UK Government

Leadership in Long Duration Battery Energy Storage

A made-in-Britain vanadium flow battery project delivering innovation on the UK electricity grid

Department for Energy Security and Net Zero (2026)

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Executive Summary

The Invinity Copwood VFB Energy Hub (“Copwood”) Long Duration Energy Storage (“LDES”) Demonstrator is a major UK project designed to showcase the role that vanadium flow battery (“VFB”) technology can play in a smarter, more flexible and secure clean power system. As the largest collocated LDES asset to be deployed in the UK to date, Copwood provides a practical demonstration of how safe, durable and longer duration battery storage can unlock the full potential of renewable generation and contribute to the wider transition to a low-carbon electricity system.

The project combines a 5.17 MW / 20.7 MWh Invinity VFB system with 3.2 MW of solar PV generation at the site near Uckfield in East Sussex. This configuration enables the project to demonstrate a range of services including multi-hour dispatch, solar firming, energy shifting and high-utilisation cycling in a real-world operating environment. It also supports the objectives of the UK Government’s Longer Duration Energy Storage (LoDES) Demonstration programme by helping to accelerate the commercialisation of innovative storage technologies capable of reducing curtailment, managing variability and improving system flexibility.

Copwood’s core value lies in its ability to move beyond desktop analysis and provide practical evidence from a commercial-scale VFB installation. The system’s four-hour rated duration, modular architecture and intrinsically safe aqueous electrolyte chemistry make it well-suited to repeated cycling and sustained output over a long operating life. Furthermore, because energy capacity and power can be scaled independently, the technology is also relevant to future projects requiring predictable longer-duration delivery, stable performance under high utilisation and flexible integration with variable renewable generation.

The project has also helped show the importance of supporting a UK battery manufacturing industry as well as strengthen Invinity’s UK manufacturing and delivery capability. Whilst Invinity had already begun expanding its UK production capacity, the development of Copwood helped accelerate the Company’s transition to a more automated manufacturing process that is enabling it to demonstrate critical capabilities as it targets much larger, commercial flow battery projects globally. Furthermore, the outcome of this project is helping to support wider clean-tech industrial objectives by building UK capability, improving supply-chain readiness and creating a replicable pathway for scaled VFB deployment.

The results of the Copwood project will set out the reasons why deploying LDES at scale from a UK manufacturer is necessary for the future UK grid and can help to provide supporting evidence of the benefits other LDES schemes, such as the Cap and Floor. Once operational, Copwood is expected to generate valuable performance, availability, cycling and renewable-coupling data that may help inform industry understanding, investor confidence and future policy thinking. More importantly, the Copwood project is a practical demonstrator of VFB capability within the wider UK LDES ecosystem, alongside other projects, market evidence and regulatory analysis.

The project's development has also produced important lessons for future deployment. The transition from an earlier partner-led concept to an Invinity-led model under direct site control improved deliverability and reduced reliance on third-party decisions. Selection of the Uckfield site, with an appropriate grid connection, a credible planning pathway and co-location with solar PV, provided a more robust basis for delivery while preserving the project's strategic purpose.

Overall, Copwood represents a significant, publicly supported demonstration of long-duration storage at commercial scale. It provides evidence of how VFB technology can contribute to renewable integration, system flexibility, operational resilience and UK manufacturing growth. The project will also make a valuable contribution to the collective evidence base needed to scale LDES deployment across the UK.

Figure 1. Invinity VFBs installed at Copwood



Initiation

Core Goals of the LoDES Funding

The Longer Duration Energy Storage (LoDES) Stream 1 Phase 1 provided the essential precursor work that enabled the Phase 2 demonstrator to proceed on a deliverable footing.

The Phase 1 outputs established the technical baseline and delivery plan that Phase 2 subsequently translated into a demonstrator project.

The Stream 1 competition was created to accelerate the commercialisation of innovative long duration storage technologies and demonstrate their system benefits, with clear objectives for the funded activities:

- The Competition aims to support first of a kind longer duration energy storage demonstrators (with a minimum discharge duration of 4 hours) to help integrate higher volumes of low carbon renewable generation into the UK energy system.
- Funding supports technologies that can deliver grid flexibility, reduce network congestion, and defer or avoid costly network reinforcement.
- The strategic purpose is to help the UK achieve a smarter, more flexible, lower carbon system by 2050, with energy storage expected to be a key enabler.

It is important to state that the key characteristics of Invinity's VFB technology - long duration, safe, and dispatchable – meant that our VFB solution was aligned with the competition from the outset.

Specific Aims and Objectives of the Funded Activities

The Competition Guidance specifies the Phase 2 project objectives under the LoDES programme. These aims define what Phase 2 was expected to deliver from initiation:

- Deliver a commercially operational MW scale VFB demonstration system.
  This forms the centrepiece of Phase 2 and is the tangible output DESNZ funded.
- Demonstrate the technical and commercial value of VFB to networks, operators, investors, and policy makers.
  This reflects DESNZ's intent to derisk emerging technologies by building evidence at scale.
- Provide a detailed cost reduction trajectory to reach TRL9 by the end of Phase 2.
  Demonstrating manufacturability, scalability, and cost down potential was a core requirement
- Accelerate Invinity's wider pipeline and attract further investment into UK LDES and green tech markets.

DESNZ expected that demonstrating VFB systems at scale would unlock commercial deployments.

- Lower the long-term cost of resilient, reliable, zero carbon electricity.
  This links the demonstrator directly to the UK's Net Zero trajectory.

These objectives explicitly guided the initiation and early design stages.

Key Deliverables at the Outset

The Work Package breakdown provides a clear list of deliverables expected from the project:

WP1 – Final Approvals

At initiation, the project was required to:

- Secure internal and regulatory approvals to proceed (including planning and land access).
- Achieve Partner board approval (for the originally partnered model).
- Complete grid connection works, demonstrating the site was viable.

Though the partnership arrangement later changed, these were the originally defined requirements at project launch.

WP2 – Final Design Documentation

Upfront deliverables also included:

- Final system layout, including site design, electrical schematics, and interconnection requirements.
- A Critical Design Review (CDR) ensuring the design met technical and commercial requirements.
- Release of the final Bill of Materials (BoM) - a critical stage gate for manufacturing.

These early documentation deliverables ensured the project was technically robust and ready for manufacture.

WP3 – Procurement of Major Components

At initiation, the programme required Invinity to:

- Begin procurement of VFB components;
- Secure orders for PCS and other long lead time equipment; and
- Tender for civil, electrical, and siteworks packages - sign an EPC Contract.

This frontloaded procurement approach was intended to keep the project on schedule given long lead times.

