Cleantech for UK



Getting Long-Duration Storage Built

Lessons from First-of-a-Kind Projects for UK Policy

OCTOBER 2026

By **Maria Belen Sanchez Bravo** and **Sarah Mackintosh**

Based on research by Maria Belen Sanchez Bravo, UCL, supervised by Sarah Mackintosh, Director, Cleantech for UK.

CONTENTS

Summary 3

1. Why this matters now 5

2. Where UK policy stands 6

3. What first-of-a-kind projects abroad tell us 8

4. What the investment data shows 10

5. What government should do 13

6. Risks and trade-offs 16

Annex A: The six case studies 17

Annex B: UK barriers in detail 17

Annex C: Approach 18

Annex D: Investment data method 18

Notes 20

SUMMARY

The UK now has a revenue scheme for long-duration energy storage (LDES) that suits large, capital-heavy projects. First-of-a-kind projects in newer technologies still need to be financed and built in time to cut bills and secure supply.

No new large-scale LDES has been commissioned in Great Britain for around 50 years.[1] In June 2026 Ofgem provisionally selected 16 projects, about 7.6 GW, for its cap and floor scheme.[2] Most of that capacity is lithium-ion and pumped hydro. Newer technologies such as compressed air and flow batteries won only two small places.[3]

We looked at six first-of-a-kind storage projects in the UK, Australia, Japan, China and North America. The ones that got built had a named customer, public support that carried through from demonstration to construction, early operating evidence and decisions made on predictable timetables. The project that failed had raised substantial venture capital but had no customer and no ready site.

Investment data points the same way. Since 2019, the investment data records no debt finance for any UK compressed air or flow battery company, and in the UK, US and Canada a single company accounts for most long-duration storage investment.[4]

The UK has some of these conditions in place. The cap and floor scheme gives revenue certainty, but novel projects still lack construction finance and a clear route into the next funding window. Storage policy is also not yet connected to the push to lower electricity prices.

RECOMMENDATIONS

1 **Keep the scheme moving.** Confirm Window 1 awards this autumn as planned and publish a firm timetable for Window 2, including a defined route for first-of-a-kind technologies.

2 **Help first projects find finance and a customer.** The National Wealth Fund should offer construction guarantees and smaller tickets for first-of-a-kind LDES. DESNZ, NESO and the network companies should set out which system services a first project could be contracted to provide.

3 **Count storage in the bills agenda.** LDES can reduce the hours when gas sets the electricity price. DESNZ and NESO should estimate whether and by how much that lowers costs for households and industry, and use the result to size Window 2.

4 **Treat LDES as an industry.** Name it in the clean energy industries sector plan and back UK capability where early deployment can create a lasting advantage, such as compressed air engineering, flow battery electrolyte and system integration.

01.

WHY THIS MATTERS NOW

LDES is storage that can discharge at full power for at least eight hours.[5] It moves cheap renewable power from windy, sunny periods into the longer spells when output is low. Batteries that run for two to four hours cannot cover a still, cold week, so LDES complements them on the system. A review of more than sixty energy system models found long-term storage becomes an important option once renewables supply more than about 80% of electricity.[6]

A growing system need

Renewables supplied a record 44% of UK electricity in 2025, with wind the largest single source at 29.7%. Gas still provided 26.8%.[7] Great Britain has about 2.8 GW of established LDES, almost all of it in four pumped hydro stations in Scotland and Wales.[5] The Clean Power 2030 Action Plan envisages 4 to 6 GW by 2030, alongside 23 to 27 GW of shorter-duration batteries,[8] and NESO has estimated a need of 11.5 to 15.3 GW over the longer term.[9]

Some LDES facilities take seven to ten years to develop and build, so capacity needed in the mid-2030s has to be committed now. In 2024 the House of Lords Science and Technology Committee warned that large-scale deployment was not being treated with enough urgency and called for clearer targets, faster grid connections and shorter planning timelines.[10]

The cost of curtailment

When wind cannot be used or moved, the system operator pays generators to switch off and pays others to switch on elsewhere. NESO put balancing costs at £2.7bn in 2024/25, with thermal constraints alone at £1.7bn.[11] These costs are passed through to bills. Storage placed behind grid bottlenecks can soak up power that would otherwise be wasted.

The problem is sharpest in northern Scotland, where wind output regularly exceeds what the network can carry south. Most of the capacity Ofgem provisionally selected in June 2026 is located there for that reason.[3]

Electricity prices

UK household electricity prices were 18% above the EU average in the second half of 2025,[12] and the 2026 Middle East crisis pushed wholesale prices up again. Gas sets the wholesale price because it is usually the last plant needed to meet demand. In April 2026 the government announced measures to weaken that link, mainly by moving older renewables onto contracts for difference.[13]

Storage works on another part of the problem, since it can reduce how often gas is needed at all. Gas set the price about 60% of the time in 2026, down from more than 90% in 2021. Even with 95% clean power in 2030, NESO expects gas to set the price around 15% of the time.[13] Those remaining hours are mostly long periods of low wind, which is when LDES is most useful.

Manufacturers also pay for network and balancing costs through their bills, and the UK had the highest industrial electricity prices among International Energy Agency countries in 2024. Even the most energy-intensive firms, after government support, are expected to pay about £86/MWh from 2026, against £69 in France and £60 in Germany.[14] Cheaper, more predictable power depends on having something other than gas to call on when the wind drops.

