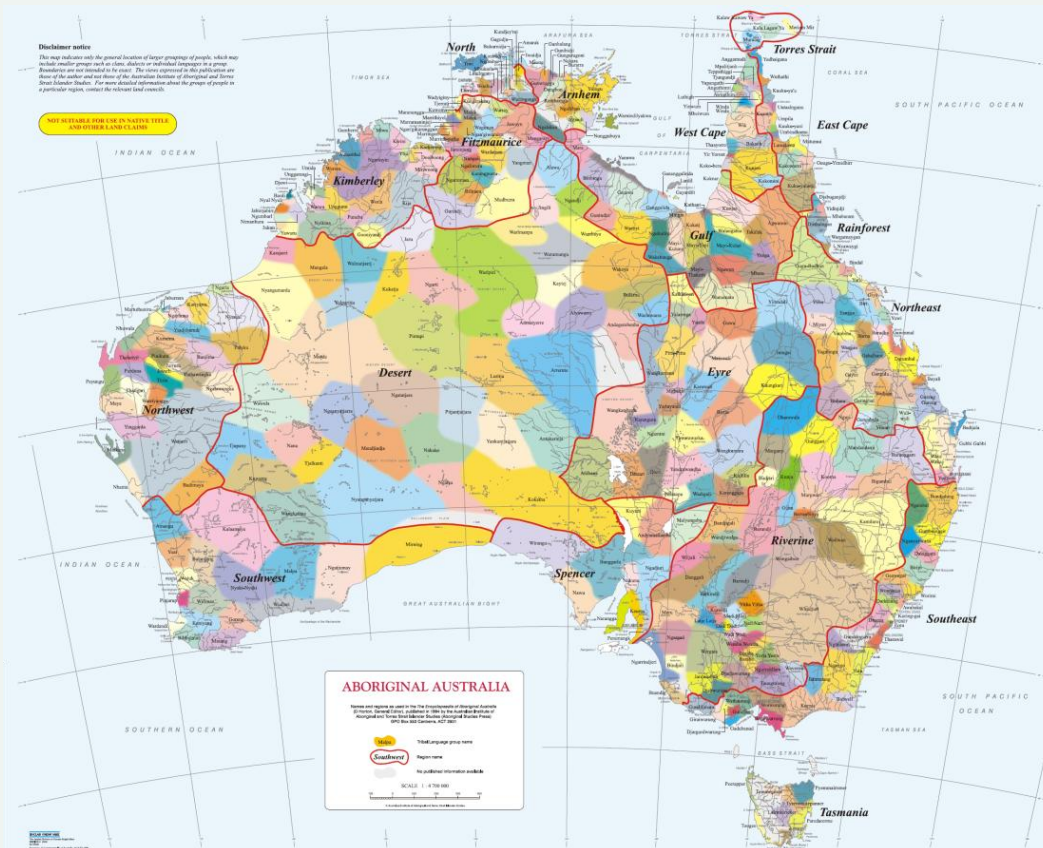


Acknowledgement of Country

ECU acknowledges and respects the continuing association with Noongar people, the traditional custodians of the land, upon which its campuses stand and programs operate.



Master Class 9th September 2026 1.30pm to 2.30pm: Energy in Western Australia

Contact

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Western Australia – State of Energy

Key Priorities

Securing the
2030 transition
away from coal
in the SWIS

Accelerating
decarbonisation
in the Pilbara
and Goldfields

Helping
industries
transition and
attracting
investment

Building public
understanding
and trust in the
transition

BESS: reliability, renewable integration, industrial decarbonization and system flexibility

Batteries and I 2018 to

Research Focus – Closed Loop Approach

Policy & Public Commentary

THE CONVERSATION

Academic rigour. Journalism's best.

Arts • Culture • Books • Music • Business • Economy • Education • Environment • Energy • Health • Politics • Society • Science • Tech



Picture this: you're cruising down the Great Ocean Road in your brand new electric vehicle (EV), the ocean to your left and the wind in your hair. But what if I told you this idyllic drive could turn into a nightmare, with the faint smell of something burning?