Project Evolution

The LoDES Phase 2 project evolved through a series of clear decision points as Invinity moved from an initially partner-led demonstration model to a fully Invinity-led project. This evolution was driven by a combination of partner, market, regulatory and site-specific factors, with each change made to preserve deliverability and maintain the project's core strategic purpose.

Phase 1 Foundation

LoDES Stream 1 Phase 1 provided the essential precursor work that enabled Phase 2 to proceed on a deliverable footing. During Phase 1, Invinity completed the:

- Front End Engineering Design (FEED)
- Product Design Report
- Mobilisation Report

The milestones established the technical baseline and delivery plan that Phase 2 subsequently built upon.

Original Phase 2 Approach

At the outset of Phase 2, Invinity proposed a 6.4 MW / 25.8 MWh vanadium flow battery demonstrator at a National Grid location. The original model relied on external delivery partners and was intended to provide a route to deployment at commercial scale.

Why the Original Model Changed

As the project progressed, the original delivery route became increasingly difficult to maintain. The project was affected by a combination of market, regulatory, partner and site-specific challenges, and Invinity was ultimately unable to reach binding terms with the earlier proposed partners. This meant that the original structure no longer provided a reliable basis for delivery.

A major turning point came in late 2024, when a key partner withdrew its planned participation following an internal strategic shift towards projects larger than 300 MWh. After a prolonged period of negotiation, this withdrawal meant the existing delivery model was no longer viable and a revised approach was required.

Shift to an Invinity-led Model

In response, Invinity reassessed the project structure and chose to pursue full project ownership and leadership. The rationale for this shift was to reduce dependency on third-party

investment decisions and site control, while giving Invinity direct responsibility for development, delivery and programme management. This transition was supported financially by capital invested via the National Wealth Fund.

Revised Scope and Site Selection

By March 2025, Invinity had submitted and obtained approval for a revised project. The updated scheme was resized to 5.17 MW / 20.7 MWh, fully owned and delivered by Invinity, and relocated to Uckfield in East Sussex. This change was a deliberate optimisation of the project around a site with viable grid access, planning potential and direct Invinity control, creating a more robust basis for successful delivery.

Outcome

Taken together, these changes reflect a pragmatic evolution from a larger, partner-dependent concept to a slightly smaller but more controlled and deliverable project. While the structure, scale and location changed over time, the central objective remained consistent: to deliver a commercially relevant vanadium flow battery demonstrator capable of evidencing the value of long-duration energy storage in the UK.

Site Selection

The project's move to a new site followed directly from the wider restructuring described above. Once the original partner-led delivery route became unviable, Invinity needed to identify a site that could support an independently delivered project while still meeting the objectives of the LoDES demonstrator. Site selection therefore became a critical step in restoring programme certainty and establishing a practical route to delivery.

Need for a New Site

The original intention had been to deploy the system at a development partner-controlled site in Scotland. That option fell away when the partner's priorities shifted toward much larger energy storage projects, meaning the demonstrator no longer had a dependable route to delivery at that location. Invinity therefore needed to identify a new site that it could control directly and progress within the remaining programme timeframe.

Criteria Used to Assess Alternative Sites

With that in mind, Invinity assessed alternative locations against a clear set of practical criteria. The replacement site needed to be capable of being brought under direct Invinity control or ownership, to have a viable grid connection, and to offer a planning route that would support delivery within programme deadlines. These criteria reflected the key lessons from the earlier delivery model: reducing dependency on third parties and selecting a site that was already aligned with the technical and regulatory needs of the project.

Selection of Uckfield

Several sites were assessed in parallel during December 2024 and January 2025. Following that review, Invinity selected the Uckfield site in East Sussex because it offered the strongest combination of grid readiness, planning potential and direct project control. This made it a more robust option than previously considered sites and provided a clearer basis for delivery under an Invinity-led model.

Why Uckfield was Chosen

Uckfield stood out for four main reasons.

1. First, it had an existing import/export grid connection with 5.5 MW capacity, which aligned closely with the revised project size and avoided the additional time, cost and uncertainty associated with reinforcement works or an oversized connection. This allowed the system to be resized to 5.17 MW / 20.7 MWh in a way that matched the

site's practical constraints while preserving the demonstrator's core purpose – a 4hr LDES system.

2. Second, the site already had planning permission for a solar-plus-BESS scheme, creating a credible route to progress the project through a minor amendment from lithium-ion technology to vanadium flow batteries rather than through a wholly new planning application. That significantly reduced planning risk and supported a faster route toward delivery.
3. Third, the site could be brought under direct Invinity control through a lease arrangement. This was a decisive advantage because it removed the dependency risk associated with partner-owned land and allowed Invinity to take full responsibility for development sequencing, procurement and delivery.
4. Fourth, the location offered the additional benefit of co-location with a separately developed solar PV array. This strengthened the overall demonstration case by combining long-duration storage with onsite renewable generation and giving the project a more visible role as a flagship UK LDES installation.

Planning Progression at the Selected Site

The planning route at Uckfield progressed because the case for vanadium flow battery technology was strong and clearly evidenced. The transition from lithium-ion to VFB technology was supported by the technology's lower fire risk profile, lower overall noise levels and UK manufacturing credentials, all of which helped create a positive basis for engagement with the planning authority and stakeholders. Invinity also engaged proactively with local stakeholders, including presenting the technology and project to Uckfield Town Council, which helped build confidence in the revised scheme.

Although the planning timetable extended beyond the earliest expectation, the main issue related to flood and drainage review across the wider site rather than any fundamental concern about the battery technology or the suitability of the location. As a result, planning remained a manageable residual risk rather than a strategic barrier to the project.

Outcome of the Site Selection Process

The selection of Uckfield marked the point at which the project moved from an uncertain, partner-dependent site pathway to a location that was technically, commercially and operationally aligned with an Invinity-led delivery model. By choosing a site with suitable grid access, an achievable planning route, direct land control and renewable co-location potential, Invinity created a stronger and more deliverable basis for the demonstrator while maintaining the strategic purpose of the project.

Figure 2. (Left) Overview render of site. (Right top and bottom) Pictures showing site entrance off main road



Programme Assurance and Site Approval

As part of the funding programme's assurance and risk management arrangements, the revised site and project approach were independently reviewed and confirmed as suitable following the project's restructuring. This constructive assurance process helped provide confidence that the new site offered a deliverable route to construction and operation within the remaining programme timeframe.

Development

The Development phase of the Uckfield LoDES Phase 2 project focused on transforming the revised project scope into a fully deliverable, technically robust and commercially viable large-scale vanadium flow battery installation. Following approval of the revised project in early 2025, Invinity progressed multiple parallel workstreams spanning planning, engineering, procurement, manufacturing, grid readiness, and site preparation. The project matured significantly during this phase, with most critical risks either eliminated or substantially reduced.

