction.



Potential barriers

- Impacto presupuestario de las modificaciones, bonificaciones e incentivos fiscales propuestos.
- Necesidad de garantizar el equilibrio entre ingresos y gastos del sistema eléctrico sin trasladar la carga a hogares, pymes o consumidores industriales.
- Dificultad para proporcionar estabilidad fiscal a inversiones con largos periodos de amortización en un contexto de evolución del marco tributario.

- Budgetary impact of the proposed amendments, tax reliefs and incentives.
- The need to ensure a balance between revenue and expenditure in the electricity system without passing the burden on to households, SMEs or industrial consumers.
- Difficulty in providing fiscal stability for investments with long payback periods against a backdrop of changes to the tax framework.
- Technical and regulatory complexities involved in verifying the origin and destination of the energy charged and discharged.
- Allocation of tax powers between the State, the autonomous communities and local authorities.
- Risk of overlap or the emergence of equivalent responsibilities between central, regional and local authorities.
- Difficulty in establishing a common approach for very different technologies and business models.
- The need to ensure that incentives are compatible with European State aid rules.
- A lack of consistent information on the effective tax burden and its impact on the operation, profitability and financial viability of projects.

6.2 Roll-out of a capacity mechanism that enhances bankability and distinguishes between firm capacity, flexible capacity and long-duration storage

What it involves

The capacity mechanism must become a key element in ensuring security of supply and facilitating investment in new firm and flexible capacity. On 29 May 2026, the European Commission approved the Spanish scheme, which has a maximum budget of €9 billion euros and a duration of ten years. Subsequently, Order TED/966/2026 of 15 September formally established the capacity market within the mainland electricity system and set out its general framework, allowing for the competitive participation of generation, storage and demand response.

This progress must be followed by the approval of the operating procedure, which will set out key technical and operational aspects, and by the launch of the first auctions. The order already sets out a large part of the mechanism's structure — auction procedures, the product, service periods, general award rules and basic obligations — so the main challenge is no longer to justify the need for the instrument, but to complete its development swiftly and to finalise the details of its implementation, which will determine its actual impact: contracted products, duration of commitments, applicable coefficients, stress hours, reserve prices, participation requirements, treatment of prior support and the penalty regime.

The mechanism should not be viewed solely as a form of aid intended to increase the profitability of projects. Its primary function in relation to storage should be to provide a **minimum level of stable and predictable revenue**, linked to the effective availability of the asset, which facilitates financial close and enables revenue from arbitrage, balancing markets and other services to be supplemented. This signal will be particularly important for projects involving a higher initial investment, long payback periods or insufficient revenue visibility, such as reversible hydraulic pumping and thermal storage, as well as other long-term solutions, without prejudice to the fact that the design is open to any supplier with the necessary capacity.

The design must clearly distinguish between three different contributions:

- **Reliability**, understood as the ability to be available and meet demand during periods of stress.
- **Flexibility**, relating to response speed, modulation, ramp control, load shedding and the integration of variable renewable generation.
- **Duration**, referring to the ability to maintain energy output for as long as the system requires.

Although a single resource may fulfil several functions, these should not be grouped together into a single, undifferentiated product. The specific parameters of each service — such as the required duration, stability coefficients, emissions criteria

or participation thresholds — determine which technologies can compete effectively. It is therefore necessary to distinguish between firm power contracts, non-fossil flexibility and long-duration storage.

The recommendation is therefore to implement the capacity mechanism as soon as possible and structure it as a fundable, competitive instrument based on the system's actual needs, with differentiated products that ensure coverage at the lowest cost whilst, at the same time, progressively developing non-fossil-fuel-based reliability and flexibility underpinned by storage and active demand management.



Objective

To put in place a capacity mechanism that:

- ensures that demand is met and that security of supply is maintained;
- provides a minimum income base that facilitates the bankability of projects;
- distinguishes between firmness, flexibility and duration;
- enables generation, storage and demand response to compete on a level playing field;
- fosters the capabilities required by the system, without indirectly favouring any specific technology, and by promoting non-fossil-fuel technologies;
- facilitates an orderly transition from conventional energy sources towards progressively decarbonised resources;
- specifically recognises the value of long-duration storage;
- complements, rather than replaces, the energy, balancing and flexibility markets;
- minimises the total cost borne by consumers.
- enables support for the development of non-fossil fuel flexibility where market-driven investment proves insufficient to meet the identified needs and objectives,

The recommendation is to implement the capacity mechanism as soon as possible and structure it as a fundable, competitive instrument based on the system's actual needs, with differentiated products.



