

WHITEPAPER UNLOCKING GLOBAL INVESTMENT IN ENERGY STORAGE

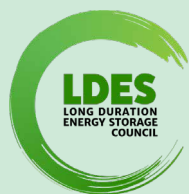




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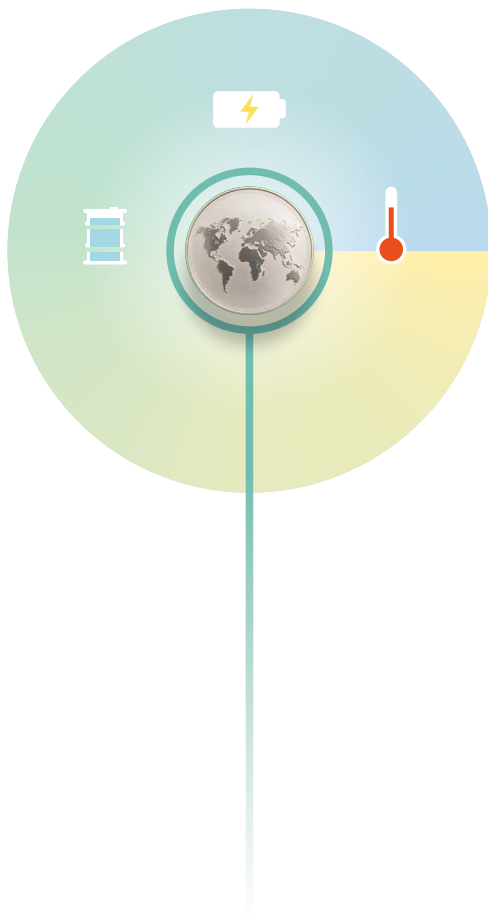


The Supercharging Energy Storage Initiative would like to thank all authors and organizations for their submissions and contributions to support this publication. This includes the Asian Development Bank, Advanced Battery Recycle, the African Development Bank, Batteries European Partnership Association, BloombergNEF, Canadian Renewable Energy Association, the European Investment Bank, the Global Energy Alliance for People and Planet, Energy Storage Canada, Energy Storage Europe, ENERGYNEST, FESSIA, Flow Batteries Europe, the Green Climate Fund, India Energy Storage Alliance, IRENA, LDES Council, Rabobank, Rocky Mountain Institute, Triodos, TriplePoint, United Nations Economic and Social Commission for Asia and the Pacific, Utilities for Net Zero Alliance, the World Bank's Energy Sector Management Assistance Program. Their inputs have been aggregated and synthesized, and no findings, or statements, recommendations, or conclusions in this report are attributable to any individual organizations or participants, nor are they responsible for any consequence or any use of the report or its contents.

WHITEPAPER

UNLOCKING GLOBAL INVESTMENT IN ENERGY STORAGE

A Clean Energy Ministerial Supercharging Energy Storage (CEM SES) Initiative



The Clean Energy Ministerial (CEM) is an international clean energy leadership platform that brings together a large community of global clean energy transition experts around the world¹. With the aim to advance clean energy technology, a high-level global platform is provided that advances policies and programs, and shares lessons-learned. The CEM consists of 29 member countries and 21 participant countries.

The Supercharging Battery Storage (SBS) initiative was launched in 2023 at COP 28, co-led by Australia and the European Commission, with participation from Canada, the United States, Republic of Korea, and the Netherlands, creating a strong foundation for accelerating the deployment of stationary battery storage. The workstream expanded its scope in 2026 and rebranded as the Supercharging Energy Storage (SES) initiative, designed to unlock the full potential of energy storage across a wide range of applications. This CEM initiative works to accelerate the development and deployment of energy storage, including electrochemical and other

storage technologies. This workstream aims to reduce technology costs through international cooperation and alignment as appropriate, to build a diversified, responsible, secure and transparent supply chain, to promote grid reliability and support the integration of advanced energy globally. Its key activities are centered around three pillars shown below. A key focus of the initiative is to focus on international collaboration and knowledge-sharing practices. This report highlights international exhibits of worldwide cases where financial streams are unlocked to deploy energy storage in the system.

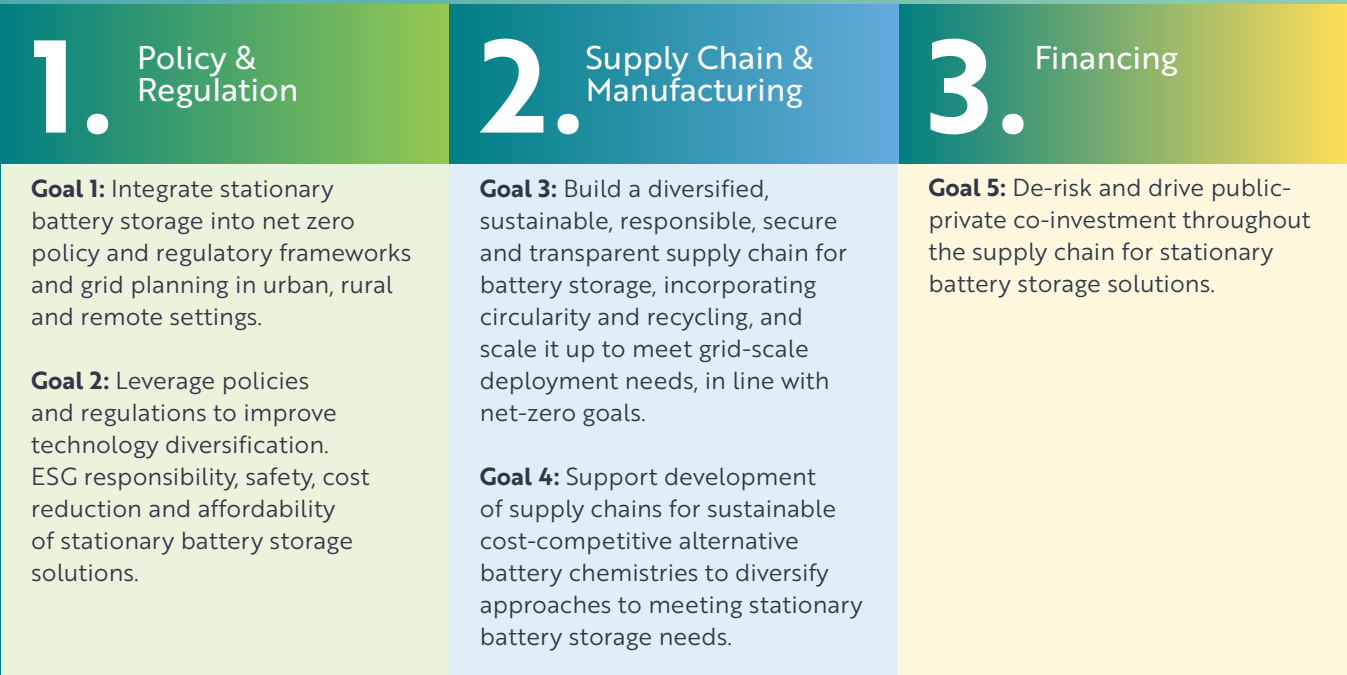


Figure 1 The three pillars of the Supercharging Energy Storage initiative to boost stationary battery storage development and deployment

Community members

Co-leads



Australia



European Commission

Participants



Canada



United States



The Netherlands



Republic of Korea

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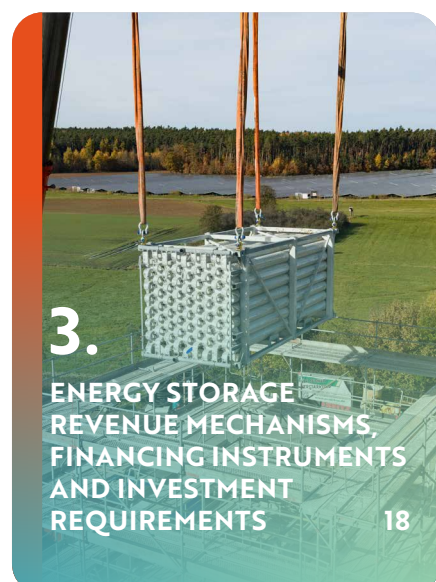
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1.

INTRODUCTION



Image Credit: Flexbase (Technology Centre Laufenburg)

1.1 The growing role of energy storage in our future energy system

At COP29 in Azerbaijan, national governments and non-state actors have endorsed the Global Energy Storage and Grids Pledge, committing to deploy 1500 GW of energy storage in the power sector by 2030². This pledge aims for a six-fold increase in installed capacity in 2030 compared to 2022 mainly driven by the large roll-out of utility-scale batteries.

Energy storage investment across all technologies has seen remarkable growth over the past decade, driven mainly by battery storage, which rose from around USD 1 billion in 2015 to an expected USD 66 billion in 2025³. The cumulative expected investment in battery storage from 2016-2026 yields a staggering 350 billion USD globally. The total installed capacity, including pumped hydro and other storage technologies in the power sector, sums to more than 450 GW at the end of 2025 (see Figure 2).

Pumped hydro and other non-battery technologies still make up a meaningful share of this installed base, though with slower growth path.

Total energy storage capacity is estimated at roughly 180 GW (8.5 TWh) for pumped hydro and a cumulative Battery Energy Storage Systems (BESS) capacity of ~160 GW (0.3 TWh) in 2025^{4,5,6}. The duration of power delivery for battery storage is gradually increasing from the typical 1-2 hours to 4 hours or more⁷. Hence, capacity additions towards reaching the global pledge are expected to follow this trend of increased storage duration. To reach

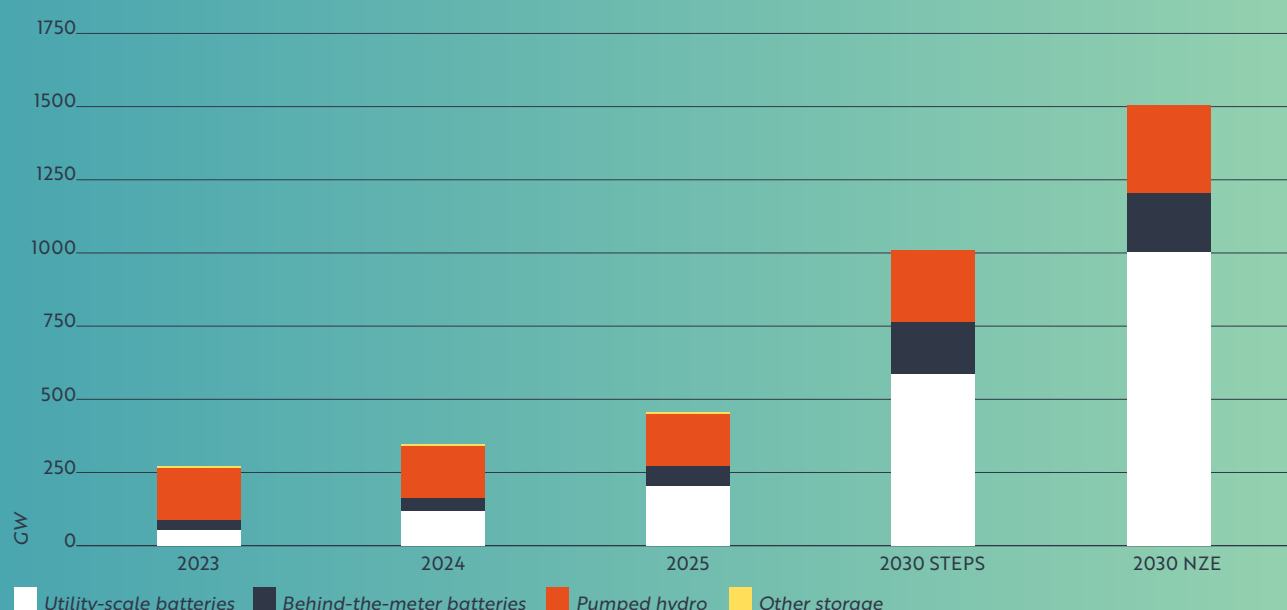
the 1500 GW pledge of installed energy storage capacity in 2030, roughly up to 2 trillion USD of global investment has to be unlocked. But stronger growth paths are also possible as IRENA suggests a rapid growth in global installed storage capacity, from more than 400 GW in 2025 to 2530 GW in 2035, and 6859 GW by 2050⁸.

Battery storage recorded the largest cost decline of any utility-scale technology in 2025⁹.

The investment portfolio is globally dominated by China, the United States and Europe. In recent years, a strong momentum is also seen for Australia, India and the Middle East. Latin America (especially Chile) and emerging markets & developing economies (EMDE) are picking up the pace since some years seeing investments growing towards several billion USD.

The technology mix is globally dominated by lithium-ion batteries and since recent years lithium iron phosphate (LFP) chemistry is the dominant technology of choice. For longer duration storage flow batteries are being deployed and also new chemistries are being

Figure 2 Installed power sector energy storage capacity globally (adapted from IEA statistics)⁴



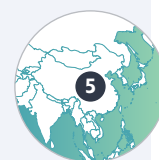
demonstrated in (early) commercial or demonstration projects, like sodium-based batteries. Sodium-ion batteries can leverage existing battery manufacturing processes while using abundant and widely available resources. They offer promising cost-reduction potential, improved supply chain versatility, and performance that is increasingly approaching or even surpassing that of lithium-ion batteries¹⁰. The Electric vehicles (EV) market dominates the global market for battery deployment, accounting for more than half of the total in 2025, reaching deployment of 1.2 TWh in an 80-100 bn USD market¹¹.

