ASX ANNOUNCEMENT
28 MAY 2026
ASX: CRR

SULPHUR-FREE SOLID-STATE ELECTROLYTE BENCHMARKS SULPHIDE-CLASS PERFORMANCE AT ROOM TEMPERATURE

Peer-reviewed benchmarking shows CRR's first-pass amorphous electrolyte (ASE) benchmarks at superionic-class ionic conductivity and competitive sulphide-class activation energy — without sulphur, removing the processing constraint recognised as the principal barrier to scaling solid-state lithium-ion batteries.

- **ASE room-temperature ionic conductivity of 3.2 mS cm^{-1}** — benchmarked against published non-sulphide, non-halide amorphous electrolytes for lithium-ion batteries — is competitive with sulphide-class benchmark values, without the toxic sulphur risk.

- **Solid-state battery advantage:** Solid-state battery designs can deliver higher energy density (more runtime and range at lower weight), improved safety (no flammable liquid electrolyte), and stable operation across a wider temperature range — critical for defence, aerospace (drones) and high-density computing applications.

- **ASE activation energy competitive with sulphide-class performance:** At 0.27 eV, Critical Resources' solid-state electrolyte is competitive with sulphide-class chemistry and shows limited temperature dependence — critical for defence, high-density computing and industrial systems where conventional lithium-ion faces thermal runaway risk and cooling constraints.

- **The real advantage is manufacturability, not just safety:** Sulphur-based solid-state electrolytes are fast — but toxic and costly to manufacture. CRR's results show that performance is achievable sulphur-free, opening a cleaner and potentially cheaper manufacturing pathway.

- **Integrated program approach reinforced:** The ASE benchmarking results complement the Company's Dry Supersonic Deposition (DSD) manufacturing program, reinforcing an integrated strategy designed to reduce both materials and manufacturing risk during the evaluation phase.

- **Strategic positioning across the battery theme:** Critical Resources holds interests in both lithium resources (Mavis Lake Lithium Project) and next-generation battery technology IP — advancing independently, but together broadening the Company's optionality across future partnerships, licensing and commercial pathways.

Critical Resources Limited ('**Critical Resources**' or the '**Company**', **ASX**: CRR) is pleased to provide the following benchmark assessment of its non-sulphide Amorphous Solid-State Electrolyte (**ASE**) initial results against published solid-state electrolyte performance data from peer-reviewed scientific literature. Reference values are derived from peer-reviewed scientific literature (**Appendix A**).

The Company's ASE program, conducted at the South Dakota School of Mines & Technology (**SDM**) within the American National Science Foundation (**NSF**) supported Centre for Solid State Electric Power Storage

(**CEPS**) evaluation framework, reported ionic conductivity of 3.2 mS cm^{-1} and activation energy of 0.27 eV from initial testing of its non-sulphide amorphous electrolyte composition (see ASX:CRR announcement 18 March 2026). The reported values were measured by Electrochemical Impedance Spectroscopy (EIS) on cold-pressed electrolyte pellets at SDM within the NSF-supported CEPS framework, and are benchmarked against published, peer-reviewed scientific literature — providing an externally-referenced basis for the comparisons that follow.

Ionic conductivity and activation energy metrics are the primary quantitative indicators of solid-state electrolyte performance in published literature and are the standard basis for comparing electrolyte classes across the field. The results demonstrate that CRR's amorphous solid-state electrolyte (ASE), being developed by SDM, delivers room-temperature ionic conductivity and activation energy competitive with sulphide-class materials — without sulphide chemistry.

In plain terms: CRR's electrolyte moves lithium ions as fast as the leading high-performance materials, but contains no sulphur. That matters because, until now, this level of transport has come only from sulphide materials that react with air and must be manufactured under inert atmosphere — widely regarded as the single biggest obstacle to making solid-state batteries affordably and at scale. Removing sulphur also removes the toxic-gas failure mode that makes those materials difficult to deploy in the defence, aerospace and data centre environments. Achieving competitive transport without sulphur, on a first-pass composition, is the necessary first step in the evaluation program toward a more manufacturable solid-state battery.

Importantly, the ASE program forms a core component of CRR's integrated battery strategy. It complements the Company's Dry Supersonic Deposition (**DSD**) solvent-free manufacturing evaluation program, with both workstreams designed to systematically reduce materials and manufacturing risk while maintaining a disciplined, capital-light laboratory-stage evaluation approach.

BENCHMARKING CONTEXT

In solid-state battery research, ionic conductivity and activation energy are the universal quantitative metrics used to characterise and compare electrolyte materials:

- **Ionic conductivity (mS cm^{-1})**: Measures the rate at which lithium ions can move through the electrolyte at a given temperature. Higher values indicate faster ion transport and are directly linked to battery charge/discharge rate capability. Values above ~1 mS cm^{-1} at room temperature are widely cited as a threshold for practical solid-state battery operation (**Figure 1**).

- **Activation energy (eV)**: Measures the energy barrier to lithium-ion transport. Lower values indicate that ion transport is less dependent on temperature — a critical requirement for operation across a broad temperature range, including low-temperature and extreme environment conditions. Values below ~0.30 eV are considered indicative of super-ionic transport behaviour (**Figure 2**).