Measures

Complete the regulatory process swiftly

- To adopt, in a coordinated manner, the **operating procedures**, pre-qualification rules, measurement and verification systems, the settlement and penalty regime, and availability requirements.
- **Publish well in advance**, the scheduled dates, delivery deadlines and the types of products to be procured at the auctions.
- Organise the first auction as quickly as possible, whilst ensuring a rigorous design. This first call for proposals will be crucial because it will establish a price benchmark, set out the practical conditions for participation and influence investment decisions in subsequent years.
- Avoid retroactive changes or amendments to key parameters once projects have been awarded, funded or have commenced construction.

Distinguishing between coverage and flexibility requirements

- **Distinguish between the product designed to guarantee firm power and that designed to develop non-fossil flexibility**. The former must address the adequacy and coverage analyses; the latter, the requirements for ramps, imbalances, renewable integration and rapid response identified by the system.
- Use the national analysis of flexibility needs to define specific calls for proposals, products or tranches for:
  - short-term flexibility;
  - ramp management;
  - integration of renewable energy generation;



  - long-duration storage;
  - active and aggregate demand response.

- To analyse options for simultaneously demanding firmness and advanced flexibility features within a single product, whilst recognising and remunerating each requirement differently.

- To allow a technology to be used in more than one product where it can be demonstrated that it provides both services, whilst avoiding double payment for the same service.

- Assess the use of **separate auctions, quotas or differentiated tranches** for new capacity, non-fossil flexibility and long-duration storage, provided that they meet previously quantified needs and are compatible with the European framework on State aid, given that a single, undifferentiated auction could be dominated by conventional technologies that have already been written off, hindering the gradual entry of new resources.

Design transparent coefficients based on actual contributions

- **To develop a publicly available methodology for calculating reliability coefficients or *de-rating factors*,** based on the actual probability of availability of each resource during peak demand periods.

- For storage, the methodology should consider at least the following:
  - available power;
  - storable energy;
  - discharge duration;
  - efficiency;
  - charge status;
  - response time;
  - resilience between episodes of stress;
  - degradation;
  - operational restrictions;
  - historical or technically verified availability.

- Define the flexibility coefficient on the basis of verifiable performance characteristics — response speed, modulation capacity, ramps, activation time and performance maintenance.

- Publish the provisional coefficients well in advance of the pre-qualification stage, together with the methodology, the data used and sensitivity analyses, so that developers and financiers can incorporate them into their financial models.

- Establish a clear timeframe for reviewing the coefficients during each benefit period and set out a predictable schedule for updating them.

- To promote greater methodological convergence across Europe; a lack of such convergence would mean that a battery with a given capacity in hours could be assigned very different coefficients across Member States, despite performing a comparable technical function.

Recognising long-duration storage

- **Define long-duration storage in terms of the benefits it provides and the system's requirements**, whilst seeking to avoid a fixed list of technologies, given the rapid evolution of the sector. Costs and configurations are evolving rapidly, and batteries initially designed to last two or four hours are now offering longer runtimes.
- Based on the coverage and flexibility analyses, determine for how many hours the service must be able to be maintained, how frequently it may be required, and what level of resilience the asset must have.
- Establish a specific product, tranche or call for tenders when a need for long-duration storage is identified that cannot be met efficiently using shorter-term resources.
- To ensure that different solutions — such as reversible pumping, longer-lasting batteries, mechanical storage or other technologies capable of feeding electricity back into the grid — can compete, provided they meet the required performance standards.

Turning pay-per-capacity into fundable revenue

- To establish a sufficiently standardised and predictable contractual and regulatory framework that sets out the following prior to the auction:
  - availability obligations;
  - payment method;
  - indexation and adjustment mechanisms;
  - guarantees;
  - cases of unavailability;
  - penalties;
  - force majeure;
  - substitution or transfer of the contract;
- To ensure that the right to payment is sufficiently stable, predictable and legally certain so that it can be taken into account in the project's financing throughout the entire period of the awarded service provision.
- Design penalties that are proportionate to the actual breach and the harm caused to the system, whilst avoiding open-ended or difficult-to-quantify risks that would prevent the project from being funded.
- Clarify, prior to the auction, how public aid previously received for CAPEX is to be treated, in order to avoid any impact on the project's bankability.