For other storage technologies in the power sector compressed air energy storage (CAES) also sees global interest and early phase market deployment. Projects are

under preparation in the US and Europe but especially China is pioneering the scaling-up of CAES (see *exhibit*)^{12,13}. Heat storage, including aquifer (ATES) and large thermal energy storage (LTES) systems, are widely deployed in the built environment and district heating but poorly documented at global scale, providing more than 2.5 TWh of heating and cooling per year^{14,15}. Industrial thermal storage could unlock substantial additional potential, for example almost 2000 TWh of fossil-fuel replacement in European industry alone¹⁶. Furthermore, current commercial underground hydrogen storage (UHS) totals 500 GWh across 4 sites, with several pilot and demonstration projects under development foreseeing a potential of several hundreds of TWh over the next decades^{17,18}.

EXHIBIT

COMPRESSED AIR ENERGY STORAGE IN CHINA RENEWABLE ENERGY AND BATTERY STORAGE PROMOTION PROJECT



Country: **China**

Energy storage technology: **Compressed Air Energy Storage (CAES) portfolio of 4700 MWh/950 MW**

Innovative aspect: **first-of-a-kind deployment of CAES at scale in China**

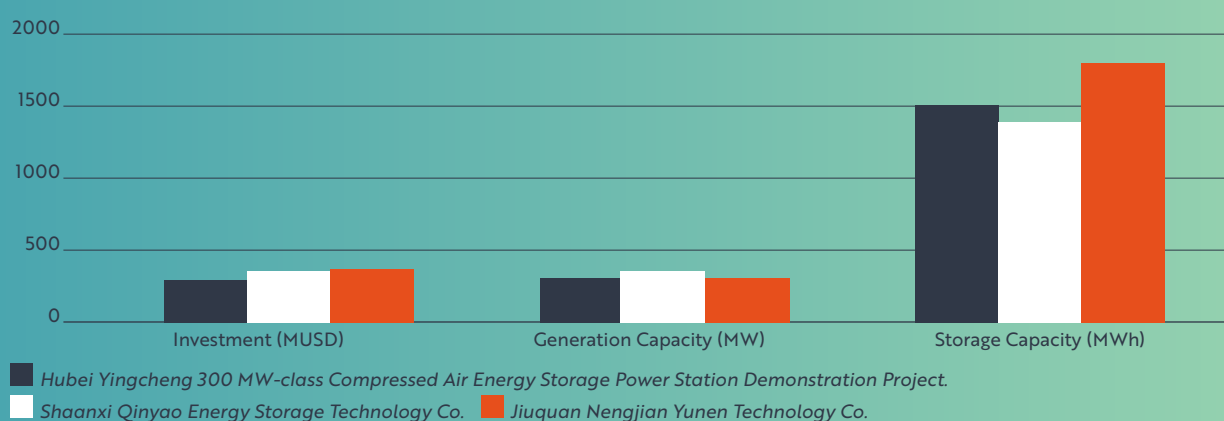
Brief project description: The objective of the project is to integrate renewable energy and reduce curtailment through energy storage. The investment component of the project entails an International Bank for Reconstruction and Development (IBRD; part of World Bank group) loan of 300 million USD (93 for CAES, remaining for BESS) and co-financing from the Huaxia Bank of about 450 million USD.

that mandated storage applications resulted in a strong interest from both state owned enterprise and private investors. Mobilizing funds for capacity building in Huaxia Bank and in policy and regulatory framework stakeholders with technical assistance from multilateral development banks (MDBs) and related programs (in this case Energy Sector Management Assistance Program and Energy Storage Partnership) supports the development and scaling-up of new storage technologies.

Highlights or lessons-learned: Regulatory changes

Figure CAES projects as part of the China Renewable Energy and Battery Storage Promotion Project

Source: Energy Storage Systems in World Bank Group Operations- Portfolio Review and Lessons Learned 2026



In summary, the global market for non-fossil energy storage is a fast growing asset class in the energy sector. To enable the transition towards a resilient future that ensures a balanced, affordable and diversified mix of energy sources in all regions of the globe, requires the deployment of a portfolio of energy storage options. For the shorter term this is showcased by battery storage (stationary and mobile) deployment. For the next growth phase other storage technologies are needed to join the growth curve covering batteries with different chemistries and long duration storage complemented with heat and molecular (e.g. hydrogen) storage technologies.

Globally it is observed that grids plus storage investments fall behind investments in new generation sources. This is now becoming a strong barrier to the development of new energy demand connections (e.g. ranging from households, industry and datacenters) and the deployment of renewable energy projects as a result of grid congestion and the inability to match demand and supply over different time spans and geographic regions.

To unlock investments for the large-scale deployment of energy storage, especially from the private sector, financial viability of storage projects is essential. Mobilising investment at trillion dollar scale is not just a question of market growth, but of risk allocation and revenue certainty. As storage technologies move beyond early deployment into large-scale deployment in different markets across the globe their success increasingly depends on whether projects and supply chains can be structured to meet investor requirements, making financial maturity a central condition for the required market expansion²⁰.

Recommendation: The G7 collectively commits to adding at least 1 to 2 MW, depending on national circumstances, of electricity storage capacity for every 10 MW of renewable power capacity added¹⁹.

1.2 Challenges for upscaling & financing energy storage projects

Upscaling energy storage towards the 1500 GW pledge and far beyond requires financially viable investments in many new energy storage projects and their globally diversified supply chains to build manufacturing facilities for energy storage technology components. In practice, establishing financially viable investments requires an integrated assessment of risk and revenue quality, combining confidence in location specific technical performance, clarity in risk allocation among stakeholders, transparent and predictable regulatory framework and the stability of revenue streams over time. For energy storage, this goes beyond traditional energy infrastructure or investment in new energy generation considerations, as projects often depend on multiple, often volatile income sources (e.g. flexibility markets, arbitrage, capacity payments), which must collectively demonstrate durability and resilience to market and policy changes.

Especially developing countries require vast mobilization and access to capital at affordable cost of financing to deploy energy storage, grid infrastructure and new supply sources to reduce their energy vulnerability. This requires de-risking investments in projects and supply chains in many different settings with respect to technology, market and regulatory conditions.

As such, financially viable investments require synchronized proven technological capability and operational markets as even technically mature storage solutions will struggle to scale without sufficiently predictable revenues, clearly defined contractual structures, and supportive regulatory frameworks. Conversely, improvements in market design, risk-sharing mechanisms, and contracting structures can significantly enhance financial viability by reducing uncertainty and aligning project risk profiles with investor requirements. In practice, this means demonstrating robust cash flows, clearly allocated risk, and reliable performance simultaneously.

Revenues from certain services are often insufficient to support storage development, making the concept of revenue stacking (e.g. from energy arbitrage; ancillary services; resource adequacy services) essential for recovering storage costs²¹. Clear market rules, appropriate remuneration mechanisms and updated grid codes are also often lacking for enabling energy storage systems to participate in all relevant services. Long-term regulated incentives contribute to the bankability of storage projects but are often absent. Clear permitting processes, with well-defined timelines and rules, can accelerate the deployment of storage projects and reduce development uncertainty but require local knowledge

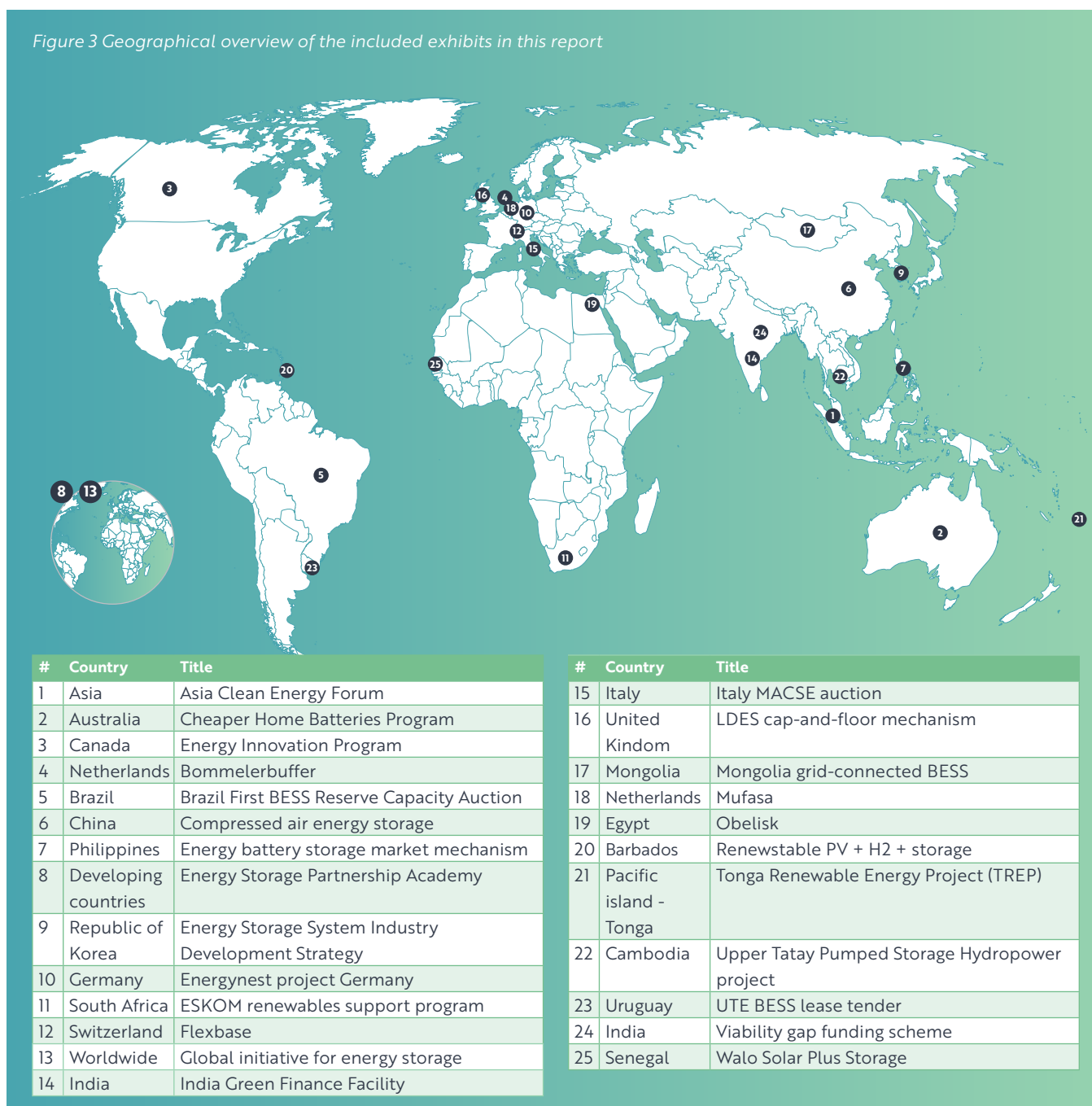
and the development of expertise among regulators and competent authorities.

1.3 Objective of this whitepaper

The purpose of this whitepaper is to explore how energy storage as one of the options for providing resilience and flexibility can become a financially viable asset class at the scale required for the global energy transition. The report draws on real-world insights and case studies from across the globe and will indicate effective risk mitigation

strategies across the vast energy storage technology portfolio and diversity in countries and jurisdictions in which they are deployed. The report also draws on published market data, policy documents, development finance material, and project examples to identify how energy storage is currently financed across different regions, technologies, and markets. These sources are complemented by semi-structured interviews with public institutions, development finance institutions, banks, industry associations, project developers, and technology providers.

Figure 3 Geographical overview of the included exhibits in this report



The scope of the report is global and technology-agnostic. It covers both developed and emerging markets, with particular attention to developing countries where access to affordable finance, market structures and institutional capacity can be limiting factors. The technology scope focusses on (near) commercial technology-market combinations and scalable stationary storage options. CEM SES takes a technology-agnostic view regarding storage technologies including short-duration batteries, long-duration storage, thermal storage, hydrogen storage, and other relevant technologies. The temporal scope focuses on the current financing landscape and near-term outlook and roadmap for scaling investment.

The report started in Chapter 1 on the trends for storage, the scale of investment required, and the financing challenge. Chapter 2 identifies the main risks and barriers that currently limit investment upscaling, grouped around market risks, regulatory risks, and technology risks. Chapter 3 reviews revenue mechanisms that can de-risk the technology, together with applicable financing instruments and structures. Chapter 4 highlights common risk mitigation measures and showcases insights from

global best practices. Chapter 5 then synthesizes the findings into a roadmap to unlock more financing in energy storage.

The goal of this report is to explore how energy storage can become a financially viable asset class at the scale required for the global energy transition



Photo by Karel Vh, Unsplash



2.

DE-RISKING ENERGY STORAGE

*Photo by David
Cristian, Unsplash*

Unlocking sufficient investments in energy storage requires adequate de-risking of the following triangle; market, regulatory and technological aspects. A fully deployed and commercial technology is de-risked on all three scales, however, energy storage technologies face significant issues on all three aspects, where the risk level can vary per technology type; commercial BESS versus new Long Duration Energy Storage (LDES) technologies¹. This chapter is mainly based on a synthesis of the conducted interviews among development banks, private finance institutes, project developers and governmental organizations. *Figure 4* provides a summary of the main market, regulatory and technology risks which are further elaborated below.

Unlocking energy storage investments requires market, regulatory and technological de-risking

2.1 Market risks

EVOLVING MARKET FRAMEWORKS

Energy storage systems can theoretically participate in multiple energy markets (see *Figure 5* for an overview of the different services energy storage can provide). In wholesale energy markets, storage can capture price fluctuations in the market, which tend to increase with higher shares of variable renewable energy (VRE) in the system. Secondly, by participating in ancillary markets, services are provided for balancing the grid towards the grid operator (usually the TSO). Thirdly, energy storage could participate in a capacity market by providing reliable reserve capacity to the grid. As a result, energy storage assets have the potential to combine multiple revenue streams rather than relying on a single service. The extent to which this potential can be realized, however, strongly depends on a nation's market design and regulatory frameworks. In many countries, some of these market mechanisms are still under development or do not exist. Some regions lack granular or locational price signals, challenging adequate revenue mechanisms on the wholesale energy market. In addition, several markets fail to remunerate system services such as

capacity provision and peak-avoidance services. As revenue models shift from a single-product mechanism to multi-market exposure, project economics become more difficult to predict. This makes it difficult to provide long-term market clarity, creating an uncertain and tightened environment for investors to clarify which markets will generate income streams and where energy storage systems can participate.