Both metrics must be considered together. High ionic conductivity with high activation energy indicates performance that degrades significantly at low temperature. Low activation energy with low ionic conductivity indicates efficient but slow ion transport. **CRR's first-pass results achieve both simultaneously and at room temperature, widening potential applications.**

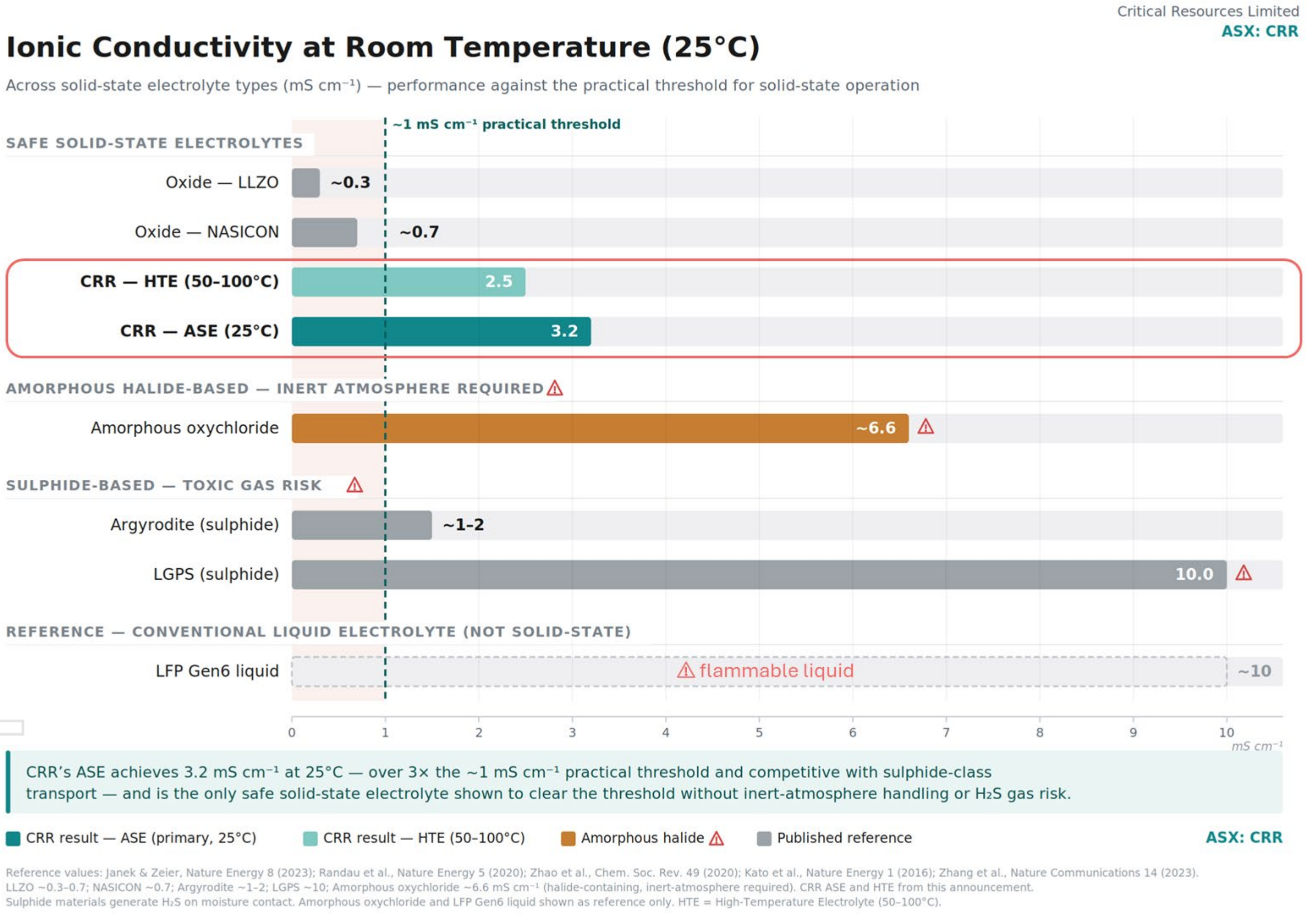
The initial ASE results are compared against published reference values for the principal solid-state electrolyte classes. All reference values are derived from peer-reviewed scientific literature (**Appendix A**).

IONIC CONDUCTIVITY PERFORMANCE

At 3.2 mS cm^{-1}, the ASE electrolyte is shown to be competitive against non-sulphide amorphous electrolytes at room temperature. It exceeds the two principal oxide benchmarks — LLZO (lithium lanthanum zirconium oxide, a garnet-type ceramic) at ~0.3 mS cm^{-1} and NASICON (sodium superionic conductor-type, a phosphate-based ceramic) at ~0.7 mS cm^{-1} — by approximately 10x and 4.5x, respectively.

Both LLZO and NASICON oxide electrolytes are recognised for their chemical stability and safety profile but are constrained by low room-temperature conductivity. CRR's ASE result is also competitive with the widely-cited sulphide-based electrolyte benchmark reference (~1–2 mS cm^{-1}) — without hydrogen sulphide (H_2S) gas generation risk.