The industrial opportunity

UK firms are developing flow batteries, compressed air, liquid air and other storage technologies. Building the first commercial projects in the UK makes it more likely that the manufacturing and intellectual property stay here. The UK also depends on imported critical minerals and components for clean energy, which makes early investment in domestic supply chains more valuable.[15]

02.

WHERE UK POLICY STANDS

How cap and floor works

The cap and floor scheme sets a minimum revenue for each project, paid for through bills if market income falls short, and income above a ceiling is shared with consumers.[1] It is modelled on the regime Ofgem already uses for interconnectors.[16] The aim is to let long-lived, capital-heavy assets raise finance on better terms by removing the risk of very low revenues.

DATE	MILESTONE
Autumn 2026 (expected)	Final Window 1 awards, followed by licence decisions
26 June 2026	Ofgem provisionally selects 16 projects: 7,645 MW, 136.9 GWh, 8 to 22 hours
September 2025	Eligible projects move to full assessment
April 2025	First application window opens
December 2024	Clean Power 2030 Action Plan sets 4 to 6 GW LDES ambition
October 2024	Government confirms a cap and floor scheme

Window 1 drew strong interest, with more than 70 projects passing the eligibility stage.[3] The provisional portfolio sits at the top of Ofgem's guided range, partly to allow for projects that

drop out.[2] Lithium-ion and pumped hydro account for most of the capacity. Five of the lithium-ion projects come from a single developer, and three pumped hydro schemes are included. Compressed air and flow batteries are represented by one small project each, TeesCAES and a hybrid vanadium and zinc scheme.[3]

Lithium-ion was not originally going to be eligible. It was admitted after industry argued the scheme should not discriminate between technologies, and some short-duration battery developers now argue the scheme will distort their market.[3]

That outcome fits a scheme designed to buy capacity at least cost, though it will do little to bring newer UK technologies to commercial scale. Ofgem has said it wants to see new and emerging technologies continue to develop. A decision on a second window is not expected until 2027.[3]

Ofgem consulted on revised licence conditions over the summer, closing on 18 August 2026. It will decide on them after the awards and then consult again on the statutory licence changes for successful projects.[17] Each step is reasonable, though the combined timetable leaves projects selected in June 2026 carrying development costs for longer before they can reach financial close.

The wider public finance landscape

Support beyond cap and floor is spread across several organisations.[18]

BODY	RELEVANT ROLE
DESNZ	Sets energy policy and owns the Clean Power 2030 plan
Ofgem	Runs the cap and floor scheme and grants licences
NESO	Plans and operates the system and assesses system need for storage
National Wealth Fund	Invests debt, equity and guarantees in clean energy and has backed first-of-a-kind storage
Great British Energy	Invests in and develops clean energy projects
Innovate UK	Funds demonstration and runs the FOAK Builder programme
British Business Bank	Supports venture and growth finance for companies

The National Wealth Fund has already shown it will take first-of-a-kind storage risk. In 2024, as the UK Infrastructure Bank, it committed £165m to Highview Power's liquid air plant at Carrington, the first commercial-scale project of its kind, as part of a £300m round alongside Centrica and private investors.[19] It has also said it would support markets for longer-duration storage, including taking more risk than private investors where needed to get first-of-a-kind projects to financial close.[20]

Its January 2026 strategy names energy storage as one of ten priority sectors and says it will consider equity investments in LDES projects shortlisted for cap and floor.[21] The fund plans to invest up to £5bn a year. It can complete around 40 investments a year and expects average deal sizes to exceed £100m. Its minimum ticket is £25m for equity and £50m for debt.[22]

A first compressed air or flow battery project may need a smaller cheque, or debt that commercial lenders will not yet provide, and it may sit outside the cap and floor shortlist. Such a project currently falls between what grant programmes offer and what the fund is set up to do.

Where the gaps are

Innovation grants stop at demonstration. Cap and floor favours projects that can match mature technologies on cost and deliverability. NWF support is tied to cap and floor shortlisting and to large tickets. A compressed air or flow battery project that has finished its demonstration but cannot yet win on cost has nowhere obvious to go. Planning, grid connection and supply chain delays then add years to projects that are already expensive to hold open.

The Modern Industrial Strategy names clean energy as a growth sector and mentions storage, but it does not list LDES among the clean energy frontier industries alongside offshore wind, hydrogen, carbon capture and nuclear.[23]

03.

WHAT FIRST-OF-A-KIND PROJECTS ABROAD TELL US

The six projects we examined cover two different technologies. Compressed air storage is an infrastructure project, tied to caverns, mines or large pressure vessels. Vanadium flow batteries are modular and can be sited more freely, but depend on materials and manufacturing. Annex A summarises each case.

Hokkaido: repeat orders from one utility

The Hokkaido grid has limited links to the rest of Japan and high wind potential. Placing storage centrally at a substation let several wind farms connect without each building its own. Japan's energy ministry funded a Sumitomo Electric flow battery demonstration of 15 MW/60 MWh that began operating in 2015. The regional grid company then bought a 17 MW/51 MWh system, which came online in 2022, and has ordered a third of 11 MW/33 MWh for 2029 with a 20-year service contract covering operation, maintenance and decommissioning.[24]

Each order built the evidence for the next. The first system provided frequency control, smoothing and management of surplus wind, and it restarted the day after the 2018 Hokkaido earthquake without damage. The third system is the first flow battery approved under a Japanese capital support scheme for batteries.[24] Public funding started the sequence, and a utility that kept buying turned a demonstration into a commercial product.