Another market formation risk relates to uncertain electricity prices and possible market cannibalization. Due to the rapid but uncertain deployment of variable renewable energy sources (VRE), future storage volumes are difficult to predict and increasingly volatile electricity prices challenge accurate revenue forecasts. In some regions (f.e. some European countries), it is already a stated policy objective to support energy storage deployment with the aim of mitigating electricity market price volatility, as well as electricity curtailments. Next to this, as storage deployment increases, the storage market can be saturated. If this is not properly regulated, the market could experience cannibalization, generating limited future income streams.

¹ Long Duration Energy Storage (LDES) is a technology that stores energy and then dispatches it as power, heat or cooling for extended periods of time, ranging from 8 hours to days, weeks or seasons.

Figure 4 Summary of the main market, regulatory and technology risks for energy storage

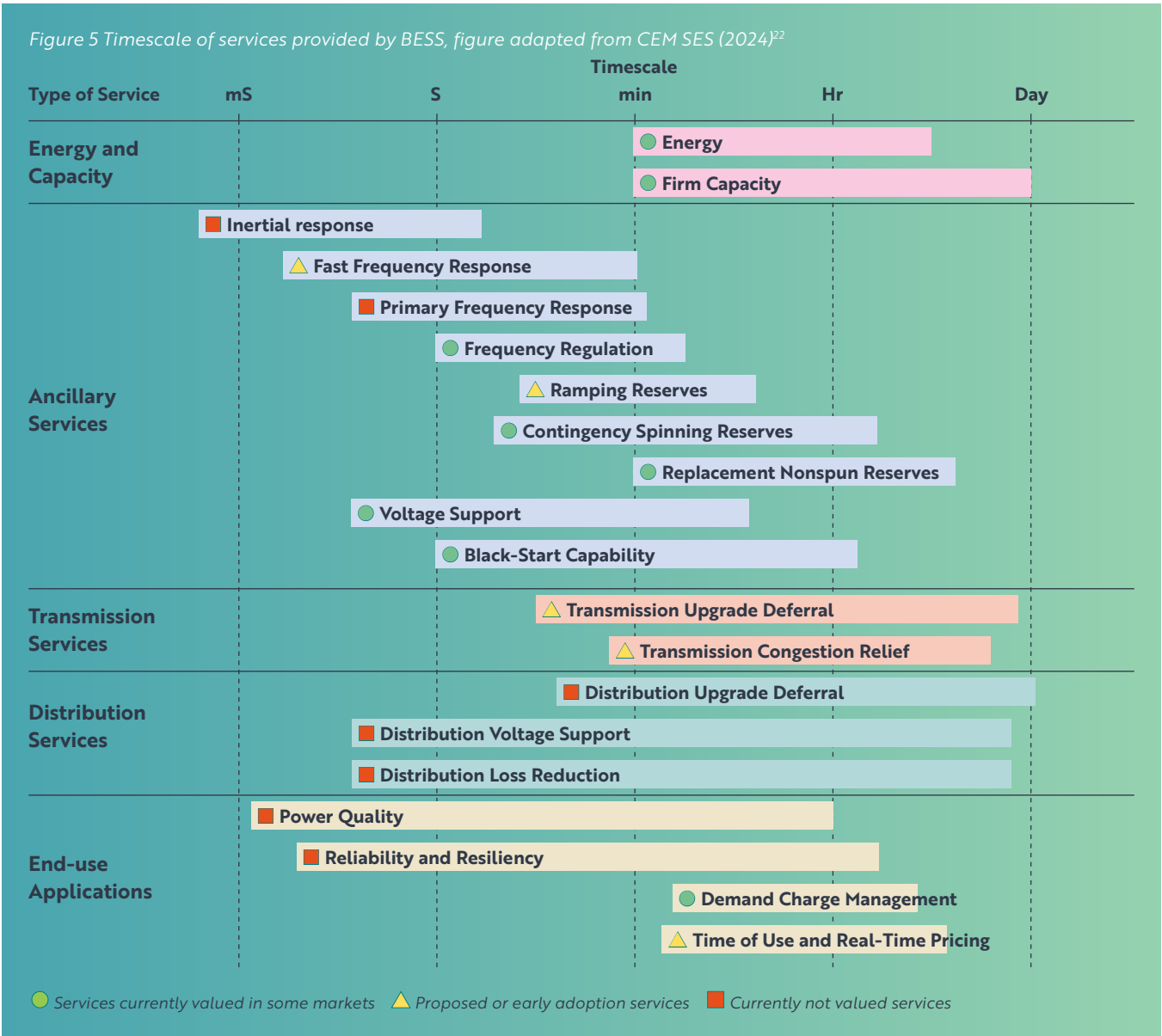
Market risks	Regulatory risks	Technology risks
- Quickly developing market formation - Revenue uncertainty - High investment costs	- Energy storage asset recognition - Grid constraints - Challenging project governance	- Rapid technology evolution - Uncertain technology performance - Widespread supply chain dependencies

REVENUE & COST UNCERTAINTY

Investors struggle with unclear use-cases when energy storage is not adequately coupled to one or multiple revenue mechanism(s). Often, energy storage projects are surrounded by multiple end-uses, various potential customers and undervalued added services. As explained above, the three market mechanisms all have different customers (for example grid operators versus behind-the-meter customers). When the main use-case for energy storage is grid support, a Transmission System Operator (TSO) that is willing to pay for it is required. On the other hand, when energy storage is targeted as a behind-the-meter functionality, an added value compared to incumbent technologies is essential to find customers that are willing to pay. For thermal energy storage and LDES specifically, a positive marginal difference needs to be present compared to incumbent technologies. This

means that revenue certainty can only be created when there is a clear end-use and customer coupling, and adequate regulations are in place.

In addition to uncertain revenue streams, cost uncertainty remains a major barrier to establishing a clear business case for energy storage projects. While technology costs are expected to continue to decline in the next decade²³, operational expenditures can have a significant impact on project economics throughout the project lifetime. For energy storage, grid fees represent a key source of uncertainty in the current system. Uncertainty regarding the future design and evolution of these charges, driven by changing regulatory frameworks and market conditions, creates additional financing risks for project developers and investors.



HIGH INVESTMENT COSTS

Despite the fact that global BESS costs have halved in the past five years (341 USD/kWh 2019 compared to 140 USD/kWh 2025²⁴), high upfront costs are still a major challenge in attracting sufficient finance for energy storage projects²⁵. Recent industry surveys indicate that this decline accelerated further in 2025, with turnkey system prices falling by around 30% in a single year, reaching their lowest recorded level²⁶. Nevertheless, capital requirements remain particularly high for LDES systems, where total plant costs can range between 220-570 USD/kWh for ~10 hour electrochemical storage and 236-338 USD/kWh for pumped heat storage²⁷. Sufficient financing should be made available to kick-start these first large scale projects. For island states specifically, upfront investment costs can be the hampering factor, where the market size and potential for energy storage are small, even though the system value is significant.

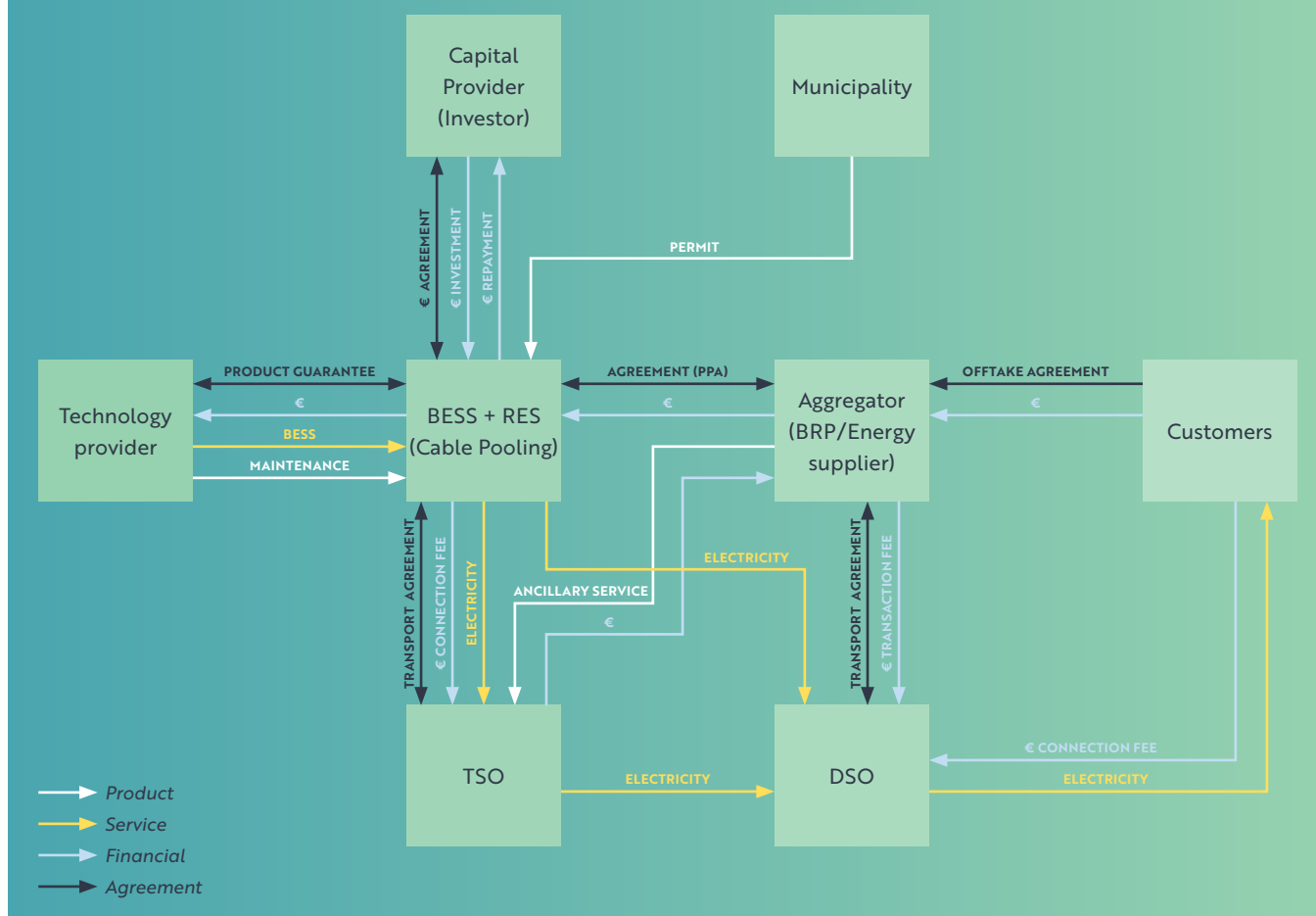
2.2 Regulatory risks

Each country has its own regional factors and associated energy system that together impact the ecosystem of energy storage. The recognition of energy storage as a distinct asset class, grid constraints, and project governance together impact the environment in which energy storage projects can operate.

ENERGY STORAGE ASSET RECOGNITION

Due to the fast technological development pace of energy storage, a significant gap persists in the balance between technological maturity, market frameworks and regulatory recognition. In many countries, non-fossil fuel-based energy storage assets have arisen in less than a decade. Through this, project developers have to negotiate on a case-by-case basis for regulatory exemptions, creating a slow and uncertain environment

Figure 6 Value network mapping of a BESS³⁰. DSO = Distribution System Operator; TSO = Transmission System Operator; BRP = Balancing Responsible Party; BESS = Battery Energy Storage System; RES = Renewable Energy Supply.



for investors. Due to current outdated frameworks, storage is often both treated as a consumer as well as a producer, resulting in double taxation and grid fee payments²⁸. Together, these factors create a difficult regulatory environment for energy storage developers to operate in.

GRID CONSTRAINTS

The regional need for energy storage is grid-specific; pumped-hydro-rich nations most likely do not need other LDES options, regions abundant with solar and wind may benefit mostly from small to medium duration energy storage projects, whereas island states need storage for resilience and reliability causes. The grid needs to be properly developed for each specific regional system to incorporate energy storage.

In developing countries, this grid connection poses a significant challenge. Many countries are still developing a reliable and strong transmission grid, where energy storage could help absorbing renewable energy fluctuations. However, the proper timing of grid strengthening and energy storage roll-out is a major challenge. On the other hand, storage can be an important alternative to grid expansion, when co-located with renewable energy projects.

In some cases, due to grid congestion, energy storage projects cannot get a grid connection and grid connection fees have increased drastically in the past few years (for example in the Netherlands), making up for a big part of the OPEX²⁹. Together, these grid constraints are a significant risk to further increase energy storage deployment.

Due to the large portfolio of energy storage technologies, it could be difficult for an investor to judge which technologies are most promising or suited to towards a specific end-use.

CHALLENGING PROJECT GOVERNANCE

A complex interface persists for the stakeholder and value chain energy storage network. The implementation of energy storage projects often involve various subcontractors and interfaces. This results in coordination and delivery challenges, increasing the perceived risk for financiers. *Figure 6* provides a graphical overview of an example BESS value mapping network, showcasing the high number of stakeholders and different types of interactions. Another challenge arises due to the relative immaturity of some energy storage technologies, which results in many developers and operation & maintenance organizations which have not been qualified yet.