The result clears the broadly cited ~1 mS cm^{-1} threshold for practical solid-state operation — more than three times that level — and this is from an unoptimised first-pass composition. Formulation optimisation is a defined next step and is expected to improve this figure further.



CRR's ASE achieves 3.2 mS cm^{-1} at 25°C — over 3× the ~1 mS cm^{-1} practical threshold and competitive with sulphide-class transport — and is the only safe solid-state electrolyte shown to clear the threshold without inert-atmosphere handling or H_2S gas risk.

Reference values: Janek & Zeier, Nature Energy 8 (2023); Randau et al., Nature Energy 5 (2020); Zhao et al., Chem. Soc. Rev. 49 (2020); Kato et al., Nature Energy 1 (2016); Zhang et al., Nature Communications 14 (2023). LLZO ~0.3–0.7; NASICON ~0.7; Argyrodite ~1–2; LGPS ~10; Amorphous oxychloride ~6.6 mS cm^{-1} (halide-containing, inert-atmosphere required). CRR ASE and HTE from this announcement. Sulphide materials generate H_2S on moisture contact. Amorphous oxychloride and LFP Gen6 liquid shown as reference only. HTE = High-Temperature Electrolyte (50–100°C).

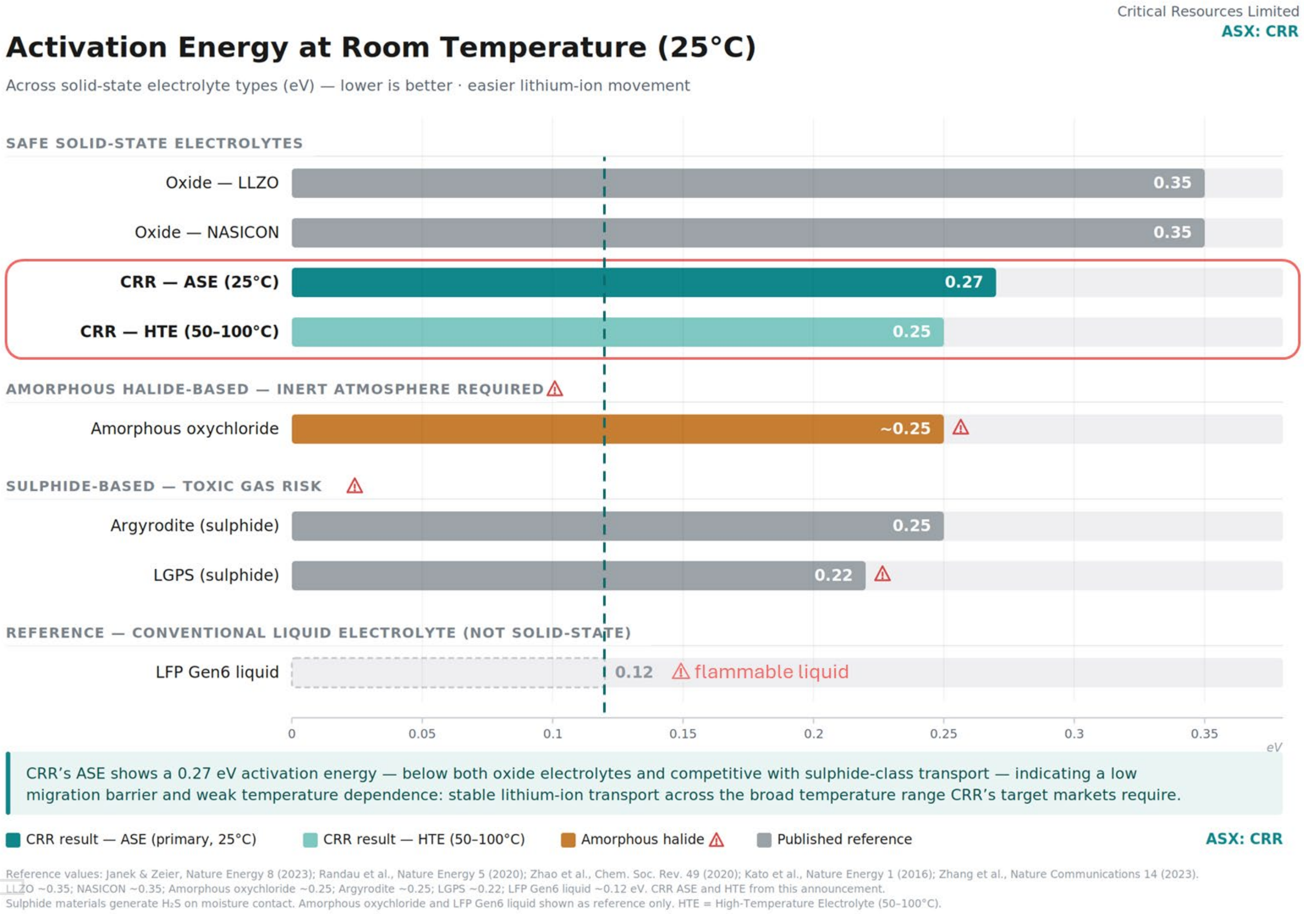
Figure 1 *– Ionic conductivity comparison. Initial ASE results exceed the ~1 mS* cm^{-1} *practical operation threshold without sulphide chemistry — with further improvement expected through ongoing formulation work.* ***HTE = High Temperature Electrolyte***

ACTIVATION ENERGY COMPETITIVE WITH SULPHIDE CLASS CHEMISTRY

At 0.27 eV, CRR's amorphous ASE matches the activation energy of sulphide electrolytes and is competitive with LGPS (~0.22 eV), the highest-performing sulphide class. It significantly outperforms both oxide benchmarks (LLZO and NASICON, both ~0.35 eV) and polymer (PEO, ~0.50 eV) (**Figure 2**).