Figure 3. Final site layout showing PV (grey) and VFBs (white)



Progression of Planning and Regulatory Activities

A major component of the development stage involved securing approval for the required Minor Material Amendment (MMA) to transition the site's existing planning permission from lithium-ion to vanadium flow technology. The planning amendment was submitted and negotiated during the March to July 2025 period, with consultation feedback indicating no fundamental issues with the proposed technology change.

The Planning Officer confirmed the amendment was supported in principle and could be determined under delegated powers, avoiding the need for committee reconsideration - substantially reducing programme risk.

Although final approval was delayed beyond the initial June 2025 expectation, the delay was attributed mainly to the council's review of flood related drainage design information for the whole site rather than any concerns with the technology or site suitability. Planning approval remained highly likely throughout this period.

The planning process therefore continued to progress as a controlled, residual risk rather than a critical blocker, with mitigations in place to adjust procurement sequencing, enhance resource deployment following approval, and manage downstream schedule compression if necessary.

Advancement of Grid Connection Works

Grid connection activities progressed during the development stage, with the 5.5 MW grid connection offer fully accepted and contracted, associated payments made, and the Distribution Network Operator (DNO) actively developing the final design and build programme.

With the connection confirmed and no remaining technical barriers identified, grid readiness - initially a material risk - was eliminated as a critical dependency for the project.

Procurement and Supply Chain Development

Procurement activities matured significantly during the development stage. Long lead items such as power conversion systems (PCS) and transformers had confirmed lead times and supplier quotations in place, with no challenges identified.

Invinity adopted a risk-aware procurement strategy, placing advance orders for non-site-specific components to maintain the manufacturing schedule, while engaging with suppliers to hold production slots for site-dependent items pending planning approval. This ensured the project remained aligned with funding milestone requirements and avoided procurement driven delays.

Battery Manufacturing and Production Readiness

Manufacturing formed a major portion of development progress. The Invinity UK facilities at Bathgate and Motherwell were actively producing the cell stacks and VS3 flow battery units, with all materials fully ordered. The company confirmed that manufacturing activities were unaffected by the planning process, enabling production to proceed in line with the revised delivery schedule.

Production capacity enhancements - including increased stack line resources and semi-automation - expanded throughput by a factor of four over previous capability, enabling the

new Motherwell facility to handle eighteen batteries simultaneously and ship at a rate of up to five units per week (with pre-assembly factories scalable to ten units per week).

Battery manufacturing was not a critical path item during development, with resource allocation able to flex to suit other project dependencies.

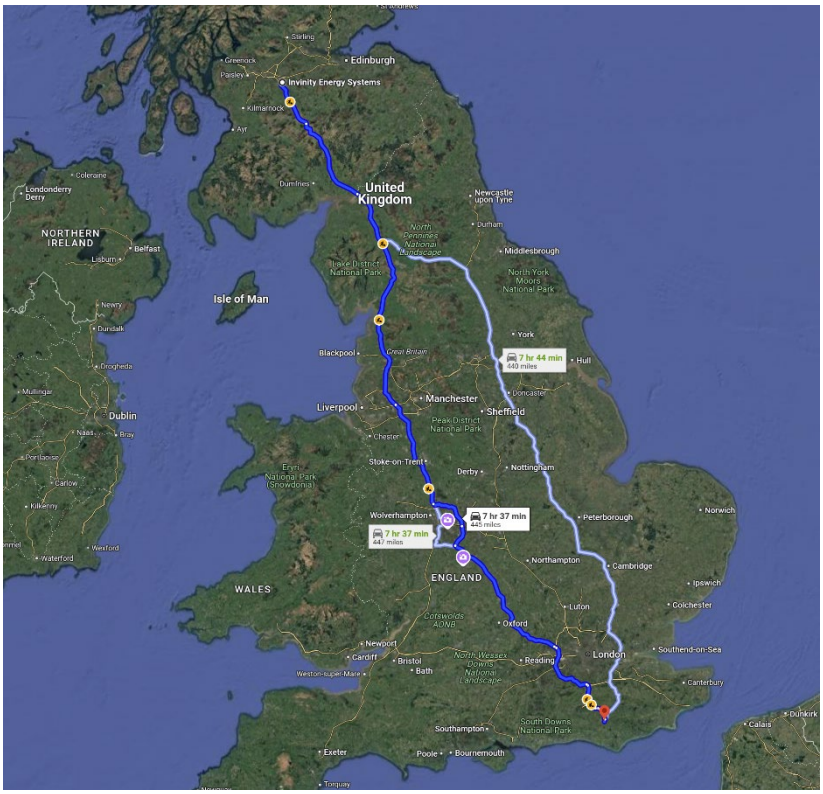
Site Works and Installation Planning

Invinity progressed detailed preparations for site works, engaging with several EPC partners and developing an accelerated installation methodology leveraging internal field-service expertise. The installation plan was designed to “frontload” resource, allowing rapid mobilisation as soon as planning was approved.

The company’s global experience – covering 100 VFB projects at increasing scales internationally - provided confidence that site activities could be delivered efficiently and to schedule.

Site works were structured to allow extensive parallelisation, reducing overall schedule sensitivity. Prefabrication activities were planned wherever possible to minimise onsite durations, while logistics partners were already prepared to support staged battery deliveries from Scotland.

Figure 4. Map showing typical route from Invinity’s Motherwell factory to project site



Commissioning Strategy and Operational Preparation

The commissioning strategy developed during this phase enabled significant time compression. The system was designed around two independently controlled battery groups, allowing commissioning of the first battery clusters to begin before installation of the second group was complete. This approach reduced the overall commissioning duration materially compared with previous Invinity projects.

Commissioning activities would be supported by both UK-based and international Invinity teams, enabling near round the clock progress through remote and onsite operations.

Risk Management and Schedule Assurance

The development phase was underpinned by robust risk analysis. Many early risks - including land acquisition, grid connection, and board approvals - were fully eliminated by mid-2025.

The planning amendment’s approval timing was identified as the primary remaining schedule risk. However, the project retained significant buffer due to highly parallel workstreams, allowing for minor to moderate delays without jeopardising the March 2026 completion date. Only a delay beyond 12 September 2025 would materially threaten overall completion, primarily affecting procurement of site-specific equipment such as the PCS.

Mitigation strategies - such as increasing installation resources, negotiating shorter lead times with suppliers, and leveraging prefabrication - were established to protect the schedule under multiple delay scenarios.

Financial Position and Cost Stability

The project’s overall cost estimate remained at £20 million, with high-confidence cost elements covering materials, logistics, grid works, planning, installation, and commissioning. Only EPC-related works (foundations, access) carried medium range uncertainty pending final quotations.