2.3 Technology risks

RAPID TECHNOLOGY EVOLUTION

Even though energy storage spans a whole range of different technologies, as a whole it is still a relatively young sector with many low technology readiness level (TRL) developments. This applies both to efficiency and cost improvements for BESS, as well as new technologies for LDES. This results in rapid technology evolution which is difficult to match with long project depreciation periods. A key risk lies in financing a specific technology which could be outcompeted in a few years' time. Secondly, due to the large portfolio of technologies, it could be difficult for an investor to judge which technologies are most promising or suited to a specific end-use.

UNCERTAIN TECHNOLOGY PERFORMANCE

Due to the nascent nature of the sector, technological performance uncertainty presents a key risk. First of all, several risks arise when moving from lab and pilot scale to wide industrial deployment. Secondly, climate conditions around the world can greatly impact technology performance, for example, related to higher temperatures and humidity levels. Especially for developing countries deploying BESS, this poses a key risk and can potentially impact the public perception of energy storage technologies. With a lack of operational assets in new geographical and environmental contexts, private investors can be reluctant to take a first step in financing this new asset class.

WIDESPREAD SUPPLY CHAIN DEPENDENCIES

Many regions consider energy storage as an enabler for energy independence and resilience. However, for most of the technologies, import dependencies persist related to (raw) materials, technology development, manufacturing capacity or human capital. Furthermore, the energy storage value chain complexity and high number of stakeholders can pose a significant financing risk.



In conclusion, several risks persist for further energy storage deployment. Figure 7 presents indicative risk scales for early innovation, pre-commercial and commercial energy storage projects, highlighting de-risking trends as technologies, markets and regulatory frameworks mature. The main risks, typical investors and financing instruments are included as well, as will be further explained in Chapter 3.

Figure 7 Risk scale indication for early innovation, pre-commercial and commercial energy storage projects and portfolios. The scoring of risks and applicable financing sources and instruments is indicative and for illustrative purposes. Note that combinations of financing sources and instruments are often project and context specific.

	Early innovation	Pre-commercial	Commercial
	Low risk —————> High risk	Low risk —————> High risk	Low risk —————> High risk
Technology risks	  	  	  
Market risks	  	  	  
Regulatory risks	  	  	  
Main risks	Technology performance	Business case & market readiness	Long-term revenue certainty
Financing sources	Seed investors, governments, state-owned enterprises, philanthropic organizations, R&D budgets	Governments, climate funds, state-owned enterprises, multi-lateral development banks, first-mover banks, seed investors	Commercial banks, state-owned enterprises, multi-lateral development banks, private equity
Financing instruments:	Low share —————> High share	Low share —————> High share	Low share —————> High share
Public grants & loans	  	  	  
Public guarantees	  	  	  
Public equity	  	  	  
Concessional grants & loans	  	  	  
Private equity financing	  	  	  
Private debt financing	  	  	  

3.

ENERGY STORAGE REVENUE MECHANISMS, FINANCING INSTRUMENTS AND INVESTMENT REQUIREMENTS



Image Credit: Leonhard Kurz - ENERGYNEST

A de-risked technical and regulatory environment, as discussed in Chapter 2, is a precondition for financing energy storage, not a guarantee of it. (Public) financing instruments and revenue mechanisms can kick-start further energy storage de-risking. This chapter first sets out the main categories of revenue mechanisms, financial instruments and structures, and then turns to the requirements applied by financial institutions, such as multilateral development banks (MDBs) and development finance institutions (DFIs), when assessing energy storage investments. After that, Chapter 4 proposes mitigation

measures to overcome the main barriers, partly driven by the proposed mechanisms and instruments.

3.1 Revenue mechanisms and contractual structures

Energy storage projects can generate revenues through a variety of contractual, market-based, and regulatory arrangements. These revenue mechanisms determine how revenues are earned and how market and revenue risks are allocated among stakeholders, thereby playing a critical role in improving investment readiness and financing viability.

CONTRACT-BASED MODELS

Contract-based models reduce merchant exposure by linking revenues to a counterparty rather than to wholesale price movements.

A tolling agreement pays a counterparty a fixed monthly or yearly fee to operate the storage asset while a separate

EXHIBIT

MUFASA

Country: **Netherlands**

Energy storage technology: **Li-ion BESS (Tesla Megapack 2 XL)**

Size (MW/MWh): **350 MW / 1,400 MWh**

Innovative aspect: First fully merchant, non-recourse project-financed BESS of this scale in the Netherlands

Brief description: Project Mufasa (Lion Storage/Return) in Vlissingen is the largest Dutch BESS fully funded through non-recourse project financing (over EUR 350 million), backed by Macquarie Capital, TINC, Return investors and six banks. It operates on a full merchant basis, with Tesla as battery supplier and EPC, and Eneco as operator.

Project highlights or lessons-learned: Shows that project finance banks and infrastructure investors will back large merchant BESS without a fixed offtake contract, given diversified access to multiple Dutch power markets.

Source: [Lion Storage's Mufasa redefines Dutch energy storage market \(energystoragenl.nl\)](#); [Lion Storage closes finance on 1.4 GWh merchant battery in Netherlands \(ess-news.com\)](#)



Source: Return 2025



EXHIBIT

OBELISK SOLAR POWER

Country: **Egypt**

Energy storage technology:

BESS co-located with solar PV

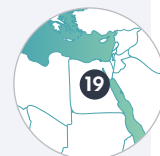
Size (MW/MWh): **1 GW solar PV / 200 MWh BESS**

Innovative aspect: Sovereign-guaranteed, USD-denominated 25-year PPA underpinning a large blended-finance package

Brief project description: Obelisk (Scatec) combines 1 GW solar PV with a 200 MWh BESS in Egypt, financed with USD 479.1 million from AfDB, EBRD and BII. Energy is sold under a 25-year, sovereign-guaranteed USD PPA with the Egyptian Electricity Transmission Company.

Project highlights or lessons-learned: Blended finance combining concessional and commercial capital de-risked the project; its PPA structure, including a termination payment regime, is now used as a template for further hybrid projects in Egypt and the wider MENA region.

Source: [African Development Bank, BII and EBRD support pioneering solar and battery storage project in Egypt \(afdb.org\)](#); [EBRD sees Egypt's hybrid solar-storage model spreading across MENA \(pv-magazine.com\)](#)



party handles trading and dispatch, transferring market risk away from the owner³¹. Capacity contracts work along similar lines but remunerate availability directly: they pay revenue for ensuring availability of energy or grid services regardless of dispatch, positioning storage closer to a hybrid between a merchant and a contracted asset (see Mufasa exhibit).

Long-term offtake agreements, a long-term contract committing a buyer to purchase the output of a project, couple storage revenue directly to a renewable generation asset and are often structured as a power purchase agreement (PPA). In Egypt, for example, the African Development Bank (AfDB) supported a 1 GW solar-plus-storage project where a 25-year PPA provided the revenue certainty needed to attract private capital and concessional finance (see *Obelisk exhibit*).

EXHIBIT

MACSE (MECHANISM FOR THE ACQUISITION OF STORAGE CAPACITY)



Country: **Italy**

Energy storage technology: **Utility-scale storage capacity (predominantly Li-ion in round 1)**

Size (MW/MWh): **Round 1 (2025, 2028 delivery): 10 GWh awarded; Round 2 (2026, 2029 delivery): 16 GWh on offer**

Innovative aspect: Long-term, technology-neutral capacity auction with 15-year guaranteed-revenue contracts

Brief description: MACSE is Terna's long-term capacity auction for utility-scale storage, offering 15-year contracts with a fixed monthly premium. The first auction (2025, for 2028 delivery) awarded 10 GWh; the second (2026, for 2029 delivery) targets 16 GWh.

Project highlights or lessons-learned: The first auction cleared well below expected prices, with 70% of capacity won by the former state utility using brownfield advantages; even so, the 15-year guaranteed-revenue contracts remain a strong bankability signal.

Source: Italy: results of the first MACSE auction and key takeaways (Lexology); MACSE 2026: What's new in Terna's updated energy storage auction rules (DLA Piper)

MARKET-BASED REVENUE MECHANISMS

Pure merchant and hedging structures expose storage to merchant risk, defined as exposure to volatile, market-based revenues instead of contracted offtakes. One common hedge is a contract for difference (CFD): a hedge that stabilizes revenues by settling differences between market and strike prices⁴¹.

Cap-and-floor schemes take a different approach. The UK regulator defines the mechanism as setting a minimum (floor) and maximum (cap) level over an extended period: shortfalls are topped up and surpluses returned to consumers³². The UK applies this to long-duration storage through a 25-year mechanism.

PROCUREMENT AND ALLOCATION MECHANISMS

Competitive procurement can achieve a similar effect without a formal cap-and-floor scheme. Italy's MACSE mechanism, for example, auctions storage capacity with a fixed-return profile (see exhibit). This makes it a financially viable alternative in markets that lack a cap-and-floor regime.

3.2 Financing instruments and structures

Financing instruments provide the capital and risk-mitigation support required to develop, construct, and operate energy storage projects. Their suitability depends on project maturity, risk characteristics, and the availability of public and private sources of finance.

PUBLIC SUPPORT INSTRUMENTS

Grants and tax credits can be a public source to improve the overall project economics. In the form of grants, capital is provided to offset or reduce upfront CAPEX. Canada's Clean Technology Investment Tax Credit provides a refundable credit of up to 30%³³. Interviewees highlighted investment tax credits as one of the most effective tools for improving storage project returns and attracting institutional investors.

Contribution agreements have a grant-like structure. EU funding practice formally defines them as an agreement concluded with entities implementing Union funds on behalf of the Commission³⁴. The key difference from a standard grant is closer monitoring of spending. Guarantees absorb a defined share of default risk, letting private lenders participate on better terms (World Bank Group, 2026). A clear example of this is South Africa's BESS support program (see exhibit).

CONCESSIONAL CAPITAL INSTRUMENTS

Concessional finance provides capital at a less than market rate, acting as a de-risking funding instrument. It is typically deployed to support climate and decarbonization objectives and is often used to de-risk

EXHIBIT

ESKOM RENEWABLES SUPPORT PROGRAM

Country: **South Africa**

Energy storage technology: **199MW / 833 MWh lithium-ion**

Innovative aspect: largest BESS on African continent

Brief description: The Eskom BESS program is a distributed lithium-ion storage project, designed to deliver about 199 MW / 833 MWh of battery storage. Upon completion of phase 1, BESS rollout has been scheduled to expand towards 144 MW / 616 MWh across Eskom substations in the Western, Northern and Eastern Cape, and KwaZulu-Natal. The project is financed through a blended structure involving AfDB (about USD 57.67 million via the Clean Technology Fund), the World Bank, the New Development Bank, and Eskom counterpart funding. The BESS assets are intended to deliver peak shaving, frequency regulation, ancillary services, renewable energy integration support, grid stabilization, and reduced diesel peaking reliance, while serving as a flagship demonstration of large-scale battery storage deployment in Africa supporting South Africa's energy transition.

Highlights or lessons-learned: The Eskom BESS initiative demonstrated that in African utility contexts, storage projects become bankable when four conditions are combined : sovereign-backed credit enhancement, concessional climate finance, strong technical procurement standards and grid-linked operational planning. The project effectively became a model for how DFIs can finance utility-scale storage in financially stressed but strategically important power systems. The Eskom structure is now influencing Kenya storage discussions, Egypt hybrid solar-storage models, Nigeria transmission stabilization concepts and SAPP regional flexibility planning

Source: <https://documents1.worldbank.org/curated/en/099635012242237815/pdf/PI223290e7fb460ca0b3600fc02a5779f42.pdf>, <https://www.eskom.co.za/eskom-unveils-a-first-of-its-kind-largest-battery-storage-project-in-the-african-continent/>, <https://www.eskom.co.za/distribution/wp-content/uploads/2023/11/BESS-eskom-brochure-Mobile-friendly.pdf>



Source: ESKOM BESS

EXHIBIT

RENEWSTABLE BARBADOS PROJECT

Country: **Barbados**Energy storage technology: **solar PV + BESS + H2 storage + fuel cells**

Innovative aspect: large scale project finance for value chain developments with blended finance structure

Brief description: The Renewstable Barbados Project is a Green Climate Fund (GCF)- project intended to provide a 24-hour dispatchable, climate-resilient renewable power solution for Barbados. The project combines solar PV, battery storage, hydrogen production and storage, and fuel cells to tackle Barbados' high dependence on imported fossil fuels, high electricity prices, and exposure to climate-related disruptions.

Highlights or lessons-learned: For small island systems, hybrid storage solutions are essential resilience and energy independence benefits. Combining short- and longer-duration storage technologies can support dispatchable renewable power in challenging contexts. Blended concessional finance can help first-of-a-kind configurations reach commercial stage, where the Green Climate Fund accounts for 24% of the project financing.

Source: FP224: [Renewstable Barbados Project | Green Climate Fund](#)



first-of-a-kind projects, technologies, or markets, such as the Renewstable Barbados project (see exhibit). Equity tends to be reserved for earlier-stage activities, such as venture capital for long-duration storage start-ups, while later-stage assets are financed with longer-term debt. The climate benefit of storage is easiest to demonstrate when the asset is directly coupled to renewable generation, for instance through a micro-grid.

India's Green Finance Facility illustrates concessional finance aimed at building a whole market rather than one technology (see exhibit), while Chile's ENGIE BESS structure is a sustainability-linked loan supporting BESS co-located with solar PV³⁵.

Philanthropic capital is typically provided through grants and does not require a financial return. It is most commonly used for feasibility studies, capacity building, technical assistance, and early-stage project development activities that are difficult to fund through commercial channels.