Achieving 0.27 eV on a non-sulphide composition is the key result: the field has historically considered sulphide-class activation energy to be inaccessible without sulphide chemistry. CRR’s first-pass data challenges that assumption, and is a result of years of combined research by the SDM team.

This has direct relevance to CRR’s strategic positioning in high-temperature and extreme environment applications, where broad temperature range operation is a primary technical requirement. Data centres, defence installations, and industrial energy storage systems demand batteries that maintain high ionic conductivity and superior energy density across sustained thermal loads — operating environments where conventional lithium-ion batteries face accelerated degradation, thermal runaway risk, and performance constraints. Low activation energy is the fundamental materials property that enables reliable solid-state battery operation under these demanding conditions.



CRR’s ASE shows a 0.27 eV activation energy — below both oxide electrolytes and competitive with sulphide-class transport — indicating a low migration barrier and weak temperature dependence: stable lithium-ion transport across the broad temperature range CRR’s target markets require.

Reference values: Janek & Zeier, Nature Energy 8 (2023); Randau et al., Nature Energy 5 (2020); Zhao et al., Chem. Soc. Rev. 49 (2020); Kato et al., Nature Energy 1 (2016); Zhang et al., Nature Communications 14 (2023).
LLZO ~0.35; NASICON ~0.35; Amorphous oxychloride ~0.25; Argyrodite ~0.25; LGPS ~0.22; LFP Gen6 liquid ~0.12 eV. CRR ASE and HTE from this announcement.
Sulphide materials generate H_2S on moisture contact. Amorphous oxychloride and LFP Gen6 liquid shown as reference only. HTE = High-Temperature Electrolyte (50-100°C).

Figure 2 *- Activation Energy comparison. CRR's amorphous ASE achieves activation energy the field has historically associated only with sulphide-class electrolytes - directly relevant to broad-temperature-range applications.*

COMBINED PERFORMANCE SIGNIFICANCE

Achieving both high ionic conductivity and low activation energy on a first-pass non-sulphide composition is the central result of this benchmarking exercise. Published peer-reviewed literature describes a persistent trade-off between non-sulphide chemistries and sulphide-class transport performance — sulphide-class transport has come bundled with sulphide processing. CRR's initial ASE results challenge that assumption.

CRR’s first-pass amorphous ASE delivers competitive ionic conductivity compared to non-sulphide, non-halide amorphous electrolytes and activation energy competitive with sulphide electrolytes — without the challenges associated with sulphide-based chemistry. Both results are from an unoptimised composition, with further potential improvements through ongoing work.

TWO WORKSTREAMS, ONE INTEGRATED STRATEGY

The initial ASE and DSD results are not independent milestones — they are complementary components of a single integrated strategy. Solid-state battery development requires both: an electrolyte that conducts lithium ions efficiently across a wide temperature range and manufactured in a way that is compatible with solid-state architectures.

- **ASE program (electrolyte):** Addresses the core materials challenge — ionic conductivity and activation energy. Initial benchmark results establish competitive performance on both primary metrics from a first-pass, unoptimised composition.
- **DSD program (manufacturing):** Addresses manufacturing pathway — solvent-free, low-temperature cathode/electrolyte fabrication. Initial results establish feasibility of the solvent-free approach and a repeatable manufacturing baseline, with readiness on electrolyte application.

Both workstreams are now generating data toward DSD integration trials — the next step, in which cathode and electrolyte architectures developed under each program are brought together into unified solid-state cell configurations. This is the critical bridge between component-level validation and full-cell prototype development.

The initial ASE results sit at the foundation of a staged cell-development pathway — compression and densification, coin-cell cycling, then pouch-cell formats — with each stage providing a discrete validation point. The coin-cell stage is currently in progress at SDM (**Figure 3**).

Solid-state battery technology also directly addresses one of the most significant infrastructure challenges facing high-density computing environments. Conventional lithium-ion battery systems generate substantial heat under load and carry thermal runaway risk, requiring dedicated cooling and containment infrastructure in data centre deployments. The low activation energy of CRR’s ASE (0.27 eV) — which enables stable lithium-ion transport across a broad temperature range — is a fundamental materials property that reduces thermal sensitivity and improves reliability under sustained thermal load. The Company continues to evaluate complementary technology opportunities in thermal management of battery technology.