Silver City: public support joined to contracted revenue

Hydrostor's Silver City project at Broken Hill in New South Wales is a 200 MW advanced compressed air plant with up to 1,600 MWh of storage. Broken Hill sits on a constrained transmission line and relies on diesel for backup, so the project offers an alternative to new transmission.[25]

The project combines an A$45m grant from the Australian Renewable Energy Agency, a network service agreement with the grid owner Transgrid that pays for reliability, and a long-term energy service agreement that protects its revenue while it trades in the market. Each piece covers a different risk. The project received planning approval in February 2025 and is targeting operation in 2028. It uses a former mine site, though a purpose-built cavern and major surface works are still needed.[25]

Hydrostor also advertised 49 work packages to local suppliers through the Industry Capability Network and worked with the New South Wales Indigenous Chamber of Commerce to widen participation, which built support around the site.[25] The plant has not yet operated, so its performance at this scale is still to be proven.

LightSail: venture capital without a customer

LightSail Energy in the United States developed compressed air storage using water spray and above-ground carbon fibre tanks, to avoid needing caverns. It raised around US$80m from high-profile investors and built a large patent portfolio. The design moved the risk into the cost of the tanks and compressors, and a move into industrial gas tanks drew focus away from delivering a grid storage reference.[26]

Its planned demonstration in Nova Scotia depended on a former paper mill site and a wind farm that had not been commissioned. The company never secured a durable paying customer. It went into hibernation in 2017 and closed in 2018 without an operating commercial system. Its Nova Scotia backer later said it had failed to commercialise while lithium-ion moved ahead.[26]

Dalian: industrial scale with a bespoke build

China's Rongke Power project in Dalian was approved in 2016 as a national demonstration. Its first 100 MW/400 MWh phase, part of a planned 200 MW/800 MWh development, began operating in 2022 at a reported cost of RMB1.9bn. Rongke combined manufacturing and system integration with research support from the Dalian Institute of Chemical Physics.[27]

It took about six years from approval to operation of the first phase. Vanadium price swings and limited electrolyte processing slowed development, and Chinese flow battery megaprojects have been described as built largely on site to a bespoke design.[27] Dalian shows the technology works at size, though repeat orders of a standard design would be stronger evidence that it can be sold as a product.

What the UK's own projects show

Energy Superhub Oxford paired a 2 MW/5 MWh Invinity flow battery with 50 MW of lithium-ion, as part of a £41m programme that received £11.3m from Innovate UK. The hybrid

served electric vehicle charging, low-carbon heating and grid services, and a University of Oxford study used the project to show how dispatch could balance revenue against battery wear. Evidence from the project also fed into a revised network charging decision after proposed changes threatened its viability.[28]

The project ran into planning delays, supply shortages, an ownership change and fundraising problems along the way. Repeat flow battery orders did not follow automatically from its success.[28]

Storelectric's TeesCAES project in Teesside is planned at 50 MW with about 1,500 MWh, around 30 hours of storage. It has a strong site, with salt caverns, industrial infrastructure and established power engineering supply chains nearby, and was provisionally selected for cap and floor. Its efficiency and cost have not yet been demonstrated at project scale, and it still needs final regulatory decisions, land and finance before construction can begin.[29]

Patterns across the cases

Delay hurt every project we looked at. It raised the capital needed before any revenue arrived and gave competing technologies time to improve. For a technology that can take five to ten years from development to operation, delays at several stages can decide whether a project arrives when the system needs it.

The risks also differ by technology. Compressed air projects depend on geology, permits and large civil works, while flow batteries depend on vanadium supply and manufacturing scale. A revenue floor on its own addresses neither.

None of the international models can be copied directly. Japan relies on utilities that plan and buy centrally, and China on state direction. The common thread the UK can use is support that carries through to construction and a buyer identified early.

04.

WHAT THE INVESTMENT DATA SHOWS

To test the case study findings against a wider set of companies, we looked at funding into long-duration storage companies recorded in Cleantech Group's i3 database between January 2019 and September 2026, for the countries where our case study projects sit.[4]

Concentration in single companies

Across all long-duration technologies, UK companies recorded about £590m over the period, almost exactly the same as Canada. US companies recorded about £1.9bn. In each country one company accounts for most of the total: Highview Power for 84% of the UK figure, Form

Energy for 91% of the US figure and Hydrostor for 86% of the Canadian figure. Without that company, each country recorded less than £180m over seven years.