Author: Muhammad Rowan Akbar, Edith Cowan University

A battery price war is kicking off that could soon make electric cars cheaper. Here's how

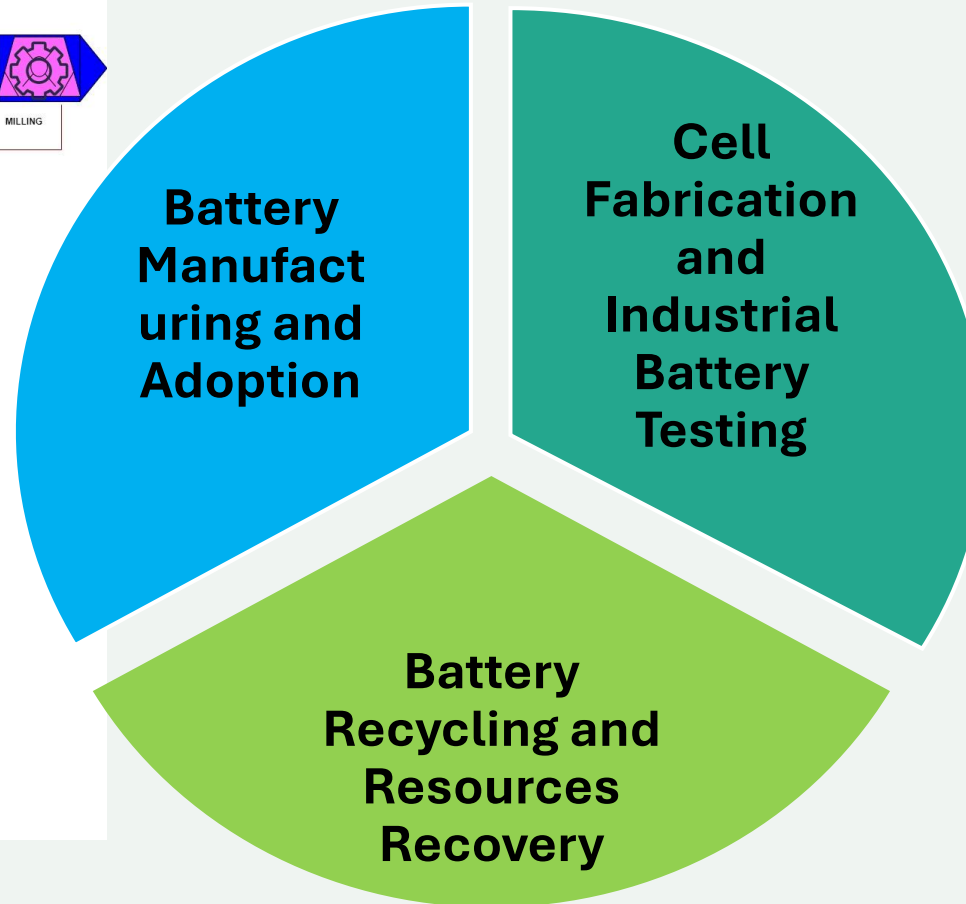
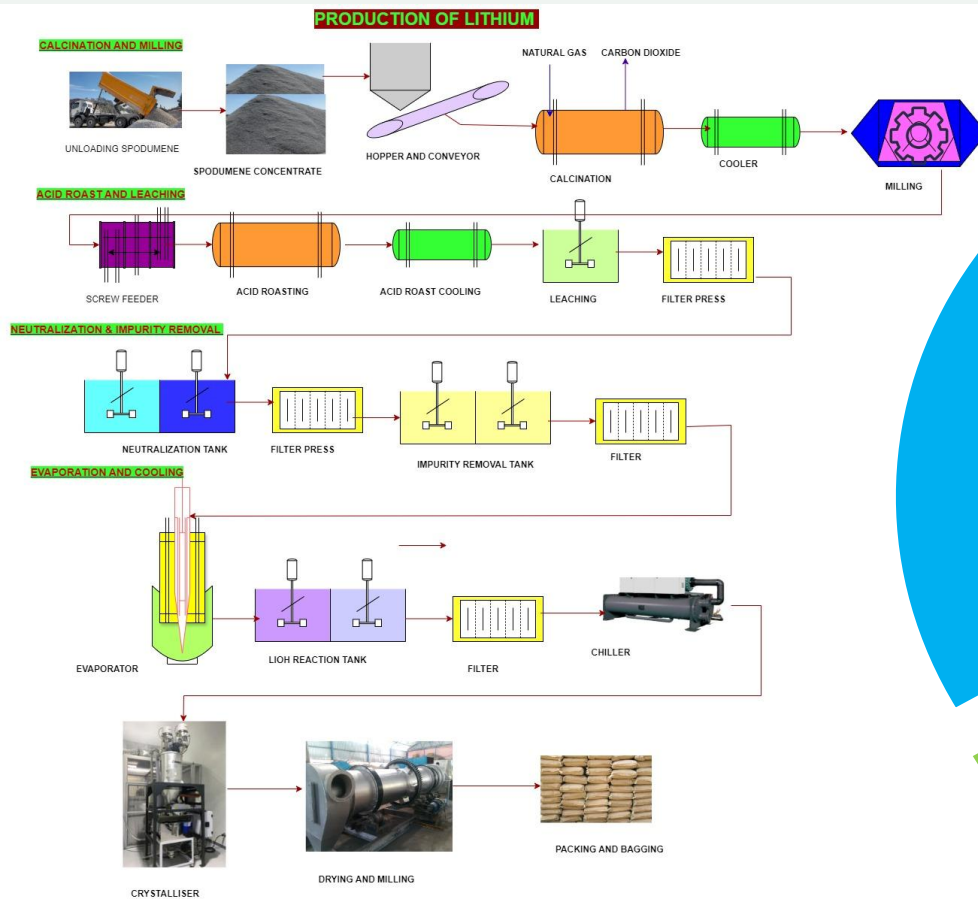
Published: March 20, 2024 4:06pm AEST