Aligning the mechanism with *revenue stacking*

- **Examine the technical and other implications and impacts of storage combining capacity payments with revenue from the day-ahead and intraday markets, balancing services, arbitrage and flexibility markets.**
- Draw a clear distinction between:
  - the availability guaranteed under the mechanism;
  - energy sold;
  - activations in adjustment services;
  - local flexibility;
  - other technical services provided to the system operator or network operators.
- To ensure that availability obligations allow for the efficient operation of the asset in other markets outside periods of stress.

Facilitate the participation of demand and aggregated resources

- Establish pre-qualification criteria tailored to **demand response, distributed storage and aggregated resources**, whilst avoiding requirements designed exclusively for large power stations.
- To enable the aggregation of multiple consumers or assets in order to meet the minimum participation thresholds, so that all consumers, large and small, can benefit from the advantages offered by aggregation.
- To define standardised methodologies for calculating the consumption baseline, measuring the actual reduction or shift in demand, and verifying availability.
- Recognise both the reduction in consumption and its temporary shift when both contribute to the stability or flexibility of the system.

- Coordinate the mechanism with the overall framework for demand-side participation and with the various entities that can facilitate aggregation, including the future involvement of the independent aggregator.

- To ensure that availability obligations or financial guarantees do not effectively exclude distributed resources that are capable of providing the service reliably through aggregation.

Managing the transition from fossil-based to non-fossil-based resources

- To recognise that, during a transitional phase, the system will continue to require some conventional firm capacity, thereby avoiding a disorderly phase-out that could jeopardise security of supply.

- At the same time, establish a **progressive decarbonisation pathway for the mechanism**, based on emissions criteria, specific products derived from non-fossil resources and a periodic review of the required conventional capacity.

- To prevent contracts awarded to fossil-fuel-fired facilities from creating a long-duration barrier that would prevent the subsequent introduction of storage, demand response and other decarbonised solutions.



Ensure the economic efficiency of the mechanism

- Before each auction, publish the volume of capacity to be contracted, the demand curve, the assumptions used and the estimated cost to consumers.

- Set reserve prices based on verifiable costs and requirements, thereby protecting the system against the exercise of market power.

Turning the first auction into a learning process

- To support the first call for tenders for a preliminary assessment that models different scenarios regarding participation, prices, the technologies to be awarded and the costs to the system.

- Following the award of the contract, publish aggregated information on:
  - volume tendered and awarded;
  - prices;
  - coefficients;
  - technologies;
  - duration;
  - new capacity mobilised;
  - demand response and storage;
  - expected impact on emissions and security of supply.

- To commission the CNMC to carry out an independent assessment of competition and the results of each auction.

To focus specifically on non-peninsular systems

- To analyse the firmness and flexibility requirements of each non-peninsular system using methodologies tailored to their characteristics.

- Avoid automatically applying the peninsular mechanism to systems subject to dispatch and regulated remuneration.

- Where necessary, design equivalent measures relating to availability or capacity that will enable

the mobilisation of private investment in storage and flexible demand, reduce technical constraints and gradually replace conventional generation.



Stakeholders – preliminary ideas for action by each of the stakeholders involved in the implementation of the measure

Ministry for Ecological Transition and the Demographic Challenge

- To analyse options and approve the first calls for applications.
- Define the products, time horizons and eligibility criteria.
- Integrate the coverage and flexibility analyses.
- Set out the mechanism's decarbonisation pathway.

Directorate-General for Energy Policy and Mines

- To oversee the drafting of regulations and the implementation timetable.
- To approve the criteria for each call for applications.
- To coordinate consultation and participation procedures within the sector.
- To ensure consistency between the capacity mechanism, energy planning, flexibility requirements and the objectives of the PNIEC.

National Commission for Markets and Competition

- To provide information on the regulations and to monitor competition at auctions.
- Check that costs are proportionate and that reserve prices are functioning correctly.
- Monitor potential strategic behaviour or barriers to entry.
- Regularly review the results and suggest adjustments.

Developers, storage operators and energy companies

- To provide technical and economic data for the design of coefficients and products.
- Take part in pre-qualification and auctions.
- To confirm availability and compliance with the obligations undertaken.

Aggregators, suppliers and consumers

- Coordinate the participation of demand and distributed resources.
- To develop aggregated portfolios capable of offering verifiable capacity and flexibility.
- To contribute to the design of methodologies for baseline assessment, measurement and settlement.