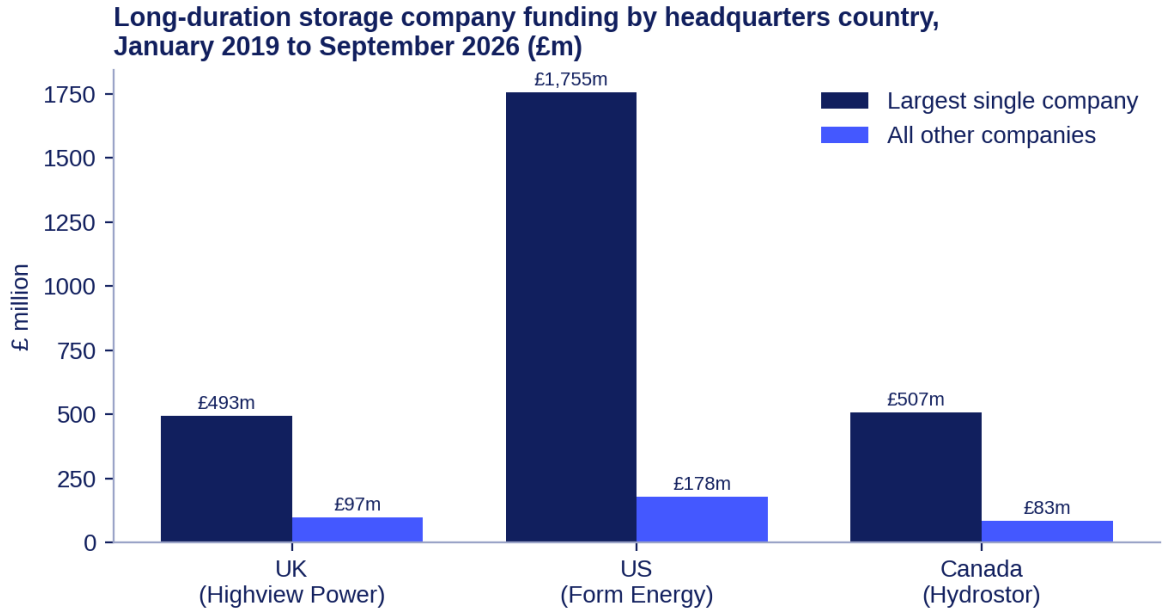


Figure 1. Long-duration storage company funding by headquarters country, January 2019 to September 2026. Source: Cleantech Group i3 database, corrected by Cleantech for UK (Annex D).

A national pipeline that depends on one company is exposed if that company stumbles, and each first project gives lenders and suppliers little evidence to apply to the next. The Hokkaido case shows the alternative, where a buyer placing repeat orders builds a market that can outlast any single contract.

Compressed air and flow batteries

For the two technologies covered by our case studies, UK company funding is much smaller. UK compressed air companies recorded about £10m since 2019, almost all of it for Keep Energy Systems and 90% of it in grants. Storelectric, whose TeesCAES project was provisionally selected for cap and floor in June 2026, has no company funding recorded since 2018. Over the same period Hydrostor, the developer of Silver City, recorded about £507m, including private equity from Goldman Sachs and the Canada Pension Plan Investment Board and debt from Export Development Canada.

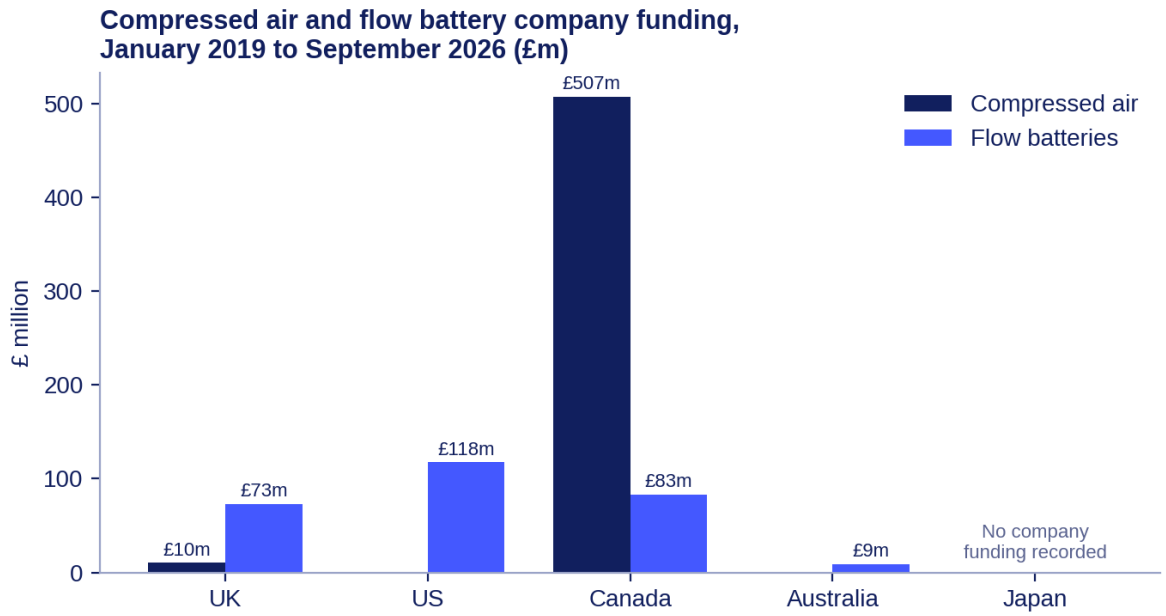


Figure 2. Compressed air and flow battery company funding by headquarters country, January 2019 to September 2026. China is excluded because coverage of Chinese companies is incomplete. Source: Cleantech Group i3 database, corrected by Cleantech for UK (Annex D).

UK flow battery funding of about £73m is larger, though 80% of it is Invinity's £57m fundraise in 2024. That round was anchored by a £25m equity investment from the National Wealth Fund (at the time called the UK Infrastructure Bank), alongside £3m from Korea Investment Partners and £28m from institutional investors.[31] US flow battery funding of about £118m is spread across more companies, which points to a deeper pipeline of early-stage firms.