The main cost of an electric vehicle (EV) is its battery. The high cost of energy-dense batteries has meant EVs have long been more expensive than their fossil fuel equivalents.

The world's 280 million electric bikes and mopeds are cutting demand for oil far more than electric cars

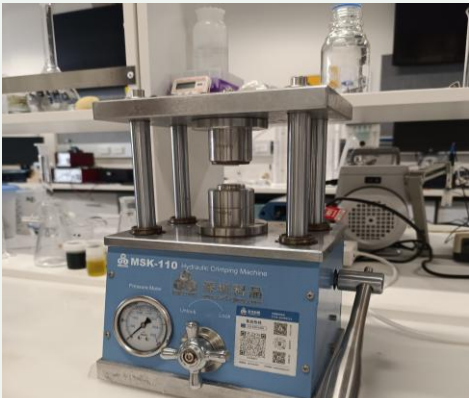
Published: November 17, 2023 9:38am AEST

We hop in the car to get groceries or drop kids at school. But while the car is convenient, these short trips add up in terms of emissions, pollution and petrol COST.

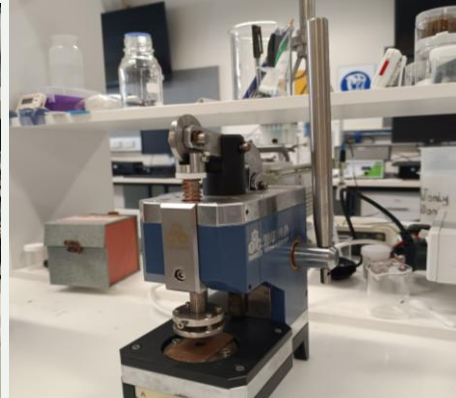


Batteries @ ECU – One Stop Shop

From Single Cell Fabrication to Battery Packs and Modules



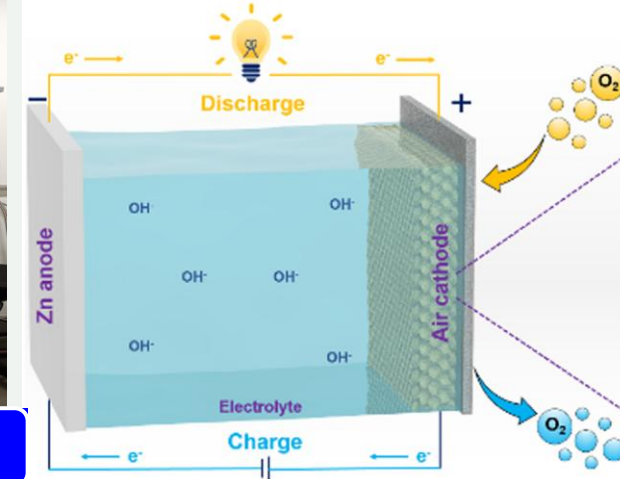
Battery Coin Cell Assembly



Lithium and Zinc Air Cells



Battery Tester



Digital Twin – Grid Simulator



Lithium Battery Pack Testing Chamber



Invertors

Battery Energy Storage System and Renewable Energy

Why storage becomes essential as renewable penetration increases



Renewable Energy

Solar

Largest
Power
Source

Wind

17%

Hybrid

?

BATTERY
ENERGY
STORAGE

Renewables create a timing and stability problem

Intermittency

Solar and wind generation vary with irradiance, wind speed and weather.

Demand mismatch

Peak solar generation often occurs away from evening peak demand.