> **Critical Resources Managing Director, Tim Wither, commented:** *‘Benchmarking our first-pass ASE results against published peer-reviewed literature reveals a performance position that is a result of years of combined research by Dr Smirnova and the SDM team. Being competitive on ionic conductivity — and matching sulphide-class activation energy — from an initial composition is a strong starting point.*
>
> *'The industry has generally accepted a trade-off of toxicity and manufacturing challenges between non-sulphide safety and sulphide-class performance. The initial results from SDM challenge that assumption. We are not claiming commercial readiness — this is early-stage laboratory validation, but the technical merits are very encouraging.*
>
> *'Importantly, our composition optimisation program is just beginning. The next steps in the ASE and DSD programs are designed to enhance cell performance and prototype readiness further. There is material upside from where we are today, and we are pursuing it systematically through a low-cost laboratory-stage evaluation approach.’*

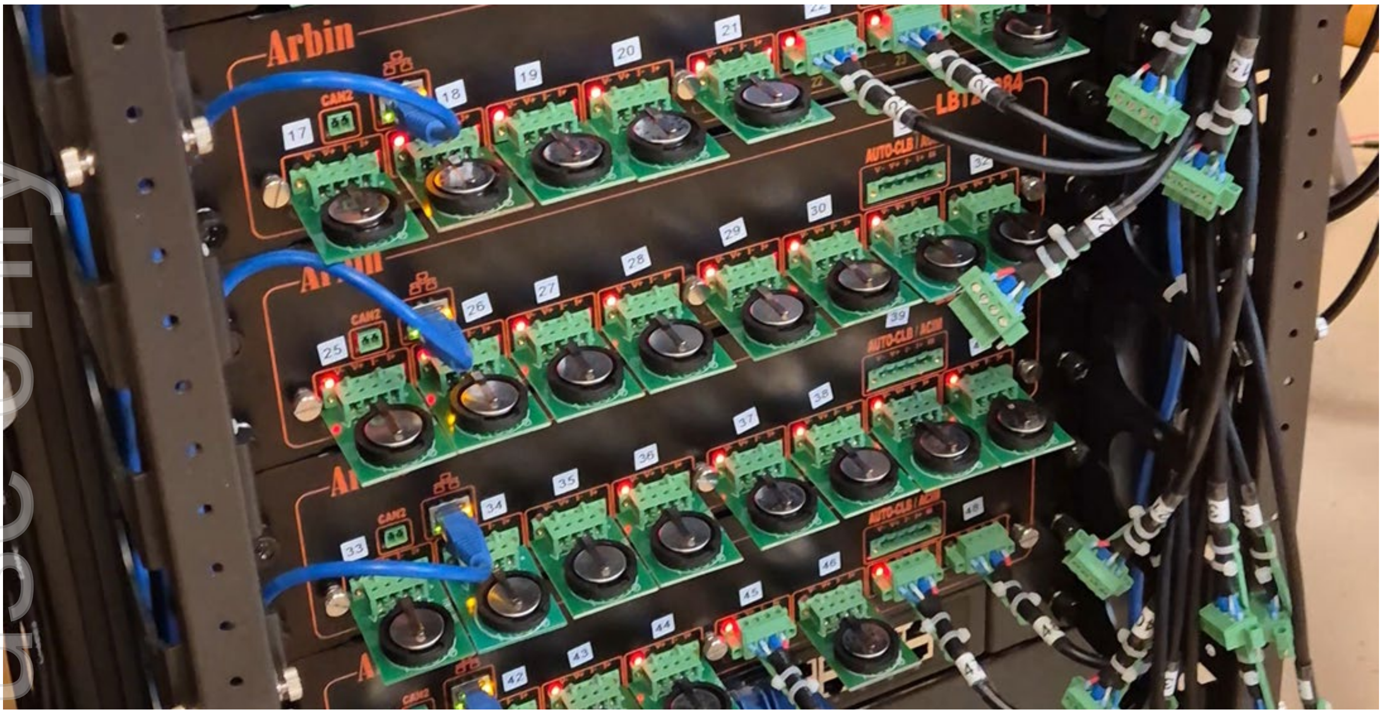


__Figure 3__ – Critical Resources test cells under evaluation on a 48-channel Arbin coin-cell cycler at the South Dakota School of Mines & Technology (SDM), which runs cells through repeated charge cycles to validate real-world performance and durability.

MARKET CONTEXT

Solid-state batteries are widely identified as the next major step-change in energy storage, with higher energy density — more usable energy per unit weight and volume — among the principal advantages driving that interest. Independent market research estimates the global solid-state battery market at approximately US$1.1–1.4 billion in 2024–25, growing to around US$22–27 billion by 2034, a compound annual growth rate above 30% (Appendix A - GM Insights, 2025; Research and Markets, 2025; InsightAce Analytic, 2025). A recurring theme across that research is that manufacturability and scale-up — rather than fundamental materials performance — represent the principal near-term commercialisation barrier, the precise constraint CRR's sulphur-free pathway is positioned to address.

CRR's initial target environments — data centres, defence and high-reliability industrial systems — sit among the fastest-growing demand pools for advanced energy storage, and are precisely the settings where energy density and thermal stability are most valued: weight, footprint and cooling load are binding constraints in each. Global data-centre electricity demand is projected to more than double by 2030 to around 945 TWh — comparable to Japan's current total electricity consumption — driven primarily by AI (Appendix A - International Energy Agency, Energy and AI, 2025). These are third-party market estimates referenced for context only; they are not forecasts of the Company's revenue or performance and are not adopted by CRR as guidance.