Japan records no company funding in either technology. Sumitomo Electric funds its flow battery business from its own balance sheet, and the Hokkaido systems were paid for by the energy ministry and the regional grid company. Silver City's Australian grant appears under Canada, where Hydrostor is based. Both points support the case study finding that procurement and public support carried those projects further than venture capital did.

No debt for UK compressed air or flow batteries

No UK compressed air or flow battery company recorded any debt finance over the period. Their funding came from grants, early-stage equity and, in Invinity's case, a share placing on AIM. US and Canadian companies in these technologies recorded some debt, though it remained a small share of their totals.

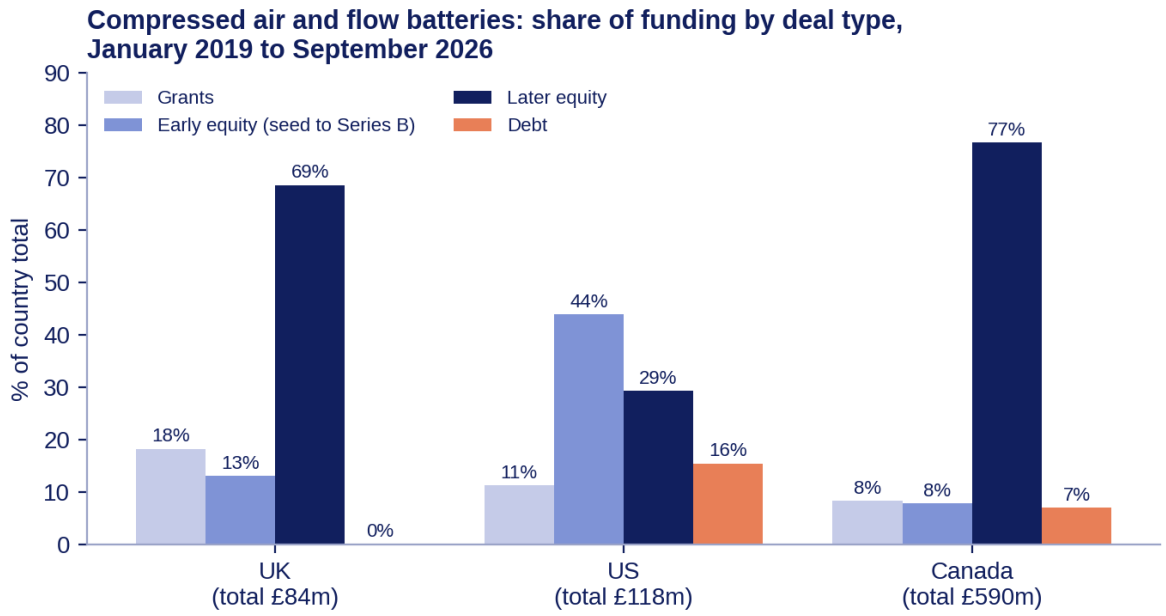


Figure 3. Compressed air and flow battery company funding by deal type, January 2019 to September 2026. Source: Cleantech Group i3 database, corrected by Cleantech for UK (Annex D).

For the UK long-duration sector as a whole, most recorded debt sits in one deal: Highview Power's 2024 financing for its Carrington plant, led by the National Wealth Fund (UKIB at the time) £165m of debt and equity.[19] That shows public finance can take first-of-a-kind construction risk in the UK, though in this data it has done so only once to date.

These findings are consistent with the case studies and the review of UK policy. First-of-a-kind projects in these technologies are reaching grants and early equity, and then struggling to find the construction finance that would take them to commercial scale.

05.

WHAT GOVERNMENT SHOULD DO

1. Keep the scheme moving and give new technologies a route in

Ofgem should confirm Window 1 awards this autumn as planned. DESNZ and Ofgem should then publish a single timetable from award to licence and financial close, with target dates for each step, and report progress against it. Developers and lenders need a date they can plan around.

Window 2 should be decided early in 2027 and include a defined route for first-of-a-kind technologies. We suggest a capped share of Window 2 capacity, open to any long-duration technology that has not yet been deployed at commercial scale in the UK. The cap keeps the cost to bill payers limited. The purpose is to get two or three compressed air, flow battery or other novel projects built, so that these technologies can compete on cost in later

windows and the market has more competition. A limited route of this kind builds a market without committing government to any technology permanently. Projects on this route should be assessed on the system value and learning they offer alongside their cost to consumers, with delivery milestones and the award withdrawn if they are missed. Projects that passed Window 1 eligibility should be able to reuse that evidence.

For projects that need several consents, a named lead official should hold one delivery timetable across Ofgem, NESO, planning authorities and the network company, and escalate delays. The EU gives priority energy infrastructure accelerated permitting, coordinated by a single national authority, with fixed deadlines for each stage.[32] Faster decisions do not require weaker environmental or community safeguards.

2. Help first projects find finance and a customer

The largest gap for first-of-a-kind LDES is capital for construction. Grants are too small and commercial lenders want an operating record that a first project cannot have. The investment data records no debt finance for any UK compressed air or flow battery company since 2019. This is the same gap Cleantech for UK sees across UK cleantech.