Grid stability

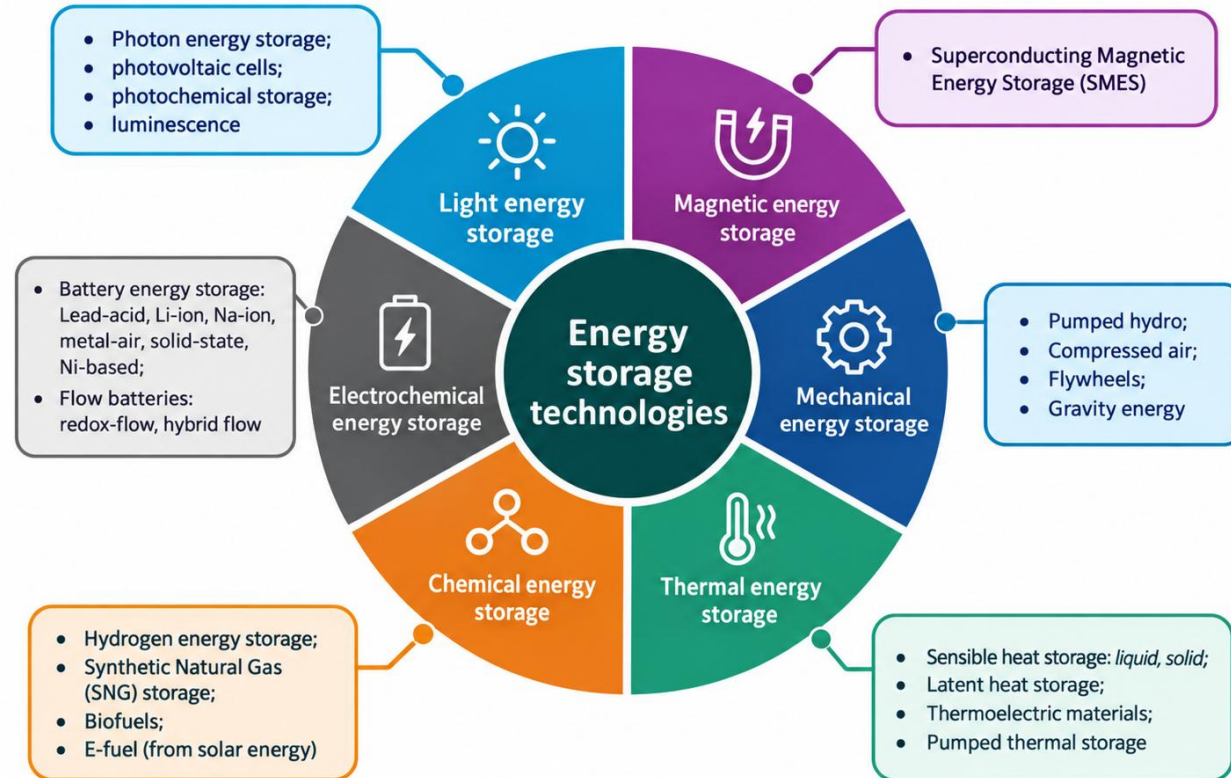
High distributed renewable penetration can affect voltage, frequency and network congestion.



Report framing: storage shifts energy across time and improves reliability by buffering fluctuations in renewable generation.

Energy storage is broader than batteries

- Storage mechanisms include mechanical, thermal, chemical, electrochemical, magnetic and light-based pathways.
- BESS dominates fast-growing distributed storage because of modularity, rapid response and falling cost.
- Technology choice depends on duration, utilisation, site constraints, safety and lifetime value.



Source: CSIRO & SEDA Malaysia (2025), Insights on Consumer-based BESS in the Tropical Climate of Malaysia.

Energy storage mechanisms

BESS Components and Chemistries

Components determine performance, safety and maintainability



Core components of a BESS

Cells / modules

Electrochemical storage unit

Battery Management System

Cell monitoring, protection, balancing

Power Conversion System

Inverter/rectifier interface with AC grid

Energy Management System

Dispatch, optimisation and control

Thermal & fire systems

Temperature control, detection, suppression

Enclosure & auxiliaries

HVAC, protection, communications

Coordinated operation is essential: component design, controls and protection systems are inseparable from safety and system value.