EXHIBIT

INDIA GREEN FINANCE FACILITY (IGFF)

Country: **India**Energy storage technology: **Round-the-clock renewable energy, green hydrogen, and other emerging clean energy technologies**Size (MW/MWh): **USD 200 million in concessional GCF funding, including a USD 65 million risk-sharing sub-facility**

Innovative aspect: Blended finance delivered through domestic DFIs, paired with partial credit guarantees for smaller developers

Brief description: GCF approved USD 200 million for ADB's India Green Finance Facility, a blended finance program channeled through domestic DFIs to build a pipeline in RTC renewables, green hydrogen, biogas and other emerging clean technologies. It includes a USD 65 million risk-sharing sub-facility with partial credit guarantees for smaller developers.

Project highlights or lessons-learned: Financing works through DFIs and guarantees to build a market rather than funding a single asset directly, an example of concessional finance used as a market-creation tool.

Source: [ADB and GCF Partner to Launch Clean Energy Financing Program in India \(adb.org\)](#)

PUBLIC-PRIVATE FINANCING STRUCTURES

Blended finance combines public and private capital to share risk and is often used to improve the business case and financial viability of a project. The OECD defines it as the strategic use of development finance for the mobilization of additional finance toward sustainable development goals³⁶. Public capital absorbs early losses. Private capital then scales in once a track record is established. This works well for energy storage projects where the perceived technology risks are too high for solely financial institutions to step in.

Public-private partnerships (PPPs) combine public and private capital in a single project structure. The World Bank defines a PPP as a long-term contract between a private party and a government entity to provide a public asset or service³⁷. The private party takes on significant risk and management responsibility and is paid based on performance. According to some of the MDBs, this model is increasingly used in developing countries where storage is procured as part of wider grid modernization or renewable energy integration programs.

EXHIBIT

MONGOLIA'S GRID CONNECTED BESS PROJECT



Country: **Mongolia**

Energy storage technology: **grid-connected lithium-ion BESS**

Size (MW/MWh): **80 MW / 200 MWh**

Innovative aspect: First utility-scale grid-connected BESS in Mongolia, financed through concessional development finance to increase renewable energy integration and grid flexibility.

Brief description: The project installed an 80 MW / 200 MWh battery energy storage system near Ulaanbaatar to support Mongolia's Central Energy System. The project was financed through a \$100 million ADB loan and a USD 3 million grant from the High-Level Technology Fund of Japan. The BESS provides peak power, reduces dependence on electricity imports, limits renewable curtailment, and enables higher penetration of wind and solar generation.

Project highlights or lessons-learned: The project demonstrates how concessional finance and international technical assistance can unlock first-of-a-kind storage projects in emerging markets. By establishing a utility-scale storage asset within the national grid, Mongolia created a viable reference project that supports renewable integration, improves system reliability, and provides a blueprint for future storage investments.

Source: Asian Development Bank (2023), Designing a Grid-Connected Battery Energy Storage System: Case Study of Mongolia (80 MW / 200 MWh). Asian Development Bank (2026), Storing Energy, Powering the Future: Mongolia's First Utility-Scale Battery Energy Storage System.

EXHIBIT

ENERGYNEST THERMAL STORAGE PROJECT



Country: **Germany**

Energy storage technology: **solid state thermal energy storage & power-to-heat**

Innovative aspect: heat as a service as an industrial decarbonization model

Brief description: ENERGYNEST offers a power-to-heat system with thermal energy storage and continuous energy market optimization, which can be integrated in industrial high-temperature processes. Further on, onsite renewable energy generation can be used to supply the industrial process heat.

Project highlights or lessons-learned: by decoupling electricity generation from heat consumption, storage can provide operational flexibility and a clear business case for industrial off-takers. Furthermore, a heat as a service model in which process heat is sold to the off-taker, rather than the technology itself, provides clear revenue streams and lowers the hurdle for industrial decarbonization.

Source: [Powering your clean energy transition | ENERGYNEST](#)



PROJECT FINANCING STRUCTURES

Project finance is a method where a project's assets and cash flows serve as collateral (LDES Council, 2025), not the sponsor's broader balance sheet. When a project is run as a freestanding entity for this purpose, the practice is called ring-fencing. Ring-fenced project finance typically relies on non-recourse financing, where lenders rely primarily on project cash flows for repayment⁴¹, rather than on the sponsor's other assets. In general, project risks increase with the number of subcontractors involved. Reducing complexity for the sponsor and/or user of the storage reduces the risk and could increase adoption of new storage concepts. One approach is to offer storage as a service. An example of such a heat storage project is the ENERGYNEST heat as a service model (see *exhibit*).

Another option for structuring is portfolio-based financing, which combines several renewable and storage assets in one financing structure, spreading the risk across a wider base of cash flows and projects. This approach can improve financing conditions by increasing scale, reducing transaction costs, and spreading technology, market, and operational risks across multiple projects.

EXHIBIT

ENERGY INNOVATION PROGRAM

Country: **Canada**

Energy storage technology: **battery storage & battery value chain innovation**

Innovative aspect: mid TRL R&D funding program related to battery strategy

Brief description: a federal innovation program led by Natural Resources Canada to advance clean energy technologies that will help Canada maintain a competitive, reliable, and affordable energy system while transitioning to a low-carbon economy. The program funds the Battery Industry Acceleration Call for Proposals to accelerate battery value chain decarbonization, security and competitiveness.

Project highlights or lessons-learned: the coupling of the Strategic Approach to Battery Innovation with funding calls and non-funding supports (e.g. ecosystem building), ensures de-risking of early stage battery innovations. The combination of a roadmap with funding ensures a proper long-term outlook

Source: [Battery Innovation - Natural Resources Canada](#)



Mini-perm financing is a distinct financing structure that can be applied to either individual projects or asset portfolios. A mini-perm is a loan with a maturity shorter than the asset's economic life, commonly seven to ten years³⁸. As a result, the borrower is required to refinance or replace the debt during the operating life of the project. While this can provide flexibility and lower financing costs in the early years, it also introduces refinancing risk. If market conditions deteriorate, revenues underperform, or lenders become less willing to provide capital, refinancing may become more expensive or unavailable altogether. Consequently, mini-perm structures require a robust assessment of the project's long-term cash-flow generation and financial viability

EXHIBIT

CHEAPER HOME BATTERIES PROGRAM

Country: **Australia**

Energy storage technology: **small-scale solar battery systems**



Innovative aspect: government funding program for households and small businesses introduced to support the achievement of Australia's Renewable Energy Target and capitalize on Australia's high roof top solar coverage.

Brief description: The Cheaper Home Batteries Program provides for a discount of around 30% on the upfront cost of installing a range of small-scale solar battery systems (5 kWh to 100 kWh) for Australian households, businesses and community organisations. The first 50kWh of a system is eligible for funding support with available funding moderating per kWh for medium and larger batteries for battery systems sized up to 100kWh.

Project highlights or lessons-learned: The program, introduced for batteries installed from 1 July 2025 as part of Australia's Small-scale Renewable Energy Scheme, is helping reduce electricity bills by making the most of cheap and clean solar power by storing it for when it is needed; and lowering costs for everyone by reducing peak demand and creating a more stable electricity grid. As of August 2026, over 500,000 home batteries had been installed across Australia.

Source: [Cheaper Home Batteries Program - DCCEEW](#); [Joint media release: Half a million cheaper home batteries bringing down bills for Australian homes and businesses](#) | Ministers

before implementation. In one UK example, a mini-perm was combined with capacity contracts, tolling and floor revenues, with buffers added specifically to manage downside risk in the early years.

FINANCING LONG-DURATION ENERGY STORAGE

Several interviewees noted that financing LDES can have even more challenges than other forms of energy storage. According to the LDES Council³⁹, financing structures typically involve multiple parties simultaneously, including technology providers, EPC contractors, infrastructure investors, development banks and off-takers. Examples include the UK cap-and-floor framework and Canada's emerging LDES market, where private equity, federal grants, utility engagement and regulatory support are being combined in parallel to build a financially viable project structure.

3.3 Matching financing instruments to technology maturity and system context

Instrument choice shifts in a fairly predictable way as a technology moves up the technology readiness level (TRL) curve, from concept to commercial deployment. The overview of when a financing mechanism is best suited for a technology and its maturity stage, in accordance with the system or regional conditions, was given in *Figure 7*.

At low TRLs, financing consists almost entirely of seed capital sourced by private equity (founders, friends & family, angel investors, early stage venture capital) and (RD&D) grants. At mid TRL, public research, development and demonstration (RD&D) funding supports commercial demonstration without exposing the project to full market risk. It is designed specifically to bridge the gap between lab and market: a project that is already business viable falls outside its intended scope by definition. A clear governmental support program for this early-to-mid TRL phase is Canada's Energy Innovation Program (see exhibit). Early-stage public funding plays a critical role in de-risking a technology, but it does not substitute for the deployment finance needed at the next stage.

At mid-high TRL, the emphasis can shift from subsidies towards equity, once revenue contracts, external technology validation and operation and maintenance (O&M) agreements are in place. Mission-driven lenders sometimes enter a market deliberately as first movers to demonstrate that private financing is viable, then step back once the market matures or if government capital remains directly present.

At high TRL, with a remaining market gap, public development finance still has a role wherever private

investors remain hesitant, or wherever a project supports a broader policy objective. Eligibility is typically assessed against a defined set of sector priorities. Financing can be delivered mainly through thematic investment funds (for example MDBs), spanning seed capital through to large-scale project finance, alongside dedicated programs for technology demonstration and scale-up. The intended role of this finance is threefold: de-risk a project enough to crowd in private investors, offer competitive terms and advisory support, and, where several development banks co-finance together, help raise project standards more

EXHIBIT

BOMMELERBUFFER

Country: **The Netherlands**

Energy storage technology: **BESS co-located with wind**

Size: **(MW / MWh): 11 MW / 22 MWh**



Innovative aspect: closed distribution system & local energy hub model

Brief description: the Bommelerbuffer in Zaltbommel is an 11 MW / 22 MWh battery connected to Windpark Bommelerwaard. It is one of the first BESS in the Netherlands without a direct feed-in from the grid. It is designed to operate without feeding in from the national grid, it will charge from locally generated wind power and discharge during scarcity to the grid.

Project highlights or lessons-learned: the project is financed by a private first-mover bank (Triodos). Co-locating storage with generation and local demand can reduce grid reinforcement needs and the bankability can improve when revenues combine congestion management, flexibility markets, and local balancing services.

Source: [Zaltbommel krijgt 'eigen' energieopslag-systeem na bereiken financial close Bommelerbuffer - Windunie](#)



broadly. The Dutch Bommelerbuffer BESS co-location project is an example of a high-TRL technology where a private first-mover bank has financed the project (see *exhibit*).

3.4 Investor requirements for energy storage projects

Financial institutions apply a recurring set of criteria before committing capital to energy storage projects. While specific requirements vary between MDBs, DFIs, commercial lenders, and other types of investors, most assess projects against a common set of technical, commercial, contractual, and governance criteria. Projects that are embedded within broader energy system plans and supported by clear policy frameworks are generally perceived as lower-risk investments than stand-alone assets without a clearly defined system function.



EXHIBIT

PHILIPPINES ENERGY BATTERY STORAGE MARKET MECHANISM



Country: **Philippines**

Energy storage technology: **BESS in wholesale electricity market**

Innovative aspect: market design reform for wholesale & ancillary-service participation

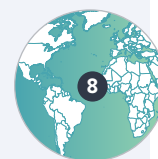
Brief description: with support of the Energy Transition Partnership, the Philippines is currently modernizing its energy market and regulatory system to let BESS participate more effectively in the market. Grid codes are being updated, together with market rules for variable renewable, energy storage, and smart-grid technologies.

Project highlights or lessons-learned: market participation rules and ancillary-service frameworks are essential to ensure a viable business case for BESS. The development of BESS protocols (scheduling/dispatch) and recognizing energy storage assets are key enablers here and receiving technical assistance on how to do this is key for capacity building.

Source: [NGCP Review of Actual Expenditure & Upgrading Design and Implementation of the Energy Battery Storage Market Mechanism of the Philippines Electricity Market Mechanism – Southeast Asia Energy Transition Partnership](#)

EXHIBIT

ENERGY STORAGE PARTNERSHIP ACADEMY



Country: **developing countries**

Innovative aspect: capacity building & concessional finance training, technical assistance, peer exchange for governments

Brief description: the Energy Storage Partnership Academy is a World Bank (WB) & Energy Sector Management Assistance Program (ESMAP) capacity-building initiative designed for government officials from developing countries, energy storage experts and World Bank staff. Through structured training modules, it shares practical knowledge on storage deployment, financing, testing, planning, and policy. It sits within the broader Energy Storage Partnership, which has mobilized substantial storage-related support across multiple countries.

Project highlights or lessons-learned: training on concessional finance, procurement, testing, and recycling possibilities can materially improve energy storage deployment. International partnerships can help developing countries deploy storage solutions and build their own capacity in terms of technical know-how and project roll-out

Source: [The Energy Storage Partnership Academy | ESMAP Energy Transition Partnership](#)

REVENUE CERTAINTY

Creating revenue certainty remains one of the most important determinants of financing viability. Financiers distinguish between theoretical and financeable revenue streams, generally preferring revenues that can be contracted, forecasted with reasonable confidence, or demonstrated through operating track records. Long-term contracts such as tolling agreements, capacity contracts, and PPAs therefore continue to play an important role in attracting capital, although some mature markets are increasingly able to accommodate higher levels of merchant exposure. Expanding market mechanisms to recognize energy storage services help in ensuring more revenue streams (see Philippines exhibit). Of the revenue models reviewed, tolling agreements and hybrid PPAs carry the lowest merchant exposure. CFD-style stabilization sits in between. Full value-stacking carries the highest exposure, alongside the highest revenue potential.