Potential barriers

- Delays in the approval of operating procedures or the first call for applications.
- An overly complex design that hinders participation and delays investment.
- Use of a single product that combines coverage, flexibility and duration.
- Coefficients that lack transparency or are insufficiently linked to the actual contribution of each resource.
- Unequal competition between existing depreciated assets and new investments.
- Lock-in to fossil-fuel technologies, preventing the gradual introduction of non-fossil-fuel solutions.
- Premature phasing out of conventional capacity before sufficient alternatives are available.
- Contracts that are too short to finance capital-intensive projects.

- Disproportionate penalties or guarantees that prevent the financial closure.
- Excessive discounting of pre-CAPEX grants.
- Difficulty in identifying peak periods and anticipating how the system's requirements will evolve.
- Risk of oversizing and an unnecessary increase in the costs borne by consumers.
- Technical and administrative barriers to the participation of aggregate demand and resources.
- There is insufficient information to assess the actual availability of storage and demand.
- Significant methodological differences compared with other Member States.
- The rigidity of contracts in the face of rapid changes in technology, costs and system requirements..

6.3 To define a functional and verifiable framework for long-duration storage facilities in line with the climate neutrality objective



What it involves

The growing uptake of renewable energy will increase the need for resources capable of shifting energy over periods longer than those typically covered by short-term storage. The system must be able to respond not only to intraday imbalances, but also to prolonged periods of low renewable generation, surpluses that are difficult to integrate, and stress scenarios that may last for many hours or several days.

However, there is currently **no harmonised definition of long-duration storage within the European Union**. Furthermore, there is no consensus on whether 'long-duration' should be defined solely by the number of hours or by the type of technology. A definition based on specific technologies would make it possible to target support towards emerging solutions other than lithium-ion batteries and pumped-storage hydro, but would run the risk of excluding future innovations or facilities capable of providing the required service. Conversely, a definition based solely on nominal runtime might classify a battery that initially provides eight or ten hours' runtime as having a long runtime, even though its capacity may decrease significantly as a result of degradation.

International experiences provide useful examples. Both the United Kingdom[1] and California[2] use eight hours of discharge as the threshold for certain categories or long-duration instruments. This figure could serve as an initial benchmark in Spain, without making it a rigid or permanent criterion, as the system's requirements and technological capabilities will evolve over time.

Based on these positive experiences and the discussion that took place during the working group sessions, the recommendation is to establish

[1] The British experience provides a useful benchmark for a functional and technologically open definition of long-duration storage. The UK scheme considers facilities capable of supplying electricity continuously for eight hours or more without recharging to be eligible, and includes various technological solutions, such as pumped storage, compressed air or liquid air storage, and certain types of batteries. In the first round of the *cap and floor* mechanism, projects involving hydraulic pumping, compressed air, lithium-ion batteries and vanadium redox flow batteries were provisionally selected. See Department for Energy Security and Net Zero (DESNZ), *Long-Duration Electricity Storage: Open Letter to Industry*, UK Government, 2025; and Ofgem, *Ofgem boosts long-duration storage to secure more homegrown energy for customers*, 26 June 2026.

[2] California provides another relevant example. The California Public Utilities Commission (CPUC) defines long-duration storage, for the purposes of certain procurement obligations, as storage capable of storing energy and subsequently feeding it back into the grid for at least eight hours at its maximum capacity. Furthermore, the *Resource Adequacy* programme requires supply organisations (Load Serving Entities) to procure sufficient capacity to ensure that the necessary resources are available to the system operator when and where they are required, thereby translating previously identified adequacy requirements into actual procurement obligations. See California Public Utilities Commission (CPUC), *Decision Fact Sheet – Integrated Resource Planning*, 2026; and CPUC, *Resource Adequacy Programme Overview.*

in Spain a **functional definition based on guaranteed provision**, using discharge hours as the main criterion. Compliance with this requirement must be guaranteed throughout the entire contract period, which entails maintaining sufficient levels of available power, useful energy, availability and performance in the face of degradation.

The definition must be technology-neutral. Reversible pumping, electrochemical batteries — including lithium, flow, iron or sodium batteries—, thermal storage with electrical reconversion, compressed air, liquid air or CO_2-based systems may be considered long-duration storage provided they demonstrate the required performance. However, falling within this category should not automatically confer access to public support: eligibility for each instrument should also depend on technological maturity, additionality, the risk assumed and the existence of a market failure.



Objective

To establish a clear, technologically neutral and verifiable national definition that enables:

- to identify which facilities may be regarded as long-duration storage;
- to design capacity, flexibility and support mechanisms tailored to each need;
- to ensure that classification does not depend solely on the technology used;
- to facilitate the comparison, funding and evaluation of different solutions;
- to focus innovation on features that the system will actually need.