Battery chemistry selection is application-driven

Li-ion

High energy density; fast response; dominant for residential, commercial and grid BESS

Lead-acid

Mature and recyclable; limited by lower energy density and shorter life

Sodium-ion

Emerging lower-cost alternative; less critical-material dependence

Redox flow

Energy and power can be scaled separately; strong fit for longer duration

Molten salt

Robust high-temperature systems; specialised infrastructure requirements

Metal-air

Long-duration potential; many chemistries still developing – zinc air and iron air dominating

Aqueous Metal Cell

A non-lithium, aqueous metal-cell platform positioned for stationary storage

No single chemistry is optimal for all storage durations, environments and commercial cases

Application scale changes the best-fit technology

Residential

5–20 kWh
Li-ion dominant

Community

50–500 kWh
Li-ion / flow
options

Commercial

kWh to MWh
Li-ion, V-RFB, Fe-
RFB,

Industrial

MWh to GWh
Portfolio approach



- Fast-response services favour Li-ion systems.
- Longer-duration services may improve the relative competitiveness of flow batteries.
- For industrial loads, mixed chemistries can match different demand profiles.

Battery Energy Storage System Components

Core components: coordinated operation of battery packs, BMS and PCS

Thermal management: temperature-control strategies using liquid and air cooling

System integration: importance of modular design and standardised interfaces

Safety protection: multilayer protection circuits and fire-protection systems



Practical Decisions for Successful BESS

A BESS project succeeds when use case, site, technology and value stack align



Source: CSIRO & SED (2025), Insights on Consumer-based BESS in the Net Zero Climate of Australia

Where BESS creates value

Grid

Fast response, frequency support, voltage management and peak demand support

Industry

Power quality, resilience, behind-the-meter optimisation and decarbonisation

Community

Solar self-consumption, backup power and local energy resilience

A practical BESS is not just a battery: it is a grid-connected system designed around a use case.

Battery Energy Storage System Components

Which Battery Chemistry is/(will be) dominating in BESS?

A- LiB

B- NiMH – AMC

C- VFB

D- Na-ion

E- Metal Air

F- Lead Acid

Will Components change with Chemistries?

A- Yes

B- No

C- May be

D- I don't Know

Battery Safety and role of Components?

A- Yes

B- No

C- May be

D- I don't Know

The BESS design question is not “which battery?”

Use case

Backup, arbitrage, peak shaving, grid services, renewable firming

Sizing

Power (MW), energy (MWh), duration and cycling frequency

Location

Connection point, land, climate, access, fire separation and community interface

Controls

EMS strategy, forecasting, dispatch logic and protection coordination

Economics

Revenue stack, degradation model, augmentation and lifecycle costs

Safety: environment becomes part of the design envelope

Environmental Chamber



Temperature

High temperature accelerates degradation and can increase thermal runaway risk in Li-ion systems.

Humidity

Moisture can accelerate corrosion and affect external terminals, casing and electronics.

Salinity

Chloride-rich coastal air can accelerate corrosion and create conductive pathways.

Design implication

- Select chemistry and enclosure for local operating conditions – Pilbara.
- Treat HVAC, ventilation, detection and fire protection as core system design elements.
- Plan maintenance around degradation, corrosion and operational risk.



BESS and Battery Value Chain

Challenges and opportunities for Western Australia



Source: CSIRO & SED (October 2025), Insights on Consumer-based BESS in the National Climate Change Adaptation Strategy