TECHNICAL REQUIREMENTS

Financiers require confidence that the proposed technology will perform as expected throughout the investment horizon. Typical requirements include independent technical due diligence, performance testing, equipment warranties, degradation assessments, and proven O&M strategies. Technology validation is particularly important for long-duration and first-of-a-kind storage projects, where operating track records may be limited.

CONTRACTUAL AND OPERATIONAL REQUIREMENTS

Clear EPC and O&M arrangements are typically required to allocate construction and operational risks among project stakeholders. Financiers generally prefer well-defined contractual frameworks that specify performance obligations, liability arrangements, and maintenance responsibilities.

GOVERNANCE AND PROJECT STRUCTURE REQUIREMENTS

Commercial lenders and infrastructure investors increasingly require projects to be developed through ring-fenced Special Purpose Vehicles (SPVs), ensuring that project risks and cash flows remain isolated from the sponsor's broader activities. Governance arrangements, permitting status, ownership structures, and long-term exit strategies are also commonly assessed.

ENVIRONMENTAL, SOCIAL AND REGULATORY REQUIREMENTS

Most MDBs, DFIs and institutional investors require compliance with environmental, social, procurement, and legal standards. Projects must demonstrate regulatory compliance, permitting feasibility, and alignment with applicable sustainability and climate objectives.

ROLES OF DIFFERENT FINANCING INSTITUTIONS

Several MDBs and DFIs publish their own eligibility and investment criteria for energy storage. These include the African Development Bank, the Asian Development Bank, the Green Climate Fund, the Climate Investment Fund, IDB Invest, the EBRD, the European Investment Bank, the IFC and the World Bank Group. Each institution's portfolio reflects a different regional and technology mandate.

Taken together, these portfolios illustrate a common transition pathway observed by MDBs and DFIs: early deployment is typically supported through policy assistance, concessional finance and capacity building, while more mature markets increasingly attract commercial lenders, institutional investors and project-finance structures. Several examples are arising to enhance this capacity building throughout the world, such as the Energy Storage Partnership Academy (see exhibit).

In conclusion, for most storage projects, financing decisions are driven less by the storage technology itself than by the predictability of the revenues generated by the service it provides. Further regional financing patterns, technology-specific portfolio differences and country-level best practices are addressed in Chapter 4.



Photo by Sungrow EMEA, Unsplash

For most storage projects, financing decisions are driven less by the storage technology itself than by the predictability of the revenues generated by the service it provides.

4.

BEST PRACTICES FOR FINANCING ENERGY STORAGE



Tonga Renewable Energy Project. Image Credit: ADB



4.1 Common risk mitigation measures for energy storage

UNDERSTANDING THE ROLE OF ENERGY STORAGE IN THE ENERGY SYSTEM

To provide long-term clarity, policy certainty is necessary to provide sufficient investment certainty. Energy storage targets and roadmaps can help in providing this clarity, preferably as part of integrated energy system planning. Clarifying the system needs and coupling this to locational spatial planning can help address the need where energy storage adds most value to the system.

It is important to collectively learn from best practices and expand capacity building in all regions of the world. Asia's Clean Energy Forum is an important example of how sharing lessons-learned on energy system planning

EXHIBIT

ASIA CLEAN ENERGY FORUM

Country: **Asia/Pacific**



Innovative aspect: capacity building & peer learning

Brief description: the Asia Clean Energy Forum is an annual platform of the Asian Development Bank that brings actors around practical clean-energy solutions. Through cross-border gatherings, knowledge is shared on storage-related topics such as financing, regulation and regional integration. Emphasis is put on developing resilient energy systems and building energy security through diversified, reliable clean energy sources, where storage plays an eminent role.

Project highlights or lessons-learned: for emerging storage markets, regional learning forums help diffuse bankability lessons, procurement models, and regulatory approaches faster. Convening financiers, governments, private sector actors, academia, NGO's knowledge sharing and capacity building.

Source: ACEF 2026 | Home - Asia Clean Energy Forum

GLOBAL INITIATIVE FOR ENERGY STORAGE



Country: **Global**

Innovative aspect: capacity building & peer learning

Brief description: The Global Initiative for Energy Storage (GIFES) as a special window is implemented under UNEZA. GIFES brings together UNEZA members and partners spanning the energy storage value chain and four continents. GIFES serves as a collaborative platform for stakeholders across the energy storage ecosystem to address shared industry challenges, accelerate the deployment of energy storage, and advance innovation in technologies, applications and business models. Through this work, the initiative seeks to contribute to the safe, high-quality and sustainable development of the global energy storage industry.

Project highlights or lessons-learned: GIFES launched a Global Energy Storage Flagship Project to identify and promote energy storage capable of providing valuable technology reference and inspiration for the industry. By connecting selected projects with utilities, industry partners, policymakers and financial institutions, the initiative aims to support their further development, replication and wider deployment, while facilitating partnerships and access to financing.

Source: Utilities for Net Zero Alliance [UNEZA_Plan_of_Action_2026-2027_v2.pdf](#)

can improve the deployment of energy storage (see exhibit). Furthermore, it is important that energy storage is not considered as purely BESS. Lock-ins should be avoided with policy that only focuses on short-to medium-duration. Procurement strategies should be holistically designed and include both long-and medium, as well as long-duration strategies.

EXHIBIT

FLEXBASE (TECHNOLOGY CENTRE LAUFENBURG)

Country: **Switzerland**

Energy storage technology: **Vanadium redox flow battery (VRFB), co-located with an AI data center**

Size: **Up to 1.2 GW / 2.1 GWh**

Innovative aspect: Bankability proof point for flow batteries in a niche, high-value use case, chosen over lithium-ion for fire safety

Brief description: FlexBase is building an AI data centre and technology campus in Laufenburg, Switzerland, integrated with what will be the world's largest vanadium flow battery. Invinity Energy Systems was selected after a competitive international process; construction began in 2025, with the engineering phase running into 2027.

Project highlights or lessons-learned: Flow battery technology was chosen over lithium-ion mainly for fire safety and its ability to handle large daily load swings without degrading. The project's scale opens up more conventional capital-equipment financing, building a bankability track record for flow batteries in a defined niche.

Source: [Redox Flow Battery Storage | FlexBase, Invinity Selected to Design GWh-Scale VFB System; Giga-scale Swiss data centre project will be 'world-first' in carving out niche for flow batteries, Invinity says - Energy-Storage.News](#)



Another example of successful international cooperation is Utilities for Net Zero Alliance (UNEZA), coordinated by IRENA. This Alliance unites leading global utilities and power companies with the aim of spearheading the development of grids that are ready for renewable energy, promoting clean energy solutions, energy storage and advancing electrification efforts. UNEZA is an international platform for co-operation within the power and utilities sector, to address and overcome the common barriers hindering the achievement of emissions reduction targets and the realization of global net zero ambitions. UNEZA members have committed to invest 3 billion USD on an annual basis in energy storage solutions (see exhibit).

COUPLING TECHNOLOGIES TO CLEAR END-USES

A market-first project design approach is necessary to couple a clear use-case, market segment and customer to energy storage projects. Proper matching of technologies to specific end-uses can clarify revenue streams and is preferred over a one-size-fits-all deployment strategy. A relatively recent use-case has arisen with the large expansion of datacenters (see Flexbase exhibit). Behind-the-meter coupling with LDES can provide a reliable source of energy and increase energy security for potential customers.

EXHIBIT

WALO SOLAR PLUS STORAGE

Country: **Senegal**

Energy storage technology: **Lithium-ion battery storage**

Size (MW/MWh): **10 MW/20 MWh, co-located with 16 MW solar**

Innovative aspect: first grid-connected solar-plus-storage project in West Africa

Brief description: Africa REN developed the project under a 20-year take-or-pay PPA with national utility Senelec, financed with around EUR 42 million in blended equity and debt from FMO, Metier Sustainable Capital and PIDG/EAIF.

Project highlights or lessons-learned: a dedicated, long-term revenue stream combined with experienced DFI partners proved decisive for bankability in an untested market. The project has since strengthened local bank confidence in Senegal, helping crowd in domestic capital for follow-on projects.

Source: [EAIF](#) · [FMO](#) · [PIDG](#) · [Africa REN](#)



EXPANDING LONG-TERM CONTRACTS

When coupled to a specific end-use and customer, long-term contracts are a key enabler for investor confidence. Preferably, offtake agreements are designed to account for multi-year services. This can both relate to multi-year ancillary service products or PPA-like structures coupled to renewable energy supply. Specifically, tolling agreements can provide an outcome for reliable multi-year performance without the associated high upfront investments. Energy storage is leased to customers who pay a fixed monthly or yearly amount, providing revenue certainty for investors. Lastly, standardized contract templates can simplify this process.

An example of expanding long-term contracts is given by a project in Senegal. Within this project, a 20-year take-or-pay PPA combined with blended DFI equity and debt made Africa REN's Walo project the first bankable grid-connected solar-plus-storage project in West Africa (see exhibit). Another example of expanding long-term contracts is Brazil's first dedicated battery storage procurement. The auction awards 15-year availability contracts with fixed annual payments, providing long-term revenue certainty while ensuring storage capacity remains available to support system flexibility and renewable energy integration (see exhibit).

Another example of long-term contracts is a public procurement capacity procedure. The national government or TSO can hold an auction for a certain amount of capacity that should be made available

EXHIBIT

BRAZIL FIRST BESS RESERVE CAPACITY AUCTION

Country: **Brazil**

Energy storage technology: **stand-alone BESS**



Innovative aspect: first large-scale storage procurement through long-term availability contracts

Brief description: Brazil has launched its first dedicated battery energy storage procurement through a reserve capacity auction. The procurement is based on 15-year availability contracts, under which storage providers receive fixed annual revenues paid in monthly installments in exchange for making capacity available to the national electricity system. Successful projects will begin commercial operation in August 2028.

Project highlights or lessons-learned: The Brazilian procurement model provides long-term revenue certainty through availability payments rather than reliance on merchant market revenues. The auction also establishes clear technical requirements, including a minimum project size of 30 MW, a four-hour discharge duration, centralized dispatch by the national system operator, and continuous availability to support system flexibility and renewable energy integration. The structure demonstrates how long-term procurement programs can reduce financing risks and improve investment attractiveness for large-scale storage projects.

Source: Agência Nacional de Energia Elétrica (ANEEL), Primeiros leilões de armazenamento de energia do Brasil entram em consulta pública.

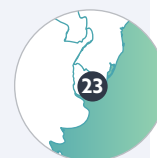
EXHIBIT

UTE BESS LEASE TENDER (P100328)

Country: **Uruguay**

Energy storage technology: **BESS, leased asset with bundled O&M (site-specific units at distribution substations)**

Size (MW/MWh): **Not disclosed in tender documents**



Innovative aspect: lease/availability-payment structure combined with a national CAPEX investment incentive (COMAP)

Brief description: UTE, Uruguay's state utility, tendered the lease of a BESS with O&M for its Distribution division at two substations, San Gregorio de Polanco and Sarandí del Yí. Payment is a 15-year annuity (15% paid in year 0, rest financed at UTE's 8.80% rate), with CAPEX reduced 50% via the COMAP investment incentive.

Project highlights or lessons-learned: the lease shifts asset ownership and performance risk to the contractor while UTE pays for availability, avoiding upfront capital outlay. Layering this with the COMAP incentive lowers the cost recovered through lease payments. One project has started installation, completion expected in 2027.

Source: UTE, Licitación Pública P100328, "Arrendamiento de un Sistema de Almacenamiento de Energía (BESS) con Operación y Mantenimiento", tender documents, 2022. <https://www.comprasestatales.gub.uy/consultas/detalle/id/i368150/mostrar-llamado/le>

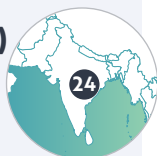
through energy storage projects. Only a fixed number of energy storage projects will be granted, avoiding market saturation and ensuring a dedicated revenue stream for these project developers (see *Uruguay exhibit*).

IMPROVING MARKET DESIGN

The energy market has to be designed to adequately enable various value stacking mechanisms for energy storage. Energy storage can fulfill services related to a combination of peak avoidance, demand charge management, demand response, energy arbitrage and wholesale energy services. For each region, these revenue streams will consist of a different mix. To enable value-stacking, markets need to be reformed to include locational pricing, quick ramp-up services, and ancillary services. This combination can significantly increase viable revenue streams and improve the business case. It is important to properly regulate these markets since investors want a guarantee to earn revenues throughout the whole project's lifetime.

EXHIBIT

VIABILITY GAP FUNDING (VGF) SCHEME FOR BESS



Country: **India**

Energy storage technology: **BESS (technology-neutral, competitively bid)**

Size (MW/MWh): **Originally 4,000 MWh by 2030-31, expanded to 13.2 GWh, then to 43.2 GWh combined**

Innovative aspect: CAPEX subsidy combined with competitive bidding and a domestic-content requirement

Brief description: The VGF scheme, approved in 2023, subsidises up to 40% of BESS capital cost through competitive bidding. The initial target of 4,000 MWh by 2030-31 was expanded to 13.2 GWh, then to a combined 43.2 GWh with a further tranche; a 20% domestic content rule was added in 2025.

Project highlights or lessons-learned: Falling battery costs let the same budget fund far more capacity, but combined with subsidy support have also driven very aggressive bidding, raising concerns about underbidding and project viability.

Source: [Cabinet approves the Scheme titled Viability Gap Funding for development of BESS \(pib.gov.in\)](#); [India introduces 20% domestic content rule for VGF of battery storage \(energy-storage.news\)](#)

REDUCING COST UNCERTAINTY

For relatively immature technologies with high investment costs and offset market risks, CAPEX support can be a key enabler to kick-start the market and induce firms to invest in these areas. India's Viability Gap Funding scheme entails a combination of CAPEX support and PPA arrangement for energy storage projects (see exhibit).