Cost forecasts therefore remained stable, with adequate controls and contingency options in place should external funding uncertainty persist.

Delivery

The Delivery phase of the Uckfield LoDES Phase 2 project marks the transition from preparatory development activity into full onsite execution, battery deployment, system integration, and commissioning. By the time planning approval was secured on 31 July 2025, the project had already positioned itself for a rapid move into physical delivery through parallel manufacturing, EPC mobilisation, and grid-related readiness activities developed during the preceding months.

Transition From Development to Delivery Following Planning Approval

Planning approval represented the final major external dependency on the critical path. Once the Minor Material Amendment was approved on 31 July 2025, Invinity initiated the transition into delivery immediately, beginning with the discharge of the planning conditions associated with the consent. Of the six key conditions, one had already been discharged by August, with drainage (the only condition triggered prior to battery installation) identified as the primary focus for early delivery sequencing.

The planning approval also unlocked progression against post-consent funding milestones associated with manufacturing evidence and site mobilisation, confirming that both regulatory requirements and programme assurance checks were satisfied to advance into full delivery.

Figure 5. Invinity VFBs having undergone final manufacture and FAT at Motherwell prior to delivery to site



Battery Manufacturing and Readiness for Deployment

Throughout 2025, battery manufacturing continued without interruption at Invinity's Bathgate and Motherwell facilities, as well as across the offsite supply chain. By May all purchase orders for battery materials were placed and progressing through the production workflow. By September, activities had advanced further, with VS3 assembly, preassembly, and FAT progress fully aligned to delivery timelines. This manufacturing stability was a deliberate outcome of the development strategy: process parallelisation, supplier slot reservations, and upfront procurement ensured that manufacturing was not a critical path dependency.

The completion of battery manufacturing batches directly supported eligibility for subsequent manufacturing-based funding milestones.

EPC Engagement, Site Preparation and Mobilisation

EPC engagement evolved significantly in the leadup to delivery. In May 2025, the EPC was in the process of finalising scope of supply and budget estimates. By August, the EPC contract was in final negotiation, with the EPC reporting readiness to begin onsite activities in October 2025.

Figure 6. Invinity VFBs being craned into position on screw pile foundations at site

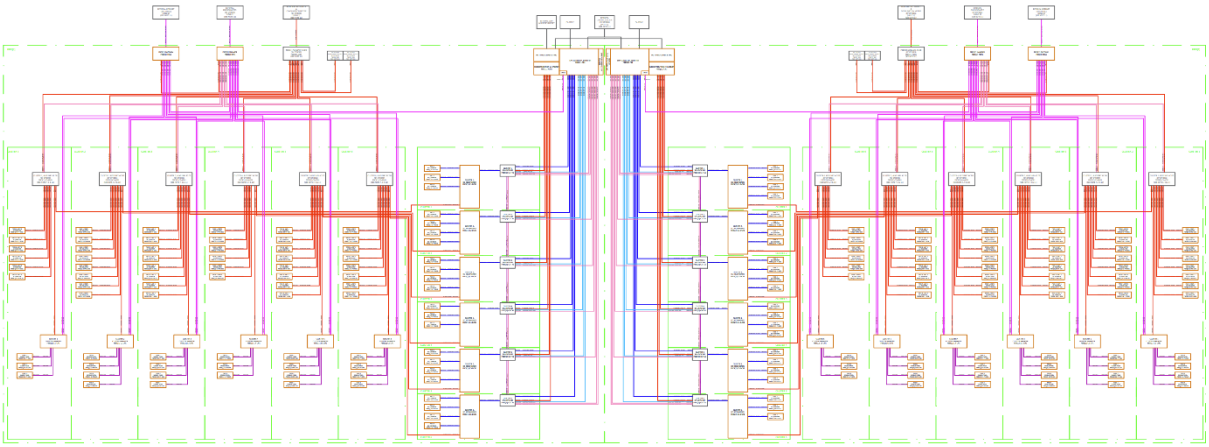


This reflected key delivery phase progress:

- A final site works plan was prepared, incorporating access, welfare, screw pile foundations, and trenching for electrical systems.
- Electrical and site design packages had matured sufficiently to support procurement and ordering of major equipment.

- PCS units, transformers, and switchgear – long lead items critical for energisation - had been fully ordered immediately after planning was secured.
- EPC related design integration (site layout, equipment placement, cabling routes) proceeded in parallel with the planning condition discharge process, positioning the project for accelerated mobilisation post-approval
- Early engagement with the EPC on installation scope and schedule optimisation, demonstrating that site readiness planning had been underway for several months prior to the delivery phase.

Figure 7. System architecture drawing showing how the overall site is connected.



Grid Connection Delivery and Integration Works

Grid connection readiness achieved during development carried directly into the delivery phase. By April 2025, all grid-connection steps - contract acceptance, payments, and evidence submission to the funding body - had been fully secured. Progress reports confirmed that all payments continued to remain up to date with the DNO schedule, with no risks or slippage recorded.

This enabled onsite electrical works - MV/LV cabling routes, switchgear placement, and integration with EPC schedules - to proceed as soon as civil works commenced in October.

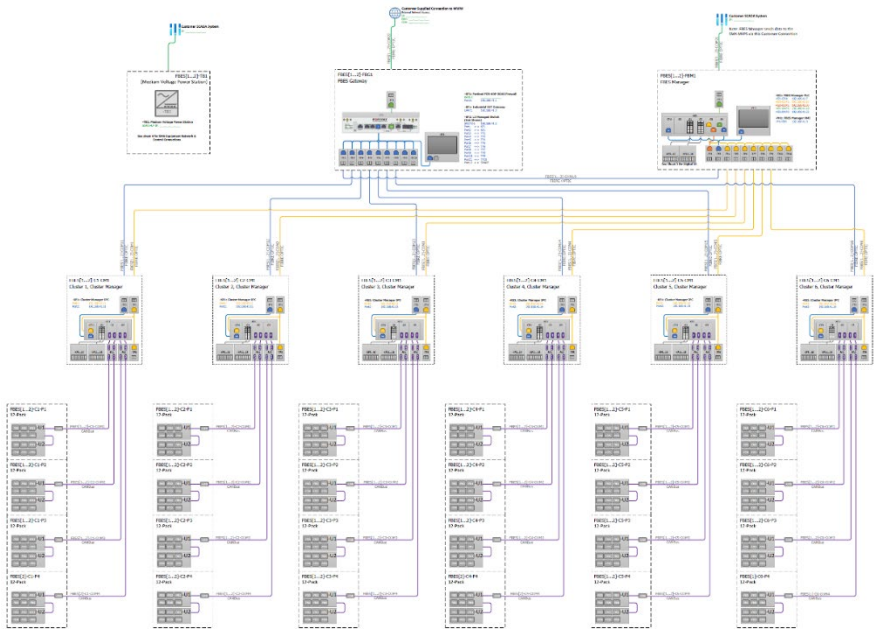
Delivery Risks and Mitigations

Risk levels entering the delivery phase were low, reflecting the extensive mitigation undertaken during development:

- **Planning Conditions:** Although now resolved in principle, the remaining risk relates solely to timing of condition discharge, primarily around drainage. Mitigation – early and direct coordination with the council - had already been implemented and this condition was discharged in November, prior to battery arrival on site. In parallel, archaeology and site emergency response plan related conditions were mitigated.