WA opportunity: connect deployment with manufacturing and recovery

Critical minerals

Lithium, nickel, manganese,
graphite and future battery
materials

Manufacturing & integration

Pack assembly, controls,
power electronics, testing
and certification

Deployment

Grid, mining, remote
communities, industry and
behind-the-meter systems

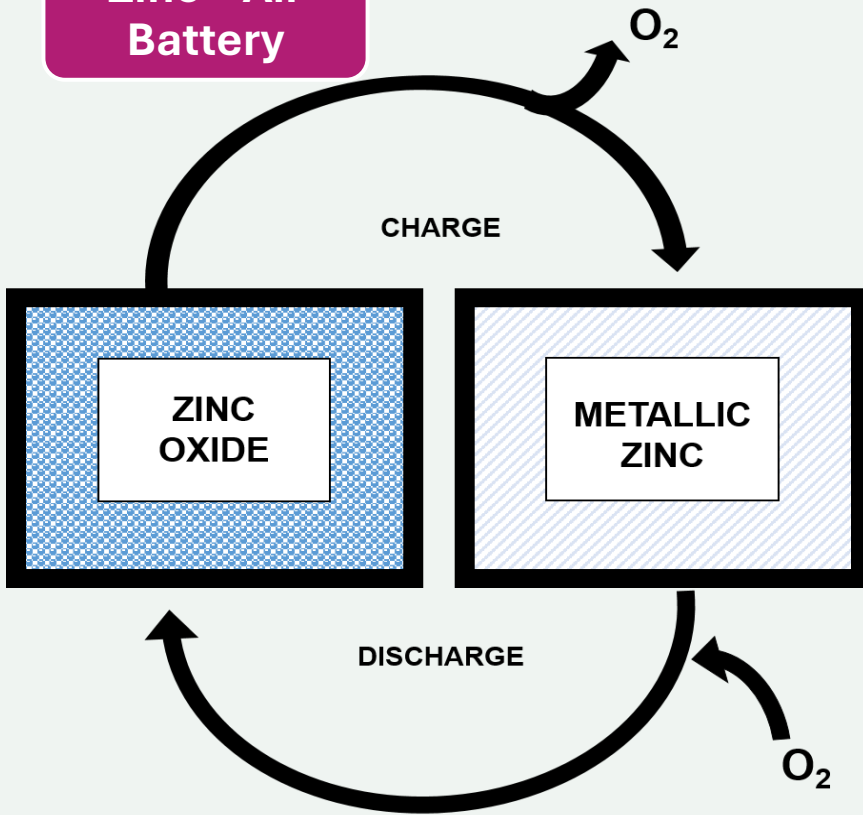
Recycling & recovery

