Long-Duration Energy Storage (LDES) Units

ANMD-MRS17-168 · Energy Storage & Grid Flexibility Technologies

A Global Sustainability Due Diligence & Market Research Study

History 2020–2024 · Base Year 2025 · Forecast 2025–2032 · Outlooks 2035 / 2040 / 2050 · Currency US$

WHY THIS REPORT

Long-duration energy storage units bridge the multi-hour-to-seasonal gap that short-duration batteries cannot — the mechanical (gravity/CAES), thermal, electrochemical (flow/metal-air), chemical/hydrogen and hybrid systems that store energy for 10 hours to multiple days. As grids approach high renewable penetration, LDES becomes essential to reliability when wind and solar are scarce for extended periods. This report is a comprehensive, decision-grade study of that LDES market across technology class, duration, application, end user and business model, spanning history 2020–2024, a 2025 base year, a 2025–2032 forecast and long-term outlooks to 2035, 2040 and 2050. This decision-grade study sizes the global market three ways — value, capacity (MWh) and rated power (MW) — across segmentation, seven regions and four scenarios to 2032, with outlooks to 2050.

SUSTAINABILITY & SDG IMPACT — THE ANMD LENS

The sustainability case is the report's backbone. LDES is essential to fully renewable, reliable grids — enabling deep decarbonisation by covering extended low-generation periods. The analysis applies double materiality, maps outcomes to GRI, SASB, ISSB, TCFD, TNFD, CSRD and the EU Taxonomy, and Material sourcing and footprint, siting and land-use, and efficiency-claim substantiation are treated as material risks — with greenwashing and SDG-washing screens applied throughout.

Mapped Sustainable Development Goals:

SDG 7	SDG 9	SDG 11	SDG 12	SDG 13
Affordable & Clean Energy	Industry & Infrastructure	Sustainable Cities	Responsible Consumption	Climate Action

Measurable sustainability outcomes assessed:

- Multi-day and seasonal grid balancing
- Deep decarbonisation of high-renewable grids
- Reliability beyond the limits of lithium-ion
- Cost-per-kWh and technology maturity as material risks

Framework alignment: Double materiality mapped to GRI, SASB, ISSB, TCFD, TNFD, CSRD and the EU Taxonomy, with greenwashing and SDG-washing screens applied throughout.

WHAT'S INSIDE AT A GLANCE

53 Chapters	**9** Report Parts	**7** Regions Covered	**40+** Country Markets
2025–32 Forecast Horizon	**4** Forward Scenarios	**25+** Companies Profiled	**5** SDGs Mapped

REPORT COVERAGE

Geographic scope: North America, Europe, Asia Pacific, Latin America, Africa, Middle East and Rest of World — with named country intelligence. North America leads LDES procurement and demonstration; Europe and Asia Pacific scale diverse technologies; other regions on their own merits.

MARKET OVERVIEW

From demonstration plants to proven cost and scale at long duration.

LDES is an emerging category critical to deep decarbonisation. Demand is driven by high-renewable-penetration reliability, multi-day and seasonal balancing, and the limits of lithium-ion at long durations — with cost-per-kWh-at-duration and round-trip efficiency central to value. The market is read three ways — value, capacity (MWh) and rated power (MW) — and forecast under four scenarios (conservative, base, accelerated and disruption), each region reported separately.

- **North America leads the LDES field** — anchored by Form Energy (iron-air), ESS, Energy Vault, Antora and Eos across diverse technologies.
- **Europe and Canada add depth** — with Highview Power (LAES), Hydrostor (CAES) and Invinity scaling mechanical and flow LDES.
- **Diverse technologies compete** — with Malta (thermal), Quidnet (geomechanical), Ambri and EnerVenue across the technology spectrum.
- **Cost-at-duration is the differentiator, the lowest cost-per-kWh at 10+ hours** — not power cost — decides LDES winners.

REGIONAL OUTLOOK

Across seven reporting regions, the report separates commercialisation and supply leaders from high-growth and emerging markets — each profiled in full rather than aggregated into Rest of World.