- **Site Works:** Initial site readiness risks noted in development diminished significantly through early EPC engagement, scope definition, and resource planning. Progress reports show this risk reducing to “Very Low.”
- **Procurement:** All major equipment Purchase Orders were placed and progressing, eliminating any material schedule threat from long lead items. The May 2025 progress report formally marked procurement risk as resolved.
- **Programme Risk:** Progress reports reconfirm no schedule change and continued on-track performance against the overall delivery – to March 2026 target.

Figure 8. Network diagram showing VFB communication and control.



Forward Delivery Plan

By the end of August 2025, the project had established a clear, structured path through the remainder of delivery:

- Complete discharge of planning conditions
- EPC mobilisation and start of onsite works in October 2025
- Install batteries progressively as ground works conclude and manufacturing batches are completed
- Begin phased commissioning of battery groups (Group 1 commissioning begins before Group 2 installation completes, as planned in the commissioning strategy)
- Achieve first energisation and proceed through functional testing
- Full system delivery by March 2026, consistent with the final funding milestone and programme end date

Lessons

With no contractual or contextual filter between the company and the project, Invinity was exposed to a multitude of opportunities to improve the company knowledge base and increase wider market intelligence and awareness.

The move to the site at Uckfield – now formally named the Invinity Copwood VFB Energy Hub - and the subsequent pursuit of the project under one company banner served to strengthen this position.

Key areas of the project development cycle became milestones for Invinity not only to understand, but frequently to own and drive forward.

Planning Approval Process

A central lesson from the Uckfield experience is that planning risk can be actively converted from a potential blocker into a controlled, low-volatility activity by assembling a robust, evidence-led case early and pairing it with independent validation.

The Minor Material Amendment (MMA) advanced smoothly because the technical case for shifting from lithium-ion to vanadium flow batteries (VFBs) - lower fire risk, lower noise, and UK-manufactured equipment - was clearly articulated and traceable for officers and consultees, which improved confidence and reduced contention points during determination. Invinity took any opportunity to engage with local stakeholders, including via a presentation of the technology and project to Uckfield Town Council.

Where delay did occur, it was due primarily to the council's need to review flood-related drainage information rather than any objection to the technology or site fundamentals - teaching us to front-load technical condition work (e.g. drainage) in parallel with the MMA so that residual planning conditions do not become schedule-critical later.

For future projects, Invinity are preparing a planning readiness pack, containing:

- Technology safety dossier – third party safety justifications and risk assessments for our products.
- Acoustic modelling information for noise assessments, and control optimisation to reduce noise further.
- Further evidence to support the intrinsically safe nature of VFB's chemistry
- Supporting material to evidence UK manufacturing credentials

Grid Connection

The grid connection strategy underscores the value of selecting sites with an accepted offer that aligns precisely to the optimised system size, then moving swiftly to acceptance and payment to remove a major execution risk at source. In Uckfield, the pre-existing 5.5 MW offer was well matched to the revised 5.17 MW / 20.7 MWh design, which limited the need for reinforcement, shortened lead times, and materially reduced regulatory exposure; this alignment was a decisive factor in site selection and ultimately de-risked the delivery phase.

By securing, contracting, and paying the connection early - and by maintaining schedule integrity with the DNO - grid readiness as a critical dependency risk was eliminated before construction commenced. This readiness translated directly into a smooth handoff to delivery, with MV/LV integration able to proceed alongside civil works without slippage.

Lesson: treat the grid as an early “gate” and make capacity-to-design matching a non-negotiable site criterion; once secured, commit to regular DNO cadence checks and evidence capture so that grid dependencies never re-enter the critical path.

Leasing and Land Acquisition

Control of land rights is a primary schedule and governance lever, not an administrative afterthought. After experiencing delays and dependency risks on partner-controlled sites, shifting to Uckfield allowed Invinity to secure land control via lease and assume full responsibility for development sequencing, thereby removing late-stage sign-off risk from third parties.

The earlier loss of the site in Scotland when the partner changed priorities reinforced this lesson: where the sponsor lacks direct control, seemingly minor commercial shifts elsewhere can cascade into major programme resets. Land control was also a required funding milestone - reinforcing that clarity on access, rights, and obligations is foundational to both risk management and funding drawdown.

Lesson: open land negotiations early, standardise rights-of-access and step-in clauses, and pre-clear title and easements before locking procurement so that site control cannot become a hidden critical path item.

Site Design

Early investment in complete, integrated design documentation pays back through fewer late changes and smoother transitions into procurement and EPC mobilisation. At initiation, final layouts, electrical schematics, and a Critical Design Review ready package provided a robust technical baseline, ensuring that downstream manufacturing and ordering could proceed with confidence.

During development, maturing site and electrical design packages in parallel enabled timely ordering of major equipment and gave the EPC the information needed to plan early civil and electrical works without rework. Importantly, optimising the design to a 20.7 MWh configuration that fit both land and grid constraints helped contain cost and schedule risk while preserving performance objectives.

Lesson: frame site design as a “constraints-led architecture” exercise: lock external constraints (land, grid, planning) early, design to those guardrails, and use the CDR to freeze interfaces so that procurement and construction aren’t destabilised by late technical shifts.

EPC Engagement and Management

Engaging the EPC as a strategic delivery partner - well before contract signature - proved critical to compressing time from planning approval to mobilisation. Scope definition, cost refinement, and schedule optimisation were advanced during development, allowing the team to move quickly in the weeks following consent rather than spending months renegotiating terms or redefining interfaces.

Because design integration work on layout, equipment placement, and cabling routes was already at a mature stage, the EPC could sequence civil and electrical works for an October 2025 start, supporting an orderly ramp of site activity. This pre-enablement meant planning approval was not just a document milestone but an actionable trigger for resources and spend.

A perfect example of this was the evidence-based pivot from concrete foundations to steel screw piles, allowing the batteries to be installed without using any concrete at all.