Diagnostics, reuse, black
mass processing and
critical-metal recovery

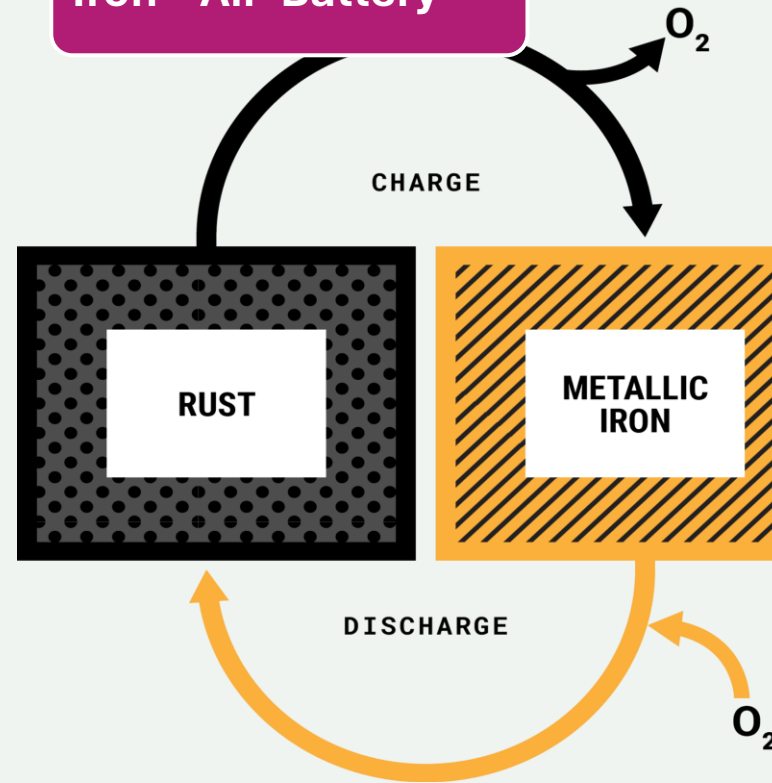
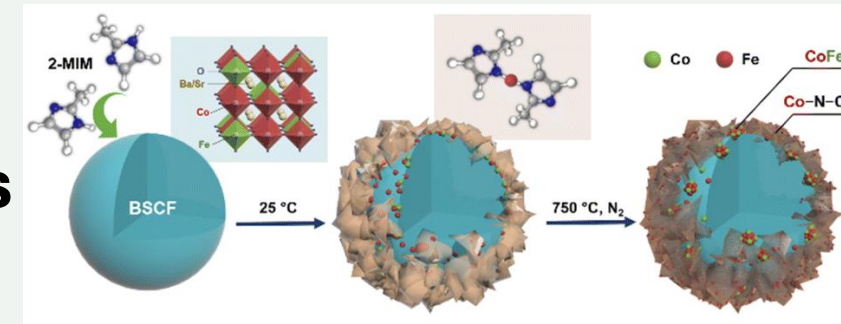
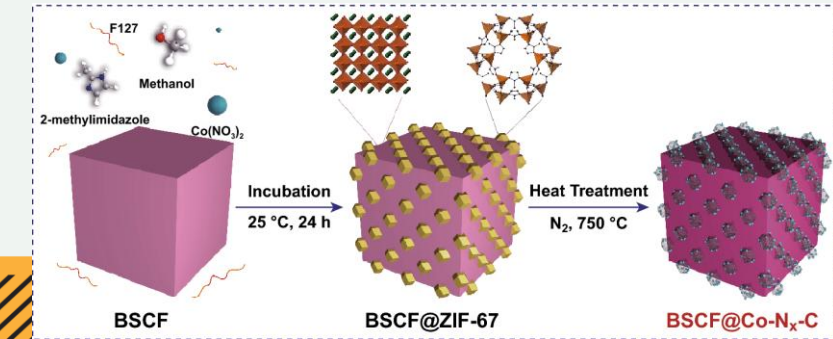
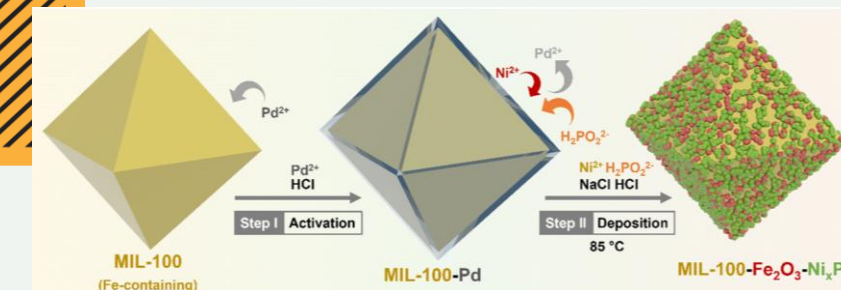
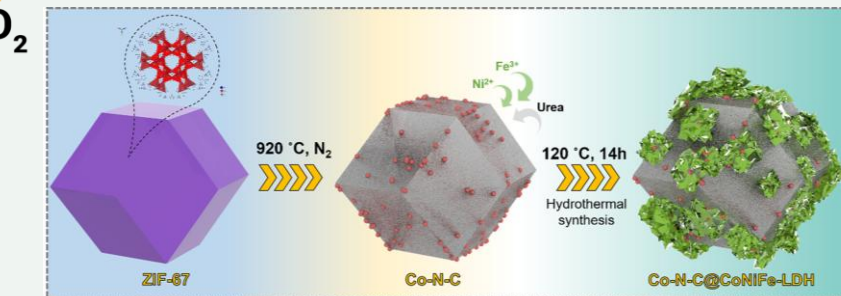
The strategic value is not only storing electricity; it is building a resilient battery ecosystem from minerals to systems to circular recovery.