Measures

Establish a functional definition based on effective duration

- Define long-duration storage primarily in terms of the number of hours for which it can maintain the specified power output without recharging, initially using eight hours as a benchmark (the number of hours of storage achievable with current technology) and reviewing this threshold in line with the system's requirements.

The recommendation is to establish a functional definition in Spain based on guaranteed provision, using off-peak hours as the main criterion.

- Measure the service life on the basis of the useful energy and net power actually available, rather than solely on the basis of the stated nominal capacities.
- Analyse and propose specific criteria based on the technologies and configurations, whilst avoiding fixed lists that might exclude future solutions.

Classify needs according to their duration

- Use these analyses to determine what duration the system actually requires, for which specific uses, at what times, and how they are integrated into the network.
- Include in the analysis trends in demand, renewable generation, interconnections, firm capacity and the characteristics of non-mainland systems.

Translating the identified needs into market-based and support instruments

- Define the obligations based on the required performance — power, energy and discharge time.

Promoting innovation and the first commercial installations

- Strengthen the instruments aimed at pilot projects, demonstrators and *first-of-a-kind* projects, particularly for technologies capable of delivering multi-day performance, low degradation, a long service life and reduced dependence on critical raw materials (in line with the identified needs of the system).
- To facilitate the transition from proof-of-concept to commercial roll-out through blended finance, loans, guarantees and other instruments tailored to the higher technological risk involved.

- Coordinate this support with national and European programmes on innovation and industrial policy.

Stakeholders – preliminary ideas for action by each of the stakeholders involved in the implementation of the measure

Ministry for Ecological Transition and the Demographic Challenge

- Establish the regulatory definition and incorporate it into planning, capacity and flexibility measures.
- To align its development with the European framework.

Red Eléctrica

- Define the technical specifications and the necessary verification procedures.

National Commission for Markets and Competition

- Set out the definition and monitor its impartiality.
- To monitor competition in procurement procedures.
- Assess the costs and benefits for consumers.

Ministry of Industry and Tourism, IDAE and CDTI

- To design programmes for innovation, demonstration and industrial scale-up.



- To support *first-of-a-kind* projects and technology consortia.
- Coordinate aid with industrial policy and the policy on strategic autonomy.

Public and European financial institutions

The ICO, the European Investment Bank and other organisations must:

- develop guarantees and funding tailored to projects with a long lead time;
- take part in blended finance schemes;
- facilitate access to capital for demonstration projects;
- reduce the risk associated with initial commercial installations.

Technology platforms, research centres and universities

- Compare the various technology families according to the different storage requirements of the system.
- To develop testing, degradation and certification methodologies.
- To facilitate the exchange of knowledge between research and industry.

Developers, manufacturers and industry associations

- To provide verifiable technical and economic data.
- Define service level agreements and degradation plans.
- Take part in demonstration projects and competitive schemes.
- To prevent the definition from being used to protect specific technologies at the expense of other solutions capable of providing the same service.



Potential barriers

- Difficulty in establishing a duration threshold that reflects all the system's current and future needs.
- Rapid technological and cost developments, which may render certain criteria obsolete.
- A lack of operational data on some emerging technologies and difficulties in assessing their long-term degradation and availability.
- High initial costs and difficulties in securing funding for the transition from the demonstration phase to commercial roll-out.
- There is a need to coordinate the definition of these measures with mechanisms relating to capacity, flexibility and public support, whilst avoiding overlaps.

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Appendix
List of participants