Not only did this drive carbon emissions for the foundations down by 80%, it increased deployment speed. The screw piles for all 90 batteries were surveyed, drilled and completed in less time than concrete would take to cure. This dramatically cut site civil works time and meant the batteries could be delivered sooner and civils works could proceed far more effectively.

Figure 9. Screw pile foundations installed



Lesson: establish a partner EPC early. Lean into opportunities for innovation, run constructability reviews, align on measurable site-start conditions, and pre-stage subcontracts and long-lead items so that final approval unlocks execution and not further negotiation.

System Architecture

Architecture choices should directly enable delivery velocity, commissioning efficiency, and operational robustness - not merely nameplate performance. The project's technical basis was established through FEED and Product Design in Phase 1, aligning requirements and manufacturability and creating a credible pathway from concept to build. A pivotal architectural decision - the two-group battery arrangement - allowed commissioning to begin on the first group while installation of the second group proceeded, materially shortening the overall commissioning timeline. Sizing the system to 5.17 MW / 20.7 MWh in response to the land and grid constraints at Copwood preserved the project's strategic intent while ensuring deliverability.

Lesson: drive commissioning requirements and deliverability under constraints as first-order architecture criteria; where possible, favour modular topologies that allow phased energisation, parallel work-fronts, and clear isolation boundaries for testing and safety.

Figure 10. Invinity VFB craned onto screw pile foundations



Site and System O&M

Designing for operations and maintenance begins at concept stage and is reinforced through technology choice, layout, and access planning. Invinity's global delivery experience (to almost 100 projects internationally) informed installation planning and will inform O&M practices, providing a tested playbook for reliability, spares, and field procedures. The intrinsic characteristics of VFB technology - no thermal runaway risk, modular design, lack of degradation, in-built bunding and lower noise - translate into practical O&M advantages, easing planning concerns, simplifying safety case management, and reducing lifecycle interventions compared to lithium-ion. Additionally, civil and electrical design decisions (equipment placement, access routes, cabling corridors) were developed with maintainability in mind, setting up efficient long-term operations.

Lesson: Carry out an O&M design review alongside CDR: validate access, lifting paths, isolation points, remote diagnostics, and spares strategy upfront so that operational reliability is engineered in wherever possible.

Route to Market and Energy Optimisation

Commercial success depends on designing the asset to participate flexibly across value streams while visibly demonstrating system-level benefits. Co-location with an adjacent solar PV array strengthens the LoDES demonstrator case by enabling energy-shifting, self-consumption optimisation, and potential revenue stacking, improving headline economics and policy relevance. The programme's objective to evidence the commercial and technical value of VFBs to operators, networks, investors, and policymakers guided the project's data, integration, and demonstration strategy from the outset, positioning Uckfield as a market-shaping reference. More broadly, LDES is expected to support a smarter, lower-carbon system by integrating more renewables and reducing reinforcement needs, so designing SCADA, control, and metering to expose flexibility services is essential to monetise capability.

Lesson: make market-readiness a technical requirement. Build in dispatchability, forecasting, telemetry, and compliance interfaces in parallel with the physical system so the plant can immediately access available markets as they become available.

Revenue Stacking and Commercialisation Pathway

Invinity Copwood demonstrates how long-duration assets can be operated as multi-service infrastructure rather than single-use projects. In practice, the system can be scheduled to stack complementary value streams across time horizons, for example; optimising solar capture and export (energy shifting) while also positioning capacity for flexibility services. The demonstrator's SCADA, metering and control integration are therefore not only technical enablers but commercial enablers: they provide the audit-grade operational evidence required to validate dispatch performance, availability, and utilisation patterns that underpin bankable revenue forecasts. In doing so, Copwood acts as a reference plant to support repeatable

project development, customer contracting, and future financing discussions for scaled VFB deployments.

Outcomes

System-level Demonstration Aligned to UK Clean Flexibility Priorities

As a DC-coupled, collocated, grid scale vanadium flow energy storage system, this project delivers a first-of-a-kind UK long duration battery demonstrator as per LoDES requirements at commercial scale, supporting the UK's goal to build a smarter, more flexible power system and the Clean Flexibility Roadmap focus on scaling both short and long duration flexibility by 2030. The project also supported innovation in key manufacturing processes (including the creation of a bespoke semi-automated stack line) that help to rapidly increase production at lower cost. Furthermore, it is the largest battery of its kind (non-lithium) in Europe, to date.

Invinity's 5.17 MW / 20.7 MWh VFB, co-located with 3.1 MW of solar, provides evidence on energy shifting, solar firming, curtailment reduction and multi-hour dispatchability that can help inform the LDES Cap and Floor Scheme and the wider long-duration storage market framework. This aligns the demonstrator's purpose (prove multi-hour flexibility and whole system benefits) with the UK's clean power ambitions and emerging LDES policy and market arrangements.

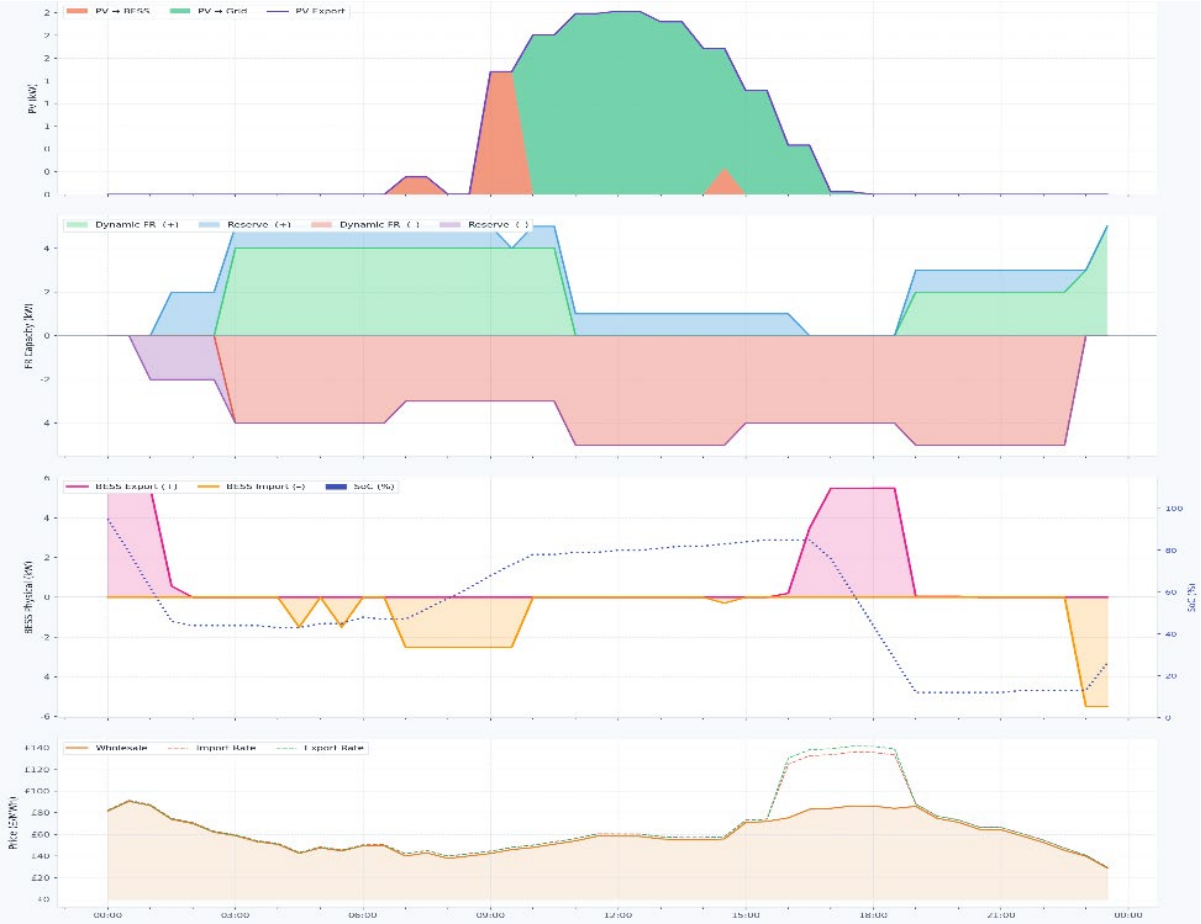
UK Manufacturing and Innovation Outcomes