Schematic Design of Rechargeable Metal Air Batteries

Zinc – Air Battery

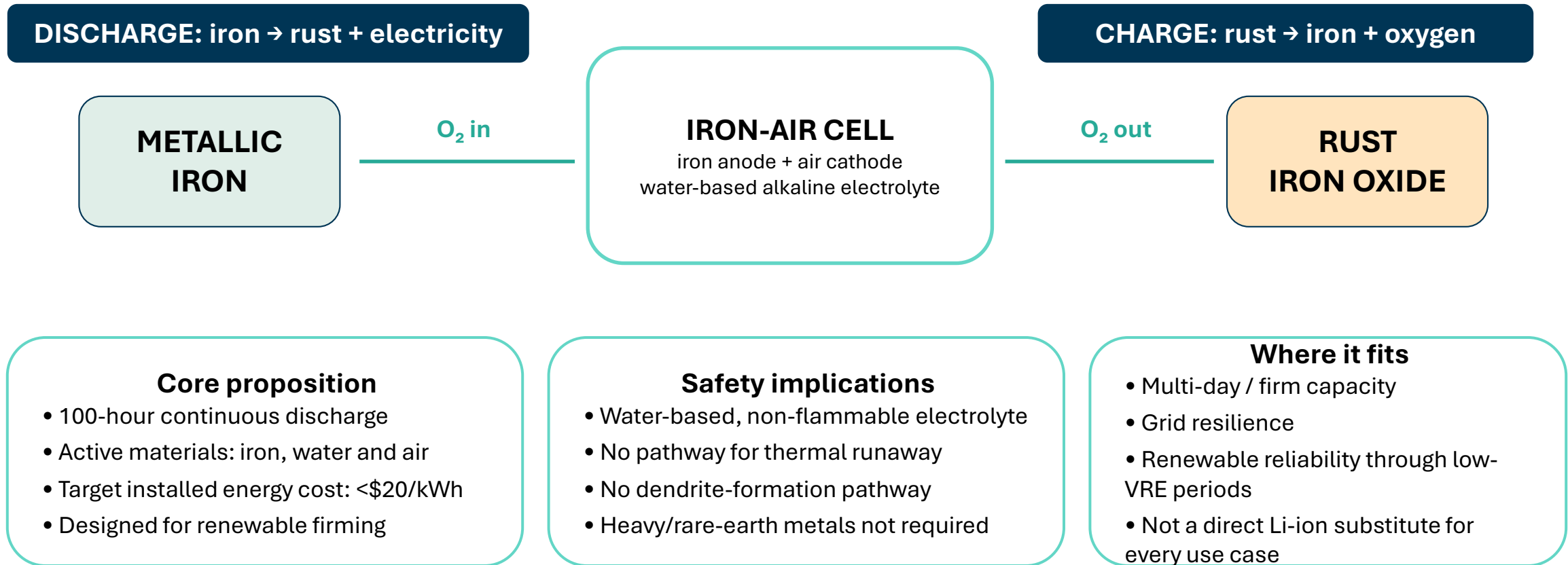


Iron – Air Battery



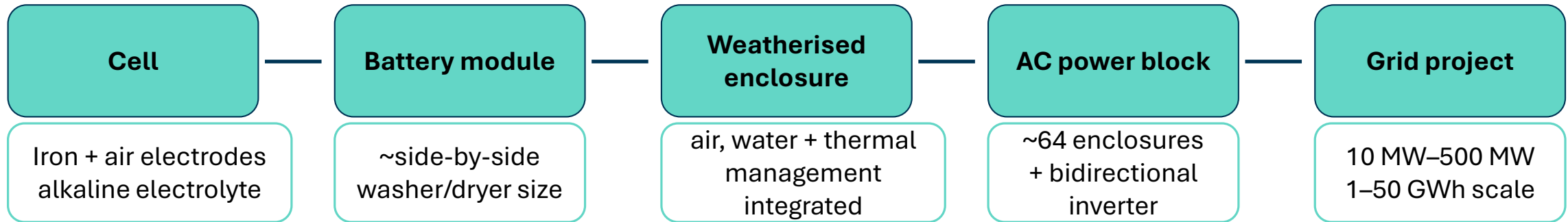
Iron-air battery: reversible rusting for multi-day storage

Complements lithium-ion by targeting long-duration capacity rather than high-power daily cycling



From cell to grid asset: Form Energy iron-air architecture

The engineering question is chemistry, modularity, site design and grid integration



Selected announced projects from Form overview



Teaching point: long-duration storage is a grid-planning asset — energy capacity, site footprint and integration architecture matter as much as cell performance.

Iron-air safety: different risk profile from lithium-ion BESS

Stable aqueous chemistry reduces thermal runaway risk, but hydrogen and caustic electrolyte still require engineered controls

What is reduced?

- No thermal runaway pathway
- No dendrite-formation pathway
- Non-flammable water-based electrolyte
- No uncontrolled destructive cell reaction under typical abuse triggers

What remains?

- Hydrogen evolution during charge
- Caustic electrolyte spill risk
- Need for ventilation / monitoring
- Need for containment, leak detection and safe-state control

How managed?

- Hydrogen kept below 25% of LFL
- Primary + secondary electrolyte containment
- BMS alarms and automatic power cut-off
- Site-specific emergency response planning

Certification pathway highlighted in the document

UL 1973	Cell / Module	Safety and reliability of electrical, thermal, mechanical and fire systems	2024
UL 9540A	Cell / Module / Enclosure	Thermal runaway fire-propagation test method	2024
UL 9540	System	System-level ESS safety and reliability standard	2025

Metal-air batteries in BESS: iron-air and zinc-air

Iron-air is directed to multi-day grid storage; rechargeable zinc-air remains more R&D / niche

IRON-AIR

Storage role

Multi-day stationary storage, firming renewables

Electrode chemistry

$\text{Fe} \rightleftharpoons \text{iron oxide/hydroxide}$ (“reversible rusting”)

Electrolyte

Water-based alkaline electrolyte

Strength

Very low active-material cost; stable safety profile

Constraint

Large, low-power-duration asset rather than compact high-power battery

ZINC-AIR

Storage role

Potential low-cost metal-air storage; more limited commercial BESS maturity

Electrode chemistry

$\text{Zn} \rightleftharpoons \text{zincate} / \text{zinc oxide}$ with air cathode

Electrolyte

Water-based alkaline electrolyte

Strength

High theoretical energy density and abundant zinc

Constraint

Air Cathode durability, zinc shape change/dendrites, carbonate management

Source note: the supplied Form Energy document supports the iron-air content. However, Zinc-air has higher energy density.

WA Resources and Metal Air Batteries