STRATEGIC ELECTROLYTE POSITIONING: NON-SULPHIDE PATHWAY

Sulphide electrolytes are the most frequently cited near-term solid-state commercialisation candidates, and for good reason: the soft, polarisable sulphur lattice both delivers fast lithium-ion transport and allows electrolyte layers to be densified by cold-pressing rather than high-temperature sintering. CRR's amorphous ASE achieves ionic conductivity and activation energy competitive with that sulphide-class benchmark — but with no sulphur in the composition. The significance is not principally one of safety; it is that sulphide-class performance has, until now, come bundled with sulphide processing.

Sulphide electrolytes react with atmospheric moisture and must be synthesised, handled and assembled under inert atmosphere or in ultra-dry rooms — a processing requirement widely identified as the dominant barrier to producing solid-state batteries at cost and scale. The most visible expression of this is hydrogen sulphide (H_2S), a toxic gas with an occupational exposure limit of around 1 ppm that sulphides release on contact with moisture; it is what drives the inert-atmosphere requirement and, in a deployed cell, imposes containment obligations. The principal non-sulphide alternative — ceramic oxides such as LLZO — avoids air-reactivity but must be sintered above 1,000°C, which is energy-intensive, produces brittle layers and limits interfacial contact. The field has therefore faced a persistent trade-off: sulphide-class transport with sulphide processing, or air-tolerant oxides with low conductivity and difficult fabrication.

CRR's non-sulphide, non-halide amorphous composition is positioned to sidestep both constraints. The amorphous (glass-like) structure has no grain boundaries to impede ion transport, conducts uniformly in all directions, and is inherently more formable than rigid sintered ceramics — properties associated with simpler, lower-temperature fabrication. The composition also avoids germanium, the costly element in the highest-conductivity sulphide (LGPS), and the halide elements that constrain competing non-sulphide routes, consistent with the Company's critical-minerals positioning. Confirming the processing and interfacial stability required to realise these manufacturing advantages is an explicit objective of the evaluation program; the results reported here establish the necessary precondition — that competitive transport is achievable in this chemistry at all. For the enclosed, ventilation-constrained environments CRR is targeting — defence, aerospace and data centre infrastructure — a composition that removes the H_2S failure mode is particularly well suited.

> CRR's technology position addresses both ends of the operating-temperature challenge: the amorphous ASE program, targeting room-temperature performance optimisation, and the halide antiperovskite electrolyte IP, targeting elevated-temperature operation where conventional batteries fail. Both positions are sulphur-free — neither carries the hydrogen sulphide (H_2S) failure mode that makes sulphide electrolytes difficult to deploy in enclosed, ventilation-limited environments.
>
> Sulphur-free chemistry is more than a safety attribute — it is what makes the material manufacturable, and it is manufacturability, more than safety alone, that defines the strategic opportunity. Achieving sulphide-class transport without sulphide processing is the precondition for a cleaner, potentially lower-cost fabrication pathway; confirming that pathway in practice remains an explicit objective of the evaluation program.
>
> Together, these directly address lithium-ion battery performance for extreme-environment, defence, and high-reliability industrial applications — combining broad-temperature capability and the energy-density potential of solid-state chemistry with the deployment advantages of sulphur-free processing and a manufacturing pathway positioned for scale.

CRR HALIDE ELECTROLYTES

The crystalline halide electrolyte class is an active area of solid-state battery research. Certain halide compositions have demonstrated high ionic conductivity in published literature, including values comparable to CRR's current ASE result. CRR's benchmark claim is appropriately scoped to the non-sulphide amorphous class — the directly relevant reference for an amorphous composition.

Crystalline halides require inert atmosphere synthesis and handling, are moisture-sensitive under ambient conditions, and face cathode compatibility and scalable manufacturing challenges that remain active areas of research. These are the constraints that have prevented crystalline halides from progressing to commercial production despite their conductivity data.

Separately from the ASE program, CRR holds an exclusive option over a lithium halide antiperovskite electrolyte IP which is a non-sulphide, lithium-halide-based technology that demonstrates performance at elevated temperatures (50–100°C) — where activation energy decreases and ionic transport improves with heat. It is a complementary position to the amorphous ASE program, not a competing one.

NOTE ON AMORPHOUS HALIDE ELECTROLYTES

Recent published literature has reported a class of amorphous oxychloride electrolytes (and related compositions) with ionic conductivities of up to 6.6 mS cm^{-1} at 25°C (Zhang et al., Nature Communications, 2023 — Appendix A). These materials are amorphous and non-sulphide; CRR's benchmark claim is therefore appropriately scoped to the non-sulphide, non-halide amorphous class.

Amorphous oxychloride electrolytes contain chlorine and are halide-containing materials. They share the core processing constraints of the broader halide class: they are moisture-sensitive under ambient conditions, require inert atmosphere synthesis and handling, and face the same containment and safety obligations in deployed systems that make halide chemistry operationally disqualifying in CRR's target defence, aerospace, and high-reliability industrial markets. These constraints are generally considered intrinsic to the halide chemistry itself and remain active areas of research.