IMPLEMENTING DOMESTIC SUPPLY CHAIN SUPPORT

To avoid foreign dependencies and increase energy security, a certain level of domestic supply chain support can be beneficial. On one hand, this can relate to critical raw materials required for energy storage technologies or the domestic manufacturing industry. On the other hand, some regions are already preparing domestic recycling facilities to deal with decommissioning and large volumes of electronic waste. Ensuring that continental or regional recycling facilities exist can again decrease the dependence on other regions.

EXHIBIT

UPPER TATAY PUMPED STORAGE HYDROPOWER PROJECT



Country: **Cambodia**

Energy storage technology: **Pumped-storage hydropower**

Size (MW/MWh): **1,000 MW (four 250 MW reversible pump-turbine units)**

Innovative aspect: China-financed BOT pumped hydro project alongside broader multilateral digital grid modernization

Brief description: Cambodia's first gigawatt-scale pumped storage project (1,000 MW), financed by Chinese investors under a BOT structure, broke ground in April 2026 to help balance a grid with growing solar and wind. Broader grid modernization also involves ADB, JICA and technology partners such as Huawei.

Project highlights or lessons-learned: Supports Cambodia's target of 70% renewables by 2030, but raises an open question of who governs the operational data behind an internationally financed, digitally sophisticated grid.

Source: [China-invested pumped storage hydropower project to empower Cambodia's green energy shift \(Xinhua\)](#); [In the age of the digital grid, who will govern Cambodia's power data? \(eco-business.com\)](#)

4.2. Characteristics that define the regional role of energy storage

Each country and region will have a different need for energy storage, depending on local conditions. It is important to adequately understand these local conditions, to make a fit-for-purpose strategy and deploy the relevant mitigation measures. This subchapter describes the key regional characteristics that should be taken into account, supported by regional examples around the world.

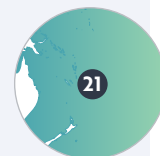
ENERGY MIX

The composition of the energy mix is one of the most decisive factors shaping the role and value of energy storage. In systems with a high share of variable renewable energy sources (VRE), such as wind and solar, temporal mismatches between supply availability and demand increase significantly. This drives a growing need for storage solutions to better use VRE assets and its associated investments. At the same time, the role of storage is influenced by the presence of dispatchable power options (e.g. hydropower, thermal) and other flexibility options, such as demand response and grid interconnections. In systems with high VRE penetration and limited flexibility, storage becomes a core component for ensuring system reliability and adequacy. In systems where substantial dispatchable capacity is already available, the need for storage may be less driven by system reliability concerns, but storage can nevertheless play an important role in providing customer-level flexibility, resilience, and cost savings. For example, the rapid growth of behind-the-meter storage in markets such as Canada represents a distinct deployment driver that exists alongside the flexibility provided by large hydropower resources. The interaction between variability, flexibility, and residual demand therefore directly defines the economic and operational role of storage. The Upper Tatay Pumped Storage Hydropower Project in Cambodia provides a good example of the expansion of hydropower to support the further

expansion of renewables (see exhibit). Furthermore, China's Jimusar project⁴⁰ illustrates this shift toward longer-duration chemistries, pairing a 1 GWh vanadium flow battery with 1 GW of co-located solar under strong state-owned sponsorship.

EXHIBIT

TONGA RENEWABLE ENERGY PROJECT



Country: **Tonga**

Energy storage technology: **BESS co-located solar PV in mini-grid**

Size (MW/ MWh): **20 MW / 28 MWh**

Innovative aspect: blended concessional finance, resilience-focused island deployment

Brief description: TREP is a renewable energy and storage program supported by the ADB & GCF and co-financiers. The program focused on the main island, two large islands and five small outer islands. It includes a battery system on Tongatapu to store renewable electricity and support grid stability. The program also includes grid upgrades, project management support, transaction advisory services, and capacity building to enable more private-sector investments.

Project highlights or lessons-learned: Blended public climate finance can unlock projects that would struggle under commercial-only financing. This project is a key example of a blended-finance construction with the ADB, GCF, Australian Government, Government of Tonga & Tonga Power Limited. Next to the project development, capacity building and grid modernization are key to ensure future private sector participation.

Source: <https://www.adb.org/node/491046/printable/pdf> & FP090: Tonga Renewable Energy Project under the Pacific Islands Renewable Energy Investment Program | Green Climate Fund



Each country and region will have a different need for energy storage, depending on local conditions

High VRE penetration	High dispatchable generation capacity
- Storage is beneficial to counteract mismatch in available supply & demand - Storage is often co-located with RES - Long-duration storage becomes increasingly important	- Baseload flexibility is often provided through hydropower plants - Storage plays a complementary role for ancillary services, congestion management or peak shaving

GRID-LEVEL CONNECTIVITY IN AND BETWEEN REGIONS AND COUNTRIES

The level of grid connectivity, both within countries and across borders, strongly influences the need for

the deployment of energy storage. Well-developed and highly interconnected electricity networks enable surplus and deficit balancing over larger geographical areas, thereby reducing the need for local storage. In this sense, interconnection can act as a substitute for storage by allowing flexibility to be imported from regions with different generation profiles or demand patterns. However, interconnected systems may still face problems to tackle longer periods of low VRE generation coupled with high demand. Conversely, in systems with limited transmission capacity, such as island states or systems with significant congestion, storage plays a critical role in decoupling production and consumption across both time and location. Under such conditions, storage is not only a flexibility provider but can also serve as an alternative to grid reinforcement and is needed for strategic security of supply purposes. Its effectiveness

UK'S LONG DURATION ELECTRICITY STORAGE CAP AND FLOOR REGIME

Country: **United Kingdom**

Energy storage technology: **Long Duration Electricity Storage**

Innovative aspect: cap and floor regime for 25 years

Brief description: the energy regulator for Great Britain Ofgem has set out a cap and floor regime for a technology agnostic portfolio with minimum capacity at 50 MW for TRL 8 technologies and at 100 MW for TRL 9 technologies. The minimum storage duration is set at 8 hours and this needs to be maintained for over the full 25 years of the project. The first application window yielded a preliminary decision by OFGEM from an assessment of 73 submitted and eligible projects to progress a portfolio of 16 projects totaling 7.6 GW with 137 GWh of storage capacity. The portfolio

includes mainly pumped hydro and lithium-ion batteries (with storage durations up to 18 hours) complemented by compressed air energy storage and a flow battery.

Project highlights or lessons-learned: The cap and floor scheme ensures investors to receive a minimum amount of revenue to enable investment in LDES assets.

Source: https://consult.ofgem.gov.uk/energy-generation/ldes-window-1-minded-to-decision/supporting_documents/ldes-window-1-minded-to-decisions-consultationpdf
ofgem.gov.uk/sites/default/files/2025-03/Long-Duration-Electricity-Storage-Technical-Decision-Document.pdf



Overview of 16 storage projects shortlisted under the UK Cap and Floor scheme



thus depends on transmission capacity, congestion levels, and the extent to which energy carriers can be transported between regions. Previously named examples relate to Prince Edward Island or Barbados where energy storage is deployed to support energy reliability, security and renewable energy integration. Furthermore, the Tonga Renewable Energy Project highlights the resilience focused energy storage deployment on a small island state through co-located BESS with solar PV (see exhibit).

MARKET DESIGN AND VALUE STACKING

The design of energy markets largely determines whether energy storage can operate as a viable business case. In energy-only markets, storage revenues are typically dependent on price volatility and arbitrage opportunities, whereas capacity markets can provide additional and more stable income streams. A key enabler for storage is the possibility of “value stacking,” where multiple revenue streams are combined, including arbitrage, frequency regulation, congestion management, and capacity provision (for more information see Whitepaper on Exploring the Value of Electricity Storage)⁴¹. Market frameworks that explicitly support such stacking, such as the UK (see exhibit), through well-functioning ancillary service markets and transparent access across market segments, significantly improve the economic viability of storage. In contrast, regulatory barriers such as double grid charges, restricted access to balancing markets, or unclear asset classification can undermine project feasibility. Market design therefore acts as a critical lever in determining how effectively storage contributes to overall system optimization.

Interconnected system	Remote transmission systems
- Storage mainly deployed for congestion management - Large, interconnected grids can share flexibility across regions - Interconnectors can partly substitute storage	- Storage is required for reliability and security of supply due to limited back-up options - Storage can alleviate expensive transmission upgrades and reduce diesel dependency - Storage is often co-located with VRE

INSTITUTIONAL MATURITY

Institutional maturity determines the extent to which energy systems can effectively integrate and scale energy storage. This includes the capabilities of market participants, the clarity and stability of regulatory frameworks, and the engagement of financial institutions. In more mature systems, storage is recognized as a distinct asset class, supported by appropriate regulatory treatment and established financing structures (see

exhibit). In less mature environments, the absence of such frameworks increases perceived risks and slows deployment. Institutional development therefore reduces transaction costs, improves investor confidence, and accelerates adoption.

Energy only market	Value-stacked market
- Revenue depends primarily on energy arbitrage and electricity price volatility - Storage deployment may require additional contracted revenues	- Storage can monetize multiple services simultaneously - Diversified revenues

SUPPLY CHAIN (DOMESTIC VS. IMPORT DEPENDENCE)

The availability and robustness of the supply chain is a critical precondition for scaling up energy storage. Countries with strong domestic (subsurface) potential for storage, manufacturing capabilities, access to critical materials, and well-developed technical expertise have a clear advantage in terms of cost control, deployment speed, and supply security (see exhibit). This applies

High storage market readiness	Low storage market readiness
- Storage is recognized as a distinct asset class - Established procurement mechanisms exist - Private capital actively finances energy storage projects	- Limited experience across utilities, regulators and lenders - Storage is often installed behind-the-meter - Deployment often depends on capacity building and technical assistance

A key enabler for storage is the possibility of 'value stacking', where multiple revenue streams are combined

not only to initial installation, but also to maintenance, replacement, and system optimization over the asset lifetime. Dependence on international supply chains can introduce risks such as price volatility, geopolitical exposure, and project delays. In addition, the availability of knowledge and expertise, such as engineering capacity

and operational experience, plays an important role in effectively deploying and operating storage systems. A well-developed supply chain therefore not only reduces costs but also enhances the reliability and scalability of energy storage as a system solution.



Strong domestic supply chain	Import-dependent system chain
- Domestic raw materials or manufacturing capacities are present - Storage deployment can support industrial policy and economic development objectives	- Projects are exposed to foreign supply chains - Storage is often prioritized for energy security and reducing fuel import dependence

EXHIBIT

ENERGY STORAGE SYSTEM (ESS) INDUSTRY DEVELOPMENT STRATEGY

Country: **Republic of Korea**

Energy storage technology: **ESS, including BESS and long-duration energy storage technologies**

Size (MW/ MWh): **25.16 GW by 2038; comprising 3.66 GW of short-duration ESS, 19.75 GW of long-duration ESS, and 1.75 GW of pumped-storage hydropower.**

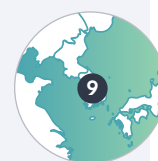
Innovative aspect: Coordinated deployment of short- and long-duration energy storage to establish a flexible and reliable power system, combined with market-based procurement and industrial policies designed to make Korea a global ESS leader

Brief description: The Republic of Korea is advancing its Energy Storage System (ESS) Industry Development Strategy in alignment with the 11th Basic Plan for Long-Term Electricity Supply and Demand. The updated plan aims to build a stable and flexible power grid by deploying 25.16 GW of storage resources by 2038. This consists of 3.66 GW of short-duration ESS for rapid response and grid balancing, 19.75 GW of long-duration ESS for renewable-energy integration and large-scale energy shifting, and 1.75 GW of pumped-storage hydropower. Total investment demand is estimated at approximately KRW 40.2 trillion (approximately USD 28.0 billion). The deployment plan complements Korea's industrial-policy objective of becoming a global ESS leader and achieving a 35% share of the global ESS market by 2036.

Project highlights or lessons-learned:

Korea's updated strategy recognizes that large-scale renewable-energy integration requires a portfolio of storage technologies with different discharge durations. Short-duration ESS will provide fast-response flexibility, while long-duration ESS will absorb renewable-energy surpluses, reduce curtailment, relieve grid congestion, and move electricity across longer periods. Long-duration ESS represents the largest component of the plan, accounting for 19.75 GW, or approximately 79% of the planned storage capacity. The projected investment provides a substantial market signal for private developers, battery manufacturers, technology providers, and financial institutions. Competitive procurement mechanisms, including the Low-Carbon Central Contract Market, can improve project bankability and support the commercialization of technologies such as lithium-ion and redox-flow batteries.

Source: STATEMENT: Republic of Korea, Energy Storage System (ESS) Industry Development Strategy and the 11th Basic Plan for Long-Term Electricity Supply and Demand, originally issued by the former Ministry of Trade, Industry and Energy; energy-storage deployment and grid-integration policies are currently overseen primarily by the Ministry of Climate, Energy and Environment.



5.