Region	Stage	Lead Markets & Drivers
North America	LDES-field leader	United States — Form Energy, ESS, Energy Vault, Antora, Eos
Europe & Canada	Mechanical & flow LDES	UK, Canada — Highview, Hydrostor, Invinity
Asia Pacific	Emerging	Australia, China — LDES demonstration
Latin America	Frontier	Chile — long-duration & seasonal interest
Africa	Frontier	South Africa — LDES resilience interest
Middle East	Emerging	Saudi Arabia, UAE — seasonal & hydrogen storage

KEY MARKET DRIVERS & RESTRAINTS

Drivers	Restraints
• High-renewable-penetration reliability	• Early commercial maturity & TRL
• Multi-day & seasonal balancing	• Round-trip-efficiency trade-offs
• Limits of lithium at long durations	• High upfront capex & financing
• Policy & LDES procurement programmes	• Long development & siting timelines
• Cost-per-kWh-at-duration advantages	• Technology-selection uncertainty

SEGMENTATION SNAPSHOT

By Technology Class	Mechanical (gravity/CAES) · thermal · electrochemical (flow/metal-air) · chemical / hydrogen · hybrid
By Duration	10–24 h · multi-day · seasonal
By Application	Front-of-meter · commercial & industrial · residential
By End User	Utilities · IPPs · developers · C&I; · residential
By Business Model	Equipment sales · integration · storage-as-a-service
By Readiness	Demonstration · early commercial · scaling

TABLE OF CONTENTS — PARTS & CHAPTERS

The full report is organised into nine parts across 53 chapters, listed below. Detailed sub-headings, country tables and directories are provided in the full report.

Part I — Report Foundation, Discovery and Strategic Intelligence

- Chapter 1. Scope, Methodology and Report Architecture
- Chapter 2. Industry Discovery Summary — Long-Duration Energy Storage Units
- Chapter 3. Executive Intelligence and Decision Dashboard
- Chapter 4. Strategic Findings, Materiality and Investment Verdict Preview

Part II — Market Intelligence, Sizing, Forecasting and Segmentation

- Chapter 5. Industry Overview and Market Evolution
- Chapter 6. Market Dynamics
- Chapter 7. Global Market Size and Forecast, 2020–2032
- Chapter 8. Market Segmentation Analysis
- Chapter 9. End-User and Demand-Side Intelligence
- Chapter 10. Pricing, Cost and Commercial Model Intelligence

Part III — Regional and Country Intelligence

- Chapter 11. Global Regional Intelligence Framework
- Chapter 12. North America Market Intelligence
- Chapter 13. Europe Market Intelligence
- Chapter 14. Asia Pacific Market Intelligence
- Chapter 15. Latin America Market Intelligence
- Chapter 16. Africa Market Intelligence
- Chapter 17. Middle East Market Intelligence
- Chapter 18. Rest of World Market Intelligence

Part IV — Technology, Innovation and Category-Specific Intelligence

- Chapter 19. Technology Landscape and Architecture
- Chapter 20. Emerging and Next-Generation Technology Intelligence
- Chapter 21. Category-Specific Intelligence Module
- Chapter 22. Research, Innovation and Funding Landscape

Part V — Company, Competition, Patent and Project Intelligence

- Chapter 23. Competitive Landscape
- Chapter 24. Company Profiles
- Chapter 25. Mergers, Acquisitions, Partnerships and Ecosystem Intelligence
- Chapter 26. Patent Landscape and Intellectual Property Intelligence
- Chapter 27. Project, Deployment and Case-Study Intelligence

Part VI — Sustainability, ESG, SDG, Climate and Natural-Capital Intelligence

- Chapter 28. Sustainability Intelligence Suite
- Chapter 29. ESG Intelligence and Double Materiality
- Chapter 30. ESG and Sustainability Framework Alignment
- Chapter 31. SDG Intelligence
- Chapter 32. Carbon, Net-Zero and Climate-Mitigation Intelligence
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Part VII — Supply Chain, Policy, Legal, Economics and Finance