CRR's non-sulphide, non-halide amorphous composition avoids these liabilities entirely. Within that class — electrolytes containing no sulphur and no halide elements — CRR's 3.2 mS cm^{-1} result appears to be among the highest published room-temperature conductivity values identified by the Company.

NEXT STEPS

Critical Resources will continue advancing the ASE program under the structured six-month evaluation framework with CEPS and SDM, building on these initial results toward later-stage cell-level validation. These activities are designed to strengthen the technical foundation of the Company's solid-state battery strategy without implying commercial manufacturing. These initial benchmark results represent the materials-validation stage of a defined development pathway. The steps below progress in sequence — from validated electrolyte performance, through interfacial and densification work, to integrated full-cell evaluation — with each stage a discrete, measurable milestone toward a representative solid-state cell.

Key next steps include:

- **Electrolyte composition optimisation:** Refine amorphous electrolyte formulations to further enhance ionic conductivity, interface stability, and temperature performance — targeting improved consistency across a broader operating range.

- **Expanded interfacial validation:** Continue post-cycling electrochemical and XRD/XPS testing across broader conditions — building the dataset required to model interface behaviour and degradation over time.

- **Compression pathway assessment:** Evaluate cell performance under conventional uniaxial pressing and Warm Isostatic Pressing (WIP) — an emerging densification technique applying uniform pressure across complex geometries to improve interface contact and reduce resistance to improve performance and potential scalable manufacturing pathways.

- **Progressive full-cell evaluation:** Integrate optimised electrolyte and cathode formulations into increasingly representative solid-state cell assemblies — the critical bridge between materials validation and cell-level performance metrics.

- **DSD integration trials:** Commence controlled cathode–electrolyte interface trials aligned with DSD-fabricated cathode architectures — connecting the ASE and DSD workstreams into a unified solid-state cell evaluation pathway during the evaluation period with SDM.

This announcement has been approved for release by the Board of Directors of Critical Resources.

To receive alerts for ASX announcements and updates sign up at **www.criticalresources.com.au** or for further information please contact us directly at:
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ABOUT CRITICAL RESOURCES LIMITED

Critical Resources Limited (ASX:CRR) is an Australian mining and technology company focused on the discovery and development of critical metals and next generation technologies essential to a sustainable future. The Company holds a diversified portfolio including the Mavis Lake Lithium Project in Ontario, Canada, the Halls Peak Base Metals Project in New South Wales, and a growing gold portfolio in New Zealand.

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FORWARD LOOKING STATEMENTS

This announcement may contain certain forward-looking statements and projections, including statements regarding the Company's solid-state battery technology and intellectual property programs, the expected performance, optimisation and development of its electrolyte and manufacturing workstreams, the potential applications and markets for that technology, and the Company's plans with respect to its mineral properties and programs. Forward-looking statements can generally be identified by words such as 'may', 'expect', 'intend', 'plan', 'target', 'potential', 'anticipate' and similar expressions. Such forward-looking statements/projections are estimates for discussion purposes only and should not be relied upon. They are subject to known and unknown risks, uncertainties and assumptions and may therefore differ materially from results ultimately achieved. The benchmark assessment and laboratory results referred to in this announcement are early-stage and are not indicative of commercial performance. There can be no assurance that ongoing optimisation will achieve improved or commercially viable results, that the Company's battery technology will be successfully developed, scaled or commercialised, or that any intellectual property option held by the Company will be exercised or prove valuable. There can also be no assurance that CRR's plans for development of its mineral properties will proceed as currently expected, that the Company will be able to confirm the presence of additional mineral resources, that any mineralisation will prove to be economic, or that a mine will successfully be developed on any of CRR's mineral properties. Critical Resources Limited does not make any representations and provides no warranties concerning the accuracy of the projections and disclaims any obligation to update or revise any forward-looking statements/projections based on new information, future events or otherwise, except to the extent required by applicable laws. While the information contained in this announcement has been prepared in good faith, neither Critical Resources Limited nor any of its directors, officers, agents, employees or advisors give any representation or warranty, express or implied, as to the fairness, accuracy, completeness or correctness of the information, opinions and conclusions contained in this announcement.

APPENDIX A

All benchmark comparisons reference published, peer-reviewed scientific literature. CRR's results are from Electrochemical Impedance Spectroscopy (EIS) measurements on cold-pressed electrolyte pellets conducted at South Dakota Mines within the CEPS framework. These are early-stage laboratory results — not indicative of commercial performance.