What the investment data means. The absence of debt shows where the gap sits. UK companies in compressed air and flow batteries have raised grants and equity, and the data records no lending to them. Revenue support on its own will not change that. A lender to a first plant takes construction and performance risk that a cap and floor does not cover, and without an operating record it will either price that risk high or decline it.

Without debt, companies pay for projects with equity, which costs more. Invinity's 2024 fundraise was partly intended to take minority stakes in UK storage projects,[33] so shareholders' money is standing in for project finance. More expensive capital raises the cost of each project, and under cap and floor it raises the revenue floor that bill payers underwrite. Cheaper finance for first projects is a bills issue as well as an industrial one.

The two deals where public finance did step in show what it can do. The UK Infrastructure Bank's £165m sat within Highview Power's £300m round,[19] and its £25m cornerstone sat within Invinity's £57m fundraise.[31] In each case other investors put in an amount of a similar order to the public stake.

Apart from Invinity's 2024 fundraise, no UK compressed air or flow battery company has raised more than about £10m in a single round since 2019. That is well below NWF's minimum tickets of £25m for equity and £50m for debt,[22] while Hydrostor, a more mature developer with projects in three countries, has raised around £500m of company funding to take them towards construction. UK firms are moving from grant-scale money straight to a need for infrastructure-scale finance, with little available in between.

The National Wealth Fund is the right institution to close this gap for storage. It has done so before with Highview Power and has said it will take more risk than private investors to get first projects to financial close. Its current LDES offer is limited to equity in cap and floor shortlisted projects, with large minimum tickets. We ask NWF to:

- offer construction guarantees and subordinated debt for first-of-a-kind LDES, so commercial lenders can come in alongside;
- allow smaller tickets for first projects, where £25m to £50m minimums rule out much of the pipeline;
- extend support to projects on a new Window 2 route and to those with other contracted revenue, such as a network or industrial offtake;
- publish how it assesses first-of-a-kind technology risk, so developers know what evidence they need.

Support should depend on a credible delivery plan, an identified customer or contracted service, and evidence that the site and supply chain are ready.

HM Treasury and DESNZ should confirm that NWF's mandate and risk appetite cover this kind of investment, and that some losses on first projects are an accepted cost of building a market.

NWF should not do this alone. DESNZ should agree a single pathway with Innovate UK, Great British Energy and the British Business Bank. Innovate UK and its FOAK Builder programme cover getting projects ready for investment. The British Business Bank supports the companies behind the projects. Great British Energy can co-invest or co-develop. NWF provides construction finance, and Ofgem's cap and floor provides long-term revenue. Each stage should hand projects to the next without a gap.

The US Department of Energy's Loan Programs Office shows this kind of role can work. It provides loans and guarantees to projects that cannot yet raise enough private debt, and in January 2025 it made a conditional commitment for a loan guarantee of up to US$1.76bn for Hydrostor's Willow Rock compressed air project in California.[34]

A customer as well as finance. The projects that progressed abroad had a buyer. Hokkaido Electric Power Network kept ordering flow batteries, and Transgrid pays Silver City for the reliability it provides to Broken Hill. A guarantee helps a lender manage risk, but it cannot stand in for a project with no identified customer.

DESNZ, NESO and the network companies should identify where a first commercial project could provide a defined system service, such as relieving a network constraint or deferring reinforcement, and set out how that service could be procured or contracted. Industrial users that want firm low-carbon power are another possible buyer. A first project with a contract of this kind alongside cap and floor would be much easier to finance.

3. Count storage in the plan to lower electricity prices

The government's April 2026 package addresses the price link with gas through contracts.[13] LDES belongs in the same plan, since it can reduce the hours when gas is needed at all.

DESNZ and NESO should estimate what additional LDES is worth to the system and to household and industrial bills, through lower balancing and constraint costs, security of supply and fewer hours of gas setting the price. The size of that benefit depends on where storage is built and how it runs, and lower system costs do not pass straight through to bills,

so the estimate should be published with its assumptions. It should inform the size of Window 2 and the case for first-of-a-kind support, and it would give ministers a tested answer when asked whether a scheme paid for through bills is worth it.

The analysis should look at where storage does most good. Sites behind grid bottlenecks, and sites near energy-intensive industrial clusters, are likely to offer the largest savings, and that should be reflected in how future windows score projects.

4. Treat LDES as an industry

LDES should be named in the clean energy industries sector plan, with the aim of building UK capability where early deployment can create a lasting advantage. The two technologies differ. Compressed air depends on sites, civil engineering and turbomachinery, while flow batteries depend on materials, electrolyte processing and manufacturing scale, so the UK may be competitive in different parts of each.

DESNZ and the Department for Business, Innovation, Science and Trade should map UK strengths and dependencies, including vanadium supply, electrolyte processing, recycling, turbomachinery and specialist construction, and link this to the Critical Minerals Strategy.[15] Cap and floor assessment and NWF investment decisions should give credit for supply chain resilience and local jobs, and local supplier and skills programmes should be tied to the actual project pipeline.

Silver City shows how local supplier and community involvement can speed delivery and build support. Hokkaido shows how repeat orders let a supplier build capability over time. A clear, steady UK pipeline would give UK suppliers the same chance.

06.

RISKS AND TRADE-OFFS

Cost to bill payers. The cap and floor floor is funded through bills, and a route for newer technologies will cost more per megawatt than mature options. Keeping that route small, capped and tied to milestones limits the exposure. The case for it rests on lower costs in later windows and on whatever system savings first projects deliver, which is why we ask government to estimate them.