The project has established a scalable domestic manufacturing baseline for flow batteries - quadrupling throughput and enabling simultaneous build of over 18 battery units at a time - supporting wider UK objectives to accelerate commercialisation and crowd in private investment around domestic supply chains. By proving repeatable build and FAT processes de-linked from planning dependencies, the programme demonstrates how publicly supported demonstrations translate into durable industrial capability and export-ready know-how, consistent with the UK's focus on jobs, growth and decarbonisation.

Market and Policy Insights to Inform LDES Policy Development

Operational, trading and performance data from a multi-hour asset co-optimised with onsite renewables can feed directly into the evidence base behind the LDES Cap and Floor Scheme and wider policy development (e.g. market access, system visibility, and planning interfaces). In particular, the site will generate real world insight on stackable revenues, grid services and flexibility roles for LDES across the seasonal demands placed on the energy system that complement wider scenario work and Ofgem's technical decision framework, arriving as Ofgem reaches the conclusion of the assessment phase of the first window of the cap and floor pipeline.

Figure 11. 1st March modelled energy trading snapshot



Expected Operational Value and Real-World Use Cases

In operation, Invinity Copwood evidences how multi-hour vanadium flow batteries deliver practical value under real grid constraints: shifting energy from periods of high renewable output to peak demand, reducing renewable curtailment, and supporting local and system balancing needs without the thermal runaway risk profile associated with some alternative chemistries. Co-location with solar PV also enables direct measurement of renewable firming benefits and the operational trade-offs between exporting, charging, and holding reserve for later dispatch, such as:

- Solar firming and time-shifting to increase the proportion of onsite renewable energy exported during higher-value periods.
- Multi-hour dispatch for peak shaving and evening peak support, demonstrating predictable duration delivery at rated power.
- Curtailment reduction by absorbing excess generation during constrained periods and releasing energy when network headroom returns.
- Provision of flexibility services where suitable (subject to market access and compliance), using dispatchability, telemetry and control integration to evidence operational performance.

- System learning use case: generating availability, response and cycling datasets to inform investor confidence, policy design, and future scaled deployments.

Replicable Delivery Model that Retires Key Risks and Strengthens Public Value

The programme shows a scalable delivery pattern: choose sites with accepted grid capacity, secure planning through evidence led technology substitution (VFB for Li-ion), parallelise manufacturing and EPC, and track progress against staged, verifiable delivery milestones.

Market Awareness and Stakeholder Engagement

As part of the LoDES programme, successful grant applicants are required to promote the awareness of their technology. Throughout the LoDES project, Invinity have actively promoted the benefits of our VFB technology through social media, attendance at events and engagement with local MPs and other government organisations.

Below are just a few of the many promotional activities Invinity have undertaken to achieve wider industry knowledge and awareness of VFB technology for LDES applications:

1. Multiple conferences (across the UK, Europe, USA, Canada and Asia), such as:
    a. Solar and Storage Live (UK)
    b. RE+ (USA)
    c. India Energy Week (India)
2. Hosted visits at our Bathgate and Motherwell factories, including:
    a. Secretary of State for Scotland (see Figure 11)
    b. UK Energy Minister
    c. UK and Scottish Government Ministers
    d. National Wealth Fund (formerly UKIB)
    e. GB Energy
    f. Department for Business and Trade (with delegates from Hungary, Bulgaria, Poland and other neighbouring countries)
3. Participated in press interviews, including:
    a. ITV news (see Figure 12)
    b. Channel 4 news (see Figure 12)
    c. The Times, Sunday Times and the Guardian (see Figure 13)
4. Participated in many other media streams, including:
    a. LinkedIn
    b. X.com
    c. Podcasts

   d. Energy Newsletters

5. Consistent Engagement at highest levels in UK governments (see Figure 14):
   a. UK Government
   b. House of Lords
   c. Scottish Government
6. Active participation in LDES groups
   a. LDES Council
   b. International Flow Battery Forum

Figure 11. Secretary of State for Scotland visit (January 2026)