- Li, X. et al. (2023). $LaCl_3$-based lithium superionic conductor with compatible interface. Nature, 616, 77–83. (Best-in-class crystalline halide: 3.02 mS cm^{-1}, 0.197 eV — included for full and transparent representation of the halide class.)
- Zhang, S. et al. (2023). A family of oxychloride amorphous solid electrolytes for long-cycling all-solid-state lithium batteries. Nature Communications, 14, 3780. (Highest-performing published non-sulphide amorphous electrolyte class: 6.6 mS cm^{-1} at 25°C. These are halide-containing (oxychloride) materials requiring inert atmosphere processing — included for full and transparent representation of the amorphous electrolyte landscape.)
- Janek, J. & Zeier, W.G. (2023). Challenges in speeding up solid-state battery development. Nature Energy, 8, 230–240. (Current standard benchmark reference for SSE performance — updated from the same authors' widely cited 2016 paper.)
- Smirnova, A. et al. (2021). Solid-State Electrolytes Based on Lithium Halides for All-Solid-State Lithium-Ion Battery Operating at Elevated Temperatures. US Patent 10,991,976 B2, South Dakota Board of Regents. (CRR holds an exclusive option over this IP.)
- Randau, S. et al. (2020). Benchmarking the performance of all-solid-state lithium batteries. Nature Energy, 5, 259–270. (Comparative electrolyte data across oxide, sulphide, and polymer classes.)
- Zhao, Q. et al. (2020). Designing solid-state electrolytes for safe, energy-dense batteries. Chem. Soc. Rev., 49, 8701–8750. (Comprehensive SSE benchmarks and performance review.)
- Kato, Y. et al. (2016). High-power all-solid-state batteries using sulfide superionic conductors. Nature Energy, 1, 16030. (LGPS and sulphide class reference.)
- Dai, T. et al. (2023). Inorganic glass electrolytes with polymer-like viscoelasticity. Nature Energy, 8, 1221–1228. (Amorphous oxychloride $MAlCl_{2-2i}O_i$: ~1 mS cm^{-1} at 30°C. Halide-containing amorphous class — included for complete representation of the amorphous electrolyte landscape.)
- Li, F. et al. (2023). Amorphous chloride solid electrolytes with high Li-ion conductivity for stable cycling of all-solid-state high-nickel cathodes. Journal of the American Chemical Society, 145(50), 27774–27787. (Amorphous chloride: ~7.16 mS cm^{-1}. Halide-containing amorphous class — included for complete representation of the amorphous electrolyte landscape.)
- Hong, B. et al. (2025). Novel Amorphous Nitride-Halide Solid Electrolytes with Enhanced Performance for All-Solid-State Batteries. Angewandte Chemie, 137(3), e202415847. (Amorphous nitride-halide $Li_3{}^{\chi}TaCl_5N\chi$: 7.34 mS cm^{-1} at 30°C. Halide-containing amorphous class — included for complete representation of the amorphous electrolyte landscape.)
- Bahmani, F. & Smirnova, A. (2025). Dual substitution in cationic and anionic sublattices of lithium indium chloride for high-performance solid-state lithium metal batteries. Journal of Materials Chemistry A. (Crystalline halide: 3.2 mS cm^{-1}. Published work from the SDM research team. Crystalline, not amorphous — included for complete representation of SDM-originating research and the broader halide landscape.)
- GM Insights — US$1.1bn (2024), 31.1% CAGR 2025–2034: https://www.gminsights.com/industry-analysis/solid-state-battery-market
- Research and Markets — US$1.4bn (2025) → US$21.8bn (2034), 35.6% CAGR: https://www.researchandmarkets.com/reports/6185192/solid-state-battery-market-outlook-market
- InsightAce Analytic — US$886.1m (2024) → US$24.3bn (2034), 40.4% CAGR: https://www.insightaceanalytic.com/report/solid-state-battery-market/2204
- IEA, Energy and AI (2025) — data-centre electricity demand more than doubling to ~945 TWh by 2030: https://www.iea.org/reports/energy-and-ai/executive-summary

APPENDIX B — ELECTROLYTE BENCHMARK COMPARISON TABLE

All reference values derived from peer-reviewed literature cited in **Appendix A**. Results from EIS measurements on cold-pressed pellets at SDM within the CEPS framework. These are early-stage laboratory results — not indicative of commercial performance. The CRR High Temperature Electrolyte (HTE) row references data from US Patent 10,991,976 B2 (Smirnova et al., 2021) — over which CRR holds an exclusive option — and is not derived from EIS measurements conducted under the current evaluation program. Hydrogen Sulphide (H_2S) gas risk applies to sulphide materials under ambient moisture exposure.

Electrolyte	Ionic Conductivity ($mS\ cm^{-1}$)	Activation Energy (eV)	Hydrogen sulphide (H_2S) Risk	Notes
CRR — ASE (25°C)	**3.2**	**0.27**	**None**	CRR result — unoptimised first-pass composition. Amorphous, non-sulphide.
CRR — HTE (50–100°C)	**2.5**	**0.25**	**None**	CRR halide antiperovskite. Elevated-temp operation.
Oxide — LLZO	~0.3	~0.35	None	Garnet-type oxide. Safe but low conductivity.
Oxide — NASICON	~0.7	~0.35	None	Phosphate-type oxide. Safe but low conductivity.
Amorphous oxychloride (xLi_2O-$TaCl_5$) ⚠	~6.6	~0.25	None	Amorphous halide-containing. Moisture-sensitive. Inert atmosphere required. (Zhang et al., Nat. Commun. 2023)
Argyrodite (Li_6PS_5Cl) ⚠	~1–2	~0.25	**Yes ⚠**	Sulphide. H_2S on moisture contact. Inert atmosphere required.
LGPS ($Li_{10}GeP_2S_{12}$) ⚠	~10	~0.22	**Yes ⚠**	Sulphide. Highest conductivity class but H_2S risk and Ge cost constrain commercial use.
Polymer (PEO)	~0.01	~0.50	None	Low room-temp conductivity. Requires elevated temperature to perform.