THE ROAD TO FINANCIALLY VIABLE ENERGY STORAGE

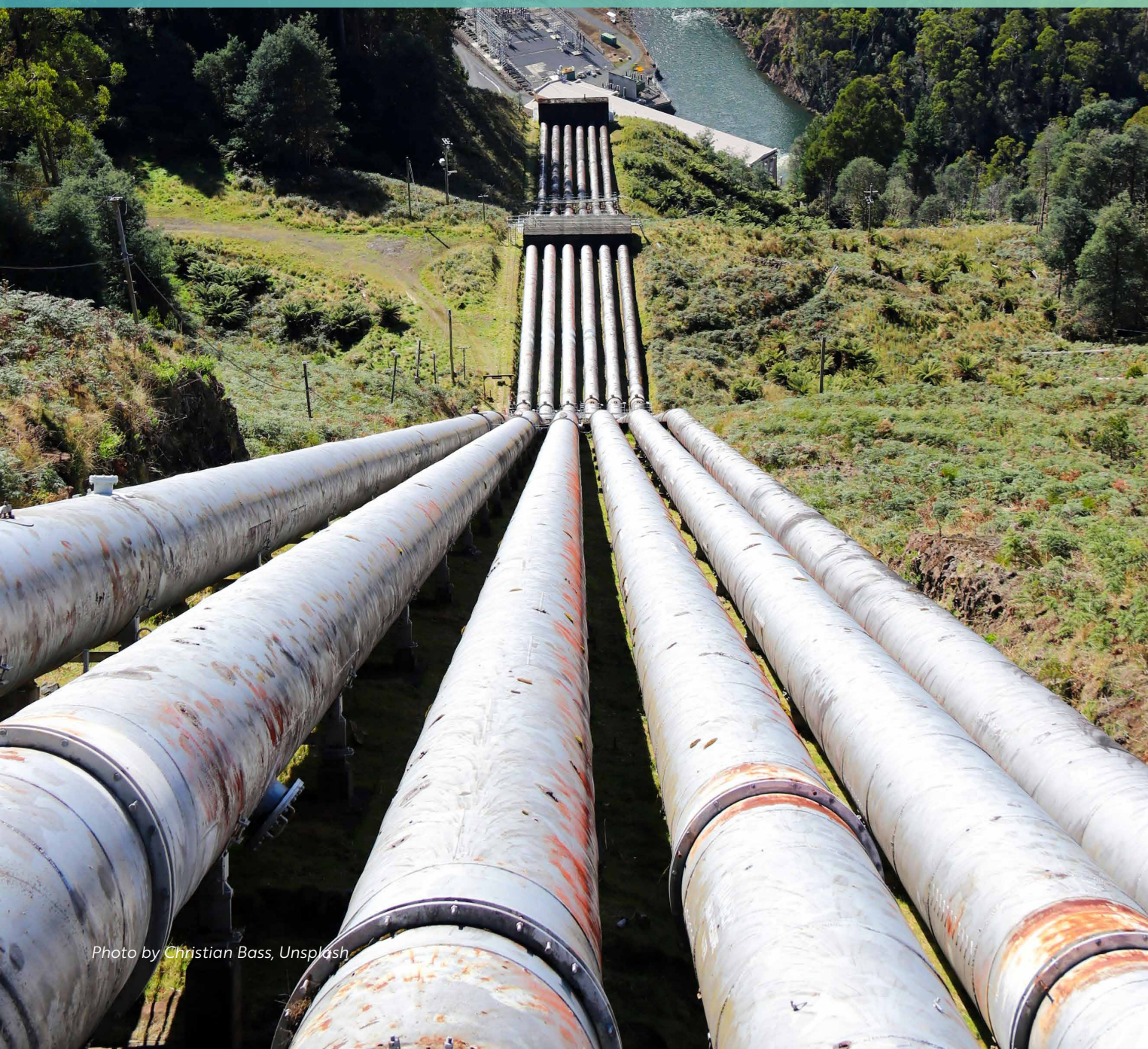


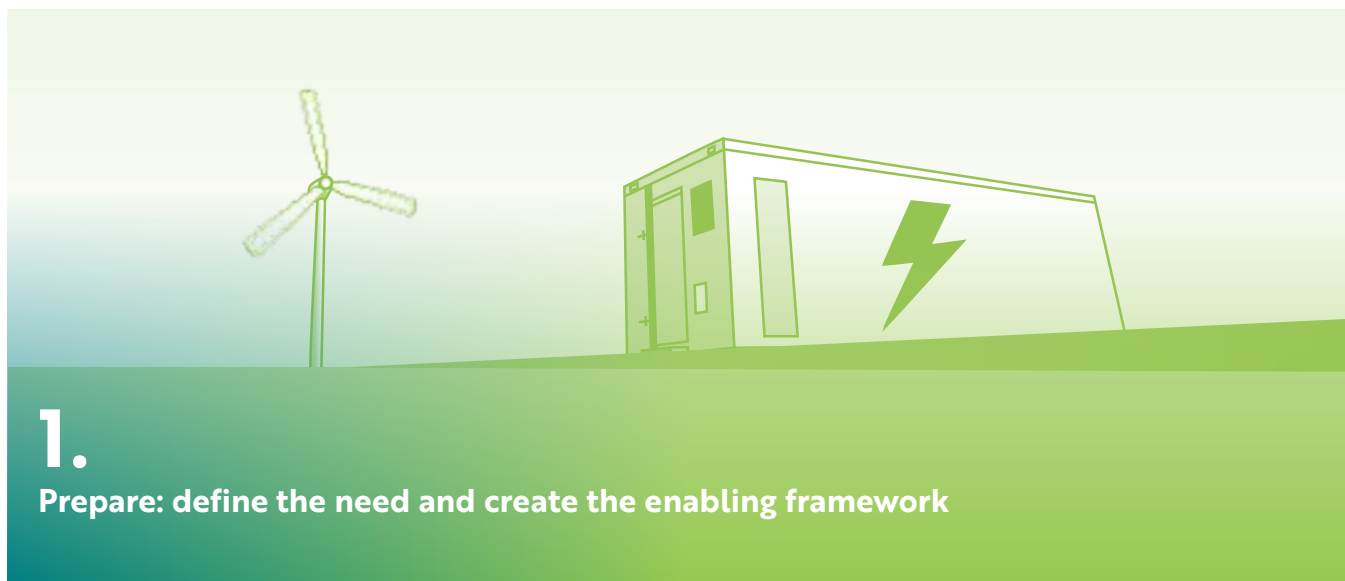
Photo by Christian Bass, Unsplash

The road to financing energy storage does not consist of a single instrument or market design. It is a staged pathway in which countries and regions first define why and where storage is needed, then reduce the risks of early deployment, and finally create the conditions under which private capital can scale. Across regions, technologies and institutional contexts, the sequence is broadly similar: financing energy storage at scale requires deliberate progression. The preparation phase defines the system need and creates the enabling framework.

The deployment phase uses public and concessional support to prove use cases, contracts and performance. The acceleration phase converts these lessons into stable markets, replicable projects and private capital at scale. This pathway turns storage from a promising flexibility option into a financially viable asset class capable of supporting a diverse energy mix with renewable integration, reliability, resilience and energy security across different regional contexts.

Figure 8 Staged financing pathway for energy storage deployment





1.

Prepare: define the need and create the enabling framework

SYSTEM PERSPECTIVE

The starting point is a clear system perspective. This requires long-term energy system planning, quantitative flexibility assessments and a national or regional storage strategy that identifies which services are required, where they are needed, and over which time horizons. Where storage competes with existing flexibility from (pumped) hydro power, gas power plants, interconnectors or flexible demand response, the role of storage may emerge more gradually. A financially viable strategy therefore starts with the system use case with geographic context and provides a perspective of total system costs and value development towards the future.

REGULATORY FRAMEWORK

The system perspective needs to be translated into enabling policy and regulation. Long-term targets can help signal demand to developers and manufacturers, but targets are only useful if supported by procurement routes, revenue mechanisms and regulatory treatment that make projects investable. Storage ideally is recognized as a distinct asset class, with clear rules for grid connection, energy storage valuation and market participation. Barriers such as double charging, unclear asset classification, restricted access to ancillary service markets and unpredictable grid tariffs can weaken the business case before project finance is even considered.

CAPACITY BUILDING

Capacity building is equally important and needed at every stage. The financing of storage requires capabilities across ministries, regulators, utilities, system operators, procurement agencies, local banks, financing institutions and project developers. Storage differs from conventional generation because value may come from multiple services, including arbitrage, balancing, capacity, congestion management and resilience. These services must be understood, quantified and,

where possible, contracted. Public agencies also need sufficient procurement capacity to specify performance requirements, evaluate bids, allocate risks and manage commissioning and operation. Without this institutional foundation, early projects can become overly dependent on bespoke negotiations, increasing transaction costs and slowing replication.

SUPPLY CHAINS

Preparation should also include early attention to supply chains and implementation capacity. Storage deployment depends on reliable equipment supply, qualified engineering and construction capacity, O&M capability, safety standards, insurance availability and, over time, recycling and circularity solutions. For import-dependent markets, supply chain risks can translate directly into project delays, higher costs and lower lender confidence. Identifying these risks early allows countries to determine where local capability should be developed and where international procurement or regional cooperation is more efficient.



Photo by American Public Power Association eIB, Unsplash



2.

Deploy: reduce risk and prove financial viability

EVIDENCE FOR REPLICATION

Projects should be designed in ways that deliberately reduce risk and create evidence for replication. First-of-a-kind projects should not be treated as isolated assets only; they should be designed as learning platforms for regulation, procurement, technical performance and financing. This is particularly important in emerging markets and developing economies, where the first storage projects often create the reference case for future private-sector participation.

REVENUE CREATION

Storage projects become financially viable when at least part of the revenue stack is predictable over a sufficiently long period. This can be achieved through PPAs, tolling agreements, capacity contracts, storage-as-a-service models, regulated asset structures, cap-and-floor mechanisms, or competitively procured availability payments. Merchant revenues and value stacking can strengthen project economics, but they are rarely sufficient for early-stage project finance unless they are supported by operating history, hedging, or a credible market design. For early markets, long-term contracts and transparent procurement are therefore more important than theoretical and uncertain value stacks.

PUBLIC AND CONCESSIONAL FINANCE

Public finance has a central role in this phase. Grants, concessional loans, guarantees, climate finance and blended finance can reduce the cost of capital and absorb risks that commercial lenders are not yet willing or able to price. These instruments are most effective when they are used to address specific barriers: concessional capital for first-of-a-kind deployment, guarantees for payment or perceived business-case risk, grants for upstream studies and institutional capacity, and blended structures where public capital crowds in private finance. The consequences of first movers in the private sector

(loans/equity) are not to be underestimated in the impact they can achieve by supporting first-of-a-kind projects. Next to this, public support should create a track record, establish replicable contractual templates and reduce uncertainty enough for private capital to enter later on better terms.

USE CASE DRIVEN APPLICATION OF STORAGE

Technologies need to be matched to applications, locations and customers. Short-duration batteries may be well suited for frequency response, short-term balancing and solar co-location. Longer-duration storage may be needed for firm capacity, resilience or multi-hour renewable integration. Thermal storage may be most viable when tied to a clear industrial heat customer or district energy system. Hydrogen or other molecular storage requires an even stronger link to future demand, infrastructure and offtake. In each case, the financing case improves when the technology is not presented as generic storage, but as a solution to a problem and providing a clear and monetized service.

REDUCE TECHNICAL AND OPERATIONAL RISK

Technical and operational risk must also be reduced during deployment. Lenders and insurers require confidence in technology performance, safety, degradation, warranties, Engineering Procurement & Construction delivery and long-term (contracted) operation and maintenance. This is especially relevant for new chemistries, long-duration technologies and projects in harsh climate conditions. Multi-year O&M arrangements, performance guarantees, independent technical due diligence and post-commissioning support can help convert technology promise into solid operating evidence. For public-sector or utility-owned projects, ring-fenced O&M budgets and staff training are essential to ensure that assets continue to deliver the intended performance after commissioning.



3.

Accelerate: scale investment and mature markets

Acceleration starts once projects have demonstrated that storage can perform technically, earn revenues and be governed through stable contracts and regulation. At this stage, the focus shifts from individual de-risked projects to repeatable markets, portfolios and supply chains. The goal is to move from bespoke financing to more standardized, scalable investment structures.

LONG-TERM REVENUE CERTAINTY

Revenue certainty for the longer-term remains the decisive condition. Especially to extend loan tenors and reduce the need for refinancing or renegotiation during the asset lifetime. Mature markets can accommodate a growing share of merchant exposure, but only where there is sufficient confidence in market depth, price signals, operating performance and regulatory stability. Contracted floors, capacity payments, tolling agreements and hybrid PPAs can provide the foundation, while merchant upside can remain available to improve returns.

NEW FINANCING STRUCTURES

Innovative financing structures will emerge as markets mature. Early projects may rely heavily on public (concessional) finance, whereas later projects can increasingly use project finance, portfolio finance, infrastructure funds, private equity, senior debt and refinancing structures. Aggregating projects into portfolios can diversify revenue and technology risks, reduce transaction costs and attract larger pools of capital. For developers, this also allows first-of-a-kind experience to be converted into a pipeline of repeatable assets. For lenders, it creates a broader evidence base for credit assessment.

BROADEN THE TECHNOLOGY PORTFOLIO

Acceleration also requires a broader technology portfolio. Lithium-ion batteries currently dominate deployment, but future system needs will require a wider set of storage

durations, chemistries and applications. The transition from a single dominant technology toward a diversified storage portfolio will only be financially viable if each technology is linked to a clear use case and suitable revenue mechanism, or multiple. This is particularly important for long-duration storage, where system value may be high, but market remuneration is often less mature.

REGULATORY TRANSPARENCY AND PREDICTABILITY

Regulatory transparency and predictability become increasingly important as capital shifts from public and concessional sources toward private debt and institutional investment. Investors can manage technical and market risks when these risks are transparent and priced. They are less able to manage sudden changes in grid tariffs, taxation, market access rules, ownership restrictions or procurement procedures. Stable regulation does not mean static regulation; storage markets will continue to evolve. However, changes should be predictable, consultative and aligned with long-term system planning.

AN INTEGRATED APPROACH

Finally, acceleration depends on an integrated approach across policy, finance, technology and capacity building. Storage financial viability cannot be created by financial instruments alone. The countries and regions that move fastest are likely to be those that treat storage not as an isolated project category, but as part of a coordinated energy system investment agenda.

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