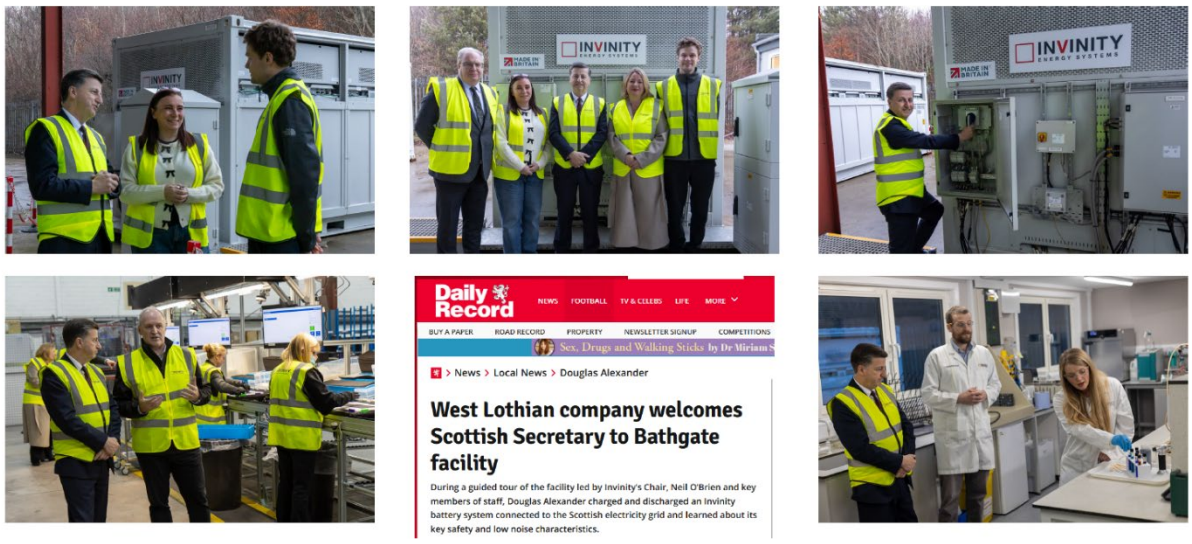


Figure 12. Invinity broadcast press coverage on ITV and Channel 4

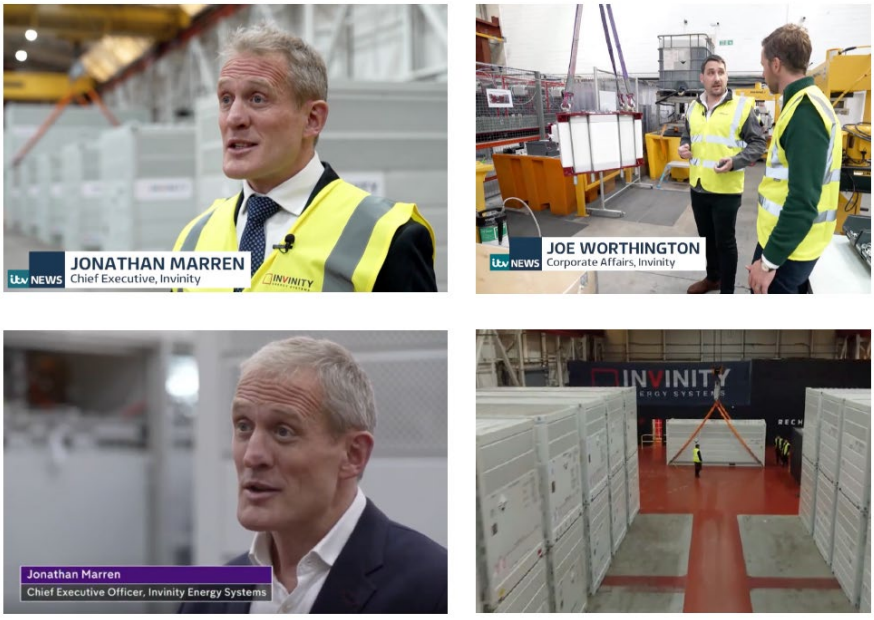


Figure 13. Invinity press coverage in The Sunday Times and the Guardian



Figure 14. Invinity engagement with UK Government, National Wealth Fund and House of Lords



Above: Invinity Chair Neil O'Brien and CFO Adam Howard with Kirsteen Sullivan MP (Bathgate and Linlithgow)

Below: Extract from NWF launch video (left) and NWF CEO Oliver Holbourn (right) in front of Invinity's stand at the reception

These engagement and awareness efforts aim to:

- Increase awareness of the company and the technology
- Secure more projects in a competitive commercial environment
- Increase volumes to UK manufacturing locations
- Continue to improve competitiveness in the global energy storage marketplace
- Capitalise on successful projects, expansions and innovations.

Next Steps

Operational Data Capture and Integration into Flexibility Evidence Base

The immediate next step is to transition from construction to operation of the site.

Once operational, the project will begin generating the performance, cycling, availability and renewable coupling data identified as essential for building the evidence base behind clean flexibility and long duration storage under the Clean Flexibility Roadmap.

This operational dataset will contribute to Invinity's ongoing analysis of how our LDES technology supports system balancing, enables higher renewable penetration and reduces curtailment, reflecting themes highlighted in wider system modelling and the Clean Flexibility Roadmap.

Preparation for Participation in the LDES Cap and Floor Investment Framework

As the Copwood system moves toward full operation in 2026, Invinity will continue to provide ongoing support to its developer customers that have submitted projects into Ofgem's Cap and Floor Scheme using our Endurium VFB technology - a mechanism designed to unlock investment at scale and support the deployment of innovative storage technologies across the UK.

The first application window opened in April 2025, with 77 projects securing eligibility status and advancing to detailed assessment. Notably, 21 of these 77 projects, totalling 16.7 GWh, have selected Invinity's vanadium flow battery technology, reflecting the suitability of Invinity's technology for the scheme and underlining Invinity's strong market position within the emerging cap and floor framework.

Building on the Invinity Copwood project demonstrator status, Invinity aims to become one of the early, large-scale VFB candidates for a cap and floor determination, strengthening investor confidence and supporting national ambitions for multi-GW LDES deployment by 2035.

Scaling, Replication and Contribution to a National LDES Deployment Pathway

The final strategic step is to use the Uckfield demonstrator as the reference model for replication - supporting wider system goals, including expanding flexibility capacity by 2030 and building domestic low-carbon storage supply chains. Lessons from planning, grid selection, manufacturing throughput, integration with solar generation and EPC mobilisation

could be consolidated into a replicable delivery framework shared with policymakers, regulators and industry partners.

This could inform both the Clean Power 2030 Action Plan and future LDES deployment scenarios, which emphasise the need for long-duration flexibility to enable renewable dominance and reduce dependence on fossil-fuel backup.

In parallel, Invinity will explore additional UK sites with grid-ready characteristics similar to Uckfield, leveraging the demonstrator's performance results to accelerate future project approvals, commercial partnerships and supply-chain growth consistent with the UK's net-zero innovation ambitions.

Continuous Development of the Product

As part of Invinity's continuous development we are already working on the roadmap for future improvements to not only meet the demand of broader market applications but also to drive down product cost to increase marketability through reduced Capex & Opex, reduced installation costs, whilst also improving other key features such as improved availability and product lifespan.

Increasingly, customers are looking for a storage product that can match the lifespan of the renewable energy system it sits alongside, and this is an area that VFB's can excel in.

In 2026, Invinity will commission more energy storage (by capacity) than it has deployed across the world to date and we forecast demand to continue to increase exponentially as countries strive to meet their environmental and sustainability targets.

Figure 15. Two image renders of the next generation of Invinity VFB: Endurium (images credit: utu design)





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