Technology neutrality. Some will argue government should not pick technologies. The route we propose would be defined by maturity and open to any novel LDES technology. Its aim is to widen competition in later windows.

Effects on other storage. Short-duration battery developers have raised concerns that subsidised LDES could reduce the price spreads they rely on.[3] Ofgem already sizes each

window against system need, and a small first-of-a-kind route would not change that materially.

Public finance risk. Some first projects will fail, and NWF will lose money on some of them. Lending alongside commercial banks, staged drawdown and clear milestones reduce that risk. Losses on a few first projects should be weighed against the market that successful ones open up for later, cheaper projects.

ANNEX A: THE SIX CASE STUDIES

Figures are as reported by developers and public sources at the time of the research, and are sourced in the notes to the main text.

PROJECT	COUNTRY	TECHNOLOGY AND SCALE	STATUS	MAIN LESSON
Sumitomo Electric, Hokkaido	Japan	Vanadium flow battery; three systems from 15 MW/60 MWh (2015) to 11 MW/33 MWh (due 2029)	Operating, repeat orders	Repeat procurement by one utility built evidence and capability
Rongke Power, Dalian	China	Vanadium flow battery; 100 MW/400 MWh first phase of 200 MW/800 MWh	First phase operating since 2022	Industrial base enabled scale; build remained bespoke
Energy Superhub Oxford	UK	2 MW/5 MWh flow battery in a 52 MW hybrid with lithium-ion	Operating since 2022	Hybrid use works; repeat orders did not follow automatically
Hydrostor Silver City	Australia	Advanced compressed air; 200 MW/up to 1,600 MWh	Approved 2025, operation targeted 2028	Grant, network contract and revenue floor combined
Storelectric TeesCAES	UK	Compressed air; 50 MW/about 1,500 MWh	Provisionally selected for cap and floor	Good site and policy support; finance and final decisions pending
LightSail Energy	US and Canada	Isothermal compressed air; demonstrations announced	Closed 2018	Venture capital without a customer or ready site was not enough

ANNEX B: UK BARRIERS IN DETAIL

The research identified six connected barriers facing first-of-a-kind LDES in the UK. Delay runs through all of them.

Policy and regulation. Electricity market rules were designed around other technologies and business models. Cap and floor addresses revenue certainty, but the timeline from confirmation in October 2024 to final awards in autumn 2026, with licence decisions after that, is long for projects carrying development costs.[16] Energy policy treats LDES as a priority while industrial policy does not yet name it as one.[35]

Finance and market design. First projects face high capital costs, long development periods, limited operating history and uncertain income all at once. Investors have raised questions about how cap and floor returns will be calculated and whether the scheme captures the full system value of long-duration technologies.[36] Some in the short-duration battery sector argue it could distort their market.[3]

Planning, permitting and grid connection. LDES projects commonly take five years or more from early development to operation.[35] Connection queues and the need for network reinforcement add to this.[37] Each year of delay adds cost before any revenue arrives.

Supply chains and skills. Transformers, switchgear and specialist cabling face long lead times. The UK depends on imported critical minerals and components, and there are

shortages of engineers and installation teams.[38] A visible, steady project pipeline would justify investment in domestic manufacturing and training.

Coordination. First projects need developers, investors, Ofgem, NESO, government departments, network companies, local authorities and communities to act in step. Each body has its own remit and timetable, and no one holds the whole delivery picture.

Communities and local value. Land use, visual impact, noise and unfamiliar technology can all generate local opposition. The ReFLEX Orkney demonstrator found that long gaps between first engagement and visible delivery strained relationships.[39] Showing local benefits through jobs, supply contracts or community investment can reduce opposition.

ANNEX C: APPROACH

The research compared six projects, three compressed air and three vanadium flow battery, chosen to cover different countries and outcomes. It used published academic work, government and regulator documents, company and project material, industry reports and media sources. Each project was assessed against the same set of technical, financial, market, policy, supply chain, organisational and community factors, drawing on the Technological Innovation Systems framework and recent LDES adoption research.[40] The sample is small and evidence on failed projects is thinner, so the findings should be read as lessons to test.