Name	Surnames	Company / Organisation	Position
Francisco Javier	**Avilés Tierno**	UGT-FICA	Head of the Energy and Water Sector in Andalusia
Xabier	**Baron Ordoyo**	SIG Coop	Chief Operating Officer (COO)
Rafael	**Belda**	Saeta Yield	CDO
Gemma	**Bedia**	**alinnea**	Senior Climate Change Project Manager
Arturo	**Buenaventura**	Magtel	Director of Hydraulics and the Environment
Sara	**Candela**	**alinnea**	Project Manager
Alicia	**Carrasco**	ENTRA Aggregation and Flexibility	Co-founder and Chief Executive Officer
Anna	**Casas Llopart**	Octopus Energy	Head of Flexibility in Spain
Álvaro	**Colino Lamparero**	CaixaBank	Head of Sustainable Business Product Coordination
Alberto	**Crespo Iniesta**	ENERGYNEST	Head of Project Development
Borja	**Dalmau Giménez**	UNEF	Storage Manager
Ana	**Delgado Casado**	Grenergy	Global Head of Regulatory Affairs
Fernando	**de Juan Astray**	Axpo Iberia	Head of Origination, Structured and Long-Term Products
Hans	**Diedrich**	CCOO Industry	Energy Co-ordinator – Industrial and Sectoral Policy Division
Lucía	**Dólera**	JinkoSolar Co.	Head of Business Development for Utility-Scale Energy Storage Systems in Europe
Ricardo	**Domínguez Sogliano**	ASEALEN	Energy Policy and Markets Associate
Bianca	**Dragomir**	Cleantech for Iberia	Director
Hajar	**El Mansouri**	Octopus Energy	Public Affairs
Luis	**García Benedicto**	IDAE	Head of the Department for Demand Management and the Integration of Renewables into the Grid
Jon	**García Garaizar**	ENGIE Spain	Renewable Energy Regulatory Analyst
Elena	**García González**	Ministry of Industry and Tourism	Head of Department at the Directorate-General for Industry and SMEs
Raúl	**García Posada**	ASEALEN	Director
Gonzalo	**Gómez Álvarez**	Fundación Renovables	Head of Renewable Technologies
Joaquín	**Gómez del Río**	Iberdrola	Head of Energy Storage and New Solutions
Pilar	**González**	Iberdrola	Head of Innovation
José María	**González Moya**	APPA Renovables	Managing Director / CEO
Dolores	**González Pastor**	Octopus Energy	Director of Institutional Relations and Public Affairs
Nayah	**Hidar**	Recurrent Energy	Senior Analyst, BESS Specialist, Strategy & Business Intelligence, EMEA
Rosana	**Hurtado**	IDAE	Technical Officer in the Department of Demand Management and Renewable Energy Integration
David	**J.A. Post**	Endesa	Chairman of e-Mobility Endesa

Name	Surnames	Company / Organisation	Position
Helena	**Jiménez**	ENTRA Aggregation and Flexibility	Communication and Operations
Vicente	**Jorro de Inza**	Agere Energy & Infrastructure	Founding partner
Elena	**Laburu**	Australian Trade and Investment Commission	Head of Investment
David	**Larroca González**	Brenmiller Europe	Business Development Director – Thermal Energy Storage
Carmen	**Longás**	Red Eléctrica	Head of the Grid Access Department
Alejandro	**López Couselo**	Naturgy	Head of PPAs and Electricity Markets – USA
David	**López Morales**	European Climate Foundation	Senior Associate, Spain
Sergio	**Luján Torres**	GFM Fotovoltaica	Industrial Engineer
Florent	**Marcellesi**	**alinnea**	Contributor
Ana	**Mariblanca Sánchez**	Spanish Association for Standardisation (UNE)	Project Manager
Luis	**Marquina**	AEPIBAL	President
Juan Fernando	**Martín Romacho**	ECODES	Head of Industrial Decarbonisation
César	**Martínez**	Endesa	Regulatory Directorate
Rubén	**Martínez Cartanyà**	Banco Sabadell	Project Finance, Head of Infrastructure & Energy
David	**Menéndez**	Fotowatio Renewable Ventures	Managing Director, Energy Storage
Rosa	**Mingo**	IDAE	Head of Energy Transition on the Islands
Ibon	**Nanclares**	Iberdrola	Ventures and Technology
Ana	**Nicolás Sánchez de Rivera**	Grenergy	Senior Regulatory Affairs Specialist
Ana Belén	**Padilla Moreno**	Enerclub	Project Co-ordinator/Secretary-General
Patrício	**Peixoto**	European Investment Bank	Project Finance Specialist
Patricia	**Pascau**	**alinnea**	Head of Communications
David	**Pérez**	Agere Energy & Infrastructure	Managing Director
Emilio	**Rodríguez Blanco**	PwC Spain	Tax Partner
Christian	**Rodulfo Barba**	EDP Renewables	Senior Director of International Business Development and Storage
Gonzalo	**Sánchez**	European Climate Foundation	Programme Manager – Politics and Policies
Ana Belén	**Sánchez**	**alinnea**	Director
Román	**Sánchez Gordon**	Abanca	Head of Corporate and Specialised Banking
Jordi	**Solé-Muntada**	Ecrowd!	Director
Sergio	**Soler**	**alinnea**	Contributor
José María	**Tapiador**	CCOO Industry	Energy sector representative
Carolina	**Vereda Gorgé**	Endesa	Regulatory Officer
Salvador	**Zaera Espinós**	Statkraft	Public and Regulatory Affairs Manager in Spain

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