- Chapter 37. Value Chain, Supply Chain and Geopolitical Intelligence
- Chapter 38. Policy, Regulation and Incentive Intelligence
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- Chapter 40. Unit Economics, CAPEX, OPEX and Return Analysis
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Part VIII — Scenario, Future Intelligence and Final Due Diligence Verdict

- Chapter 42. Scenario Analysis and Future Intelligence
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- Chapter 44. Risk Register, RAG Rating and Anti-Greenwashing Screen
- Chapter 45. Bottom-Line Verdict and Strategic Recommendations
- Chapter 46. Implementation Roadmap and Stakeholder Playbooks

Part IX — Annexes, Directories and Reference Material

- Chapter 47. Methodology Annex
- Chapter 48. Corporate Directory and Company Intelligence Annex
- Chapter 49. Patent Directory and Patent Intelligence Annex
- Chapter 50. Project Intelligence Annex
- Chapter 51. Forecast Annex
- Chapter 52. Sustainability KPI Annex
- Chapter 53. Reference Annexes

COMPETITIVE & INVESTMENT SNAPSHOT

The competitive field spans diverse LDES technology pioneers.

Representative players profiled in the full report:

Form Energy, Inc. · ESS Tech, Inc. · Energy Vault Holdings, Inc. · Hydrostor Inc. · Highview Power Storage Ltd · and 20+ further profiled players across diverse LDES technology pioneers.

Investment intelligence: venture, infrastructure, development, climate and blended finance, green bonds and sustainability-linked loans — culminating in a bankability assessment and a clear, decision-ready investment verdict.

KEY QUESTIONS THIS REPORT ANSWERS

? How large is the global long-duration energy storage units market, and how fast will it grow to 2032?
? Which regions, countries and segments offer the strongest risk-adjusted opportunity?
? How do multi-day and seasonal durations change reliability value versus short-duration batteries?
? Who leads, and where is the competitive and patent white space?
? Is the investment case bankable — and under what conditions?
? How does the category align with the SDGs, circular-economy and resource-security and disclosure regulation?

WHY ANMD — THE DIFFERENCE

Most market studies stop at units and revenue. This report is built as a sustainability due diligence instrument — fusing market sizing with ESG, SDG, climate, water and natural-capital intelligence and a decision-ready bankability verdict in a single architecture.

- **Triangulated sizing** — every market read three ways (value, capacity (MWh) and rated power (MW)) so value-led and volume-led views reconcile rather than conflict.
- **Region-honest forecasting** — Latin America, Africa and the Middle East reported in full, never hidden inside Rest of World, every forecast resolved to the 2025 base year.
- **Integrated evidence base** — company, patent and project databases linked to the analysis, with published-filing patents and FTO treated as an indicator, not a legal conclusion.
- **No-fabrication discipline** — every estimate carries a data-confidence rating and disclosed sources; gaps are flagged for further diligence, never filled with invented numbers.
- **Anti-greenwashing rigour** — SDG-washing and greenwashing screens plus claim-substantiation checks built into the ESG and project analysis.
- **Decision-first structure** — 9 Parts and 53 Chapters culminating in stakeholder playbooks and a clear, decision-ready investment verdict.

WHO SHOULD BUY THIS REPORT

Investors and infrastructure / PE funds, utilities and grid operators, LDES developers and OEMs, procurement and sustainability leaders, policymakers and lenders, and corporate strategy and ESG teams.

Access the Full Report

The complete report delivers all 53 chapters in full, with every sub-heading, country table, company and patent directory, forecast model and due diligence checklist.

Purchase at **www.anewmarketdynamics.com** · Standard & Premium licences · Single-Site (SSL) and Global-Site (GSL) options at checkout.

Want the Complete Detailed Table of Contents?

This prospectus lists the nine parts and 53 chapters. The complete detailed table of contents — every sub-heading, country table, exhibit, company and patent directory and annex — is available on request to registered users. To receive it, register with your official company email at **www.anewmarketdynamics.com**. The full detailed table of contents will be sent directly to your registered company email address.