NOTES

1. Energy UK (2026), Energy UK Explains: long duration electricity storage and Ofgem's cap and floor decisions
2. Ofgem (2026), Consultation, Window 1: minded-to decisions, long duration electricity storage
3. Energy-Storage.News (2026), UK's Ofgem goes big on LDES cap-and-floor window 1
4. Cleantech Group i3 database, accessed September 2026.
5. Ofgem (2026), Ofgem boosts long duration storage to secure more homegrown energy for customers
6. Guerra, K., Welfle, A., Gutiérrez-Alvarez, R., Freer, M., Ma, L. and Haro, P. (2024), The role of energy storage in Great Britain's future power system: focus on hydrogen and biomass, Applied Energy, 357, 122447
7. NESO (2025), Britain's Energy Explained: 2025 Review
8. UK Government (2024), Clean Power 2030 Action Plan
9. Gower-Jones, B. (2025), Emerging opportunities for UK long duration energy storage, Net Zero Investor
10. Collyer Merritt, E. (2024), Long-duration energy storage: House of Lords Committee report and plans for a new scheme, House of Lords Library
11. NESO (2025), 2025 Annual Balancing Costs Report
12. House of Commons Library (2026), Gas and electricity prices during the 'energy crisis' and beyond
13. Institute for Government (2026), The UK electricity market
14. Nesta (2026), How could the UK lower its industrial electricity prices?
15. Department for Business and Trade (2026), Vision 2035: Critical Minerals Strategy
16. Ofgem (2026), Ofgem boosts long duration storage to secure more homegrown energy for customers; Ofgem (2025), LDES cap and floor application window 1
17. Ofgem (2026), Long duration electricity storage window 1: revised special licence conditions
18. Osborne Clarke (2024), 'Who's Who' in British Energy
19. National Wealth Fund (2024), Highview Power investment
20. National Wealth Fund, Energy storage in focus
21. Solar Power Portal (2026), National Wealth Fund backs £100 billion clean energy investment
22. Business Matters (2026), National Wealth Fund to double investment pace with focus on clean energy and green steel
23. Department for Business and Trade (2025), The UK's Modern Industrial Strategy; Green, M. (2025), Clean energy industries the 'frontier' in UK Industrial Strategy, Solar Power Portal
24. Sumitomo Electric (2026), Vanadium redox flow battery selected by Hokkaido Electric Power Network for the third time; Sumitomo Electric, Frequency regulation with Hokkaido Electric Power Network and Hokkaido Electric Power Network project for wind farm integration; Colthorpe, A. (2020), 51MWh vanadium flow battery system ordered for wind farm in northern Japan and (2026), Sumitomo Electric flow battery wins HEPCO's renewables integration tender, Energy-Storage.News; Cleantech Group (2026), Long-Duration Energy Storage: Policy Levers and Investment History, unpublished briefing
25. Hydrostor, Silver City Energy Storage Centre; Hydrostor (2025), Silver City Business and Industry Engagement Session; ARENA (2025), Hydrostor: Broken Hill Advanced Compressed Air Energy Storage Demonstration; Heynes, G. (2025), Hydrostor sees 1,600MWh advanced compressed air energy storage project in Australia approved, Energy-Storage.News; ICN (2024), Silver City Energy Storage Facility
26. Woody, T. (2012), Energy storage startup LightSail raises $37.3 million from Thiel, Gates, Khosla, Forbes; Bergstein, B. (2015), The energy startup conundrum, MIT Technology Review; Henderson, J. (2017), Gone like the wind, Halifax Examiner; Gupta, A. (2017), LightSail Energy enters 'hibernation', EQ International; Moreira, P. (2018), Innovacorp's $2M LightSail bet fails, Entrevestor
27. Myer, B. (2016), 200MW/800MWh energy storage station to be built with Rongke Power's vanadium flow battery, CleanTech Alliance; Na, C. (2022), World's largest flow battery energy storage station connected to grid, Chinese Academy of Sciences; Colthorpe, A. (2022), First phase of 800MWh world biggest flow battery commissioned in China, Energy-Storage.News; China Three Gorges Corporation (2025), World's first gigawatt-hour-scale flow battery project goes into operation in China

28. Invinity (2022), Energy Superhub Oxford case study; UKRI (2023), Energy Superhub Oxford project fact sheet; Azzouz, L. et al. (2023), Energy Superhub Oxford Report, Environmental Change Institute; Murray, C. (2022), Project with world's largest lithium-vanadium hybrid BESS officially launched in Oxford, Energy-Storage.News
29. Storelectric (2026), Storelectric exchanges contracts to purchase industrial land in Teesside and TeesCAES named in Ofgem's minded-to decision list; Perry, M. (2026), Charging forward: Ofgem backs 16 LDES projects, Energy Voice
30. Exchange-Rates.org, GBP to USD exchange rate history, annual averages
31. Invinity Energy Systems plc (2024), Result of Placing and Completion of £57m Fundraising
32. ACER (2022), PCI selection; European Commission (2025), Permitting schemes and process
33. Invinity Energy Systems plc (2024), Strategic Investment and Placing for a minimum £50 million
34. Shah, J. (2022), Getting to know the Loan Programs Office and (2025), LPO announces conditional commitment for long duration compressed air energy storage, US Department of Energy
35. Spyrou, E., Suski, A. and Green, R. (2026), Designing a policy mechanism for long-duration energy storage: the British experience, Current Sustainable/Renewable Energy Reports, 13(1)
36. Guinane, E. (2025), Long-duration energy storage and the UK's clean energy future, Carbon Limiting Technologies
37. Murray, C. (2026), Grid connection challenge will get worse before it gets better, UK operator says, Solar Power Portal
38. Utility Line (2025), The challenges facing the UK National Grid
39. Gooding, L. et al. (2023), The best-laid plans: tracing public engagement change in emergent smart local energy systems, Energy Research and Social Science, 101; Green, M. (2025), Regen publishes guidance for renewable development community engagement best practice, Solar Power Portal
40. Hekkert, M.P. et al. (2007), Functions of innovation systems, Technological Forecasting and Social Change, 74(4); Bergek, A. et al. (2008), Analyzing the functional dynamics of technological innovation systems, Research Policy, 37(3); Selänniemi, A., Hellström, M. and Björklund-Sänkiaho, M. (2025), Long-duration energy storage technology adoption, Energy Reports, 13, and Key considerations for securing pilot and demonstration projects of long-duration energy storage technologies, Energy Science and Engineering, 13(11)

Cleantech for UK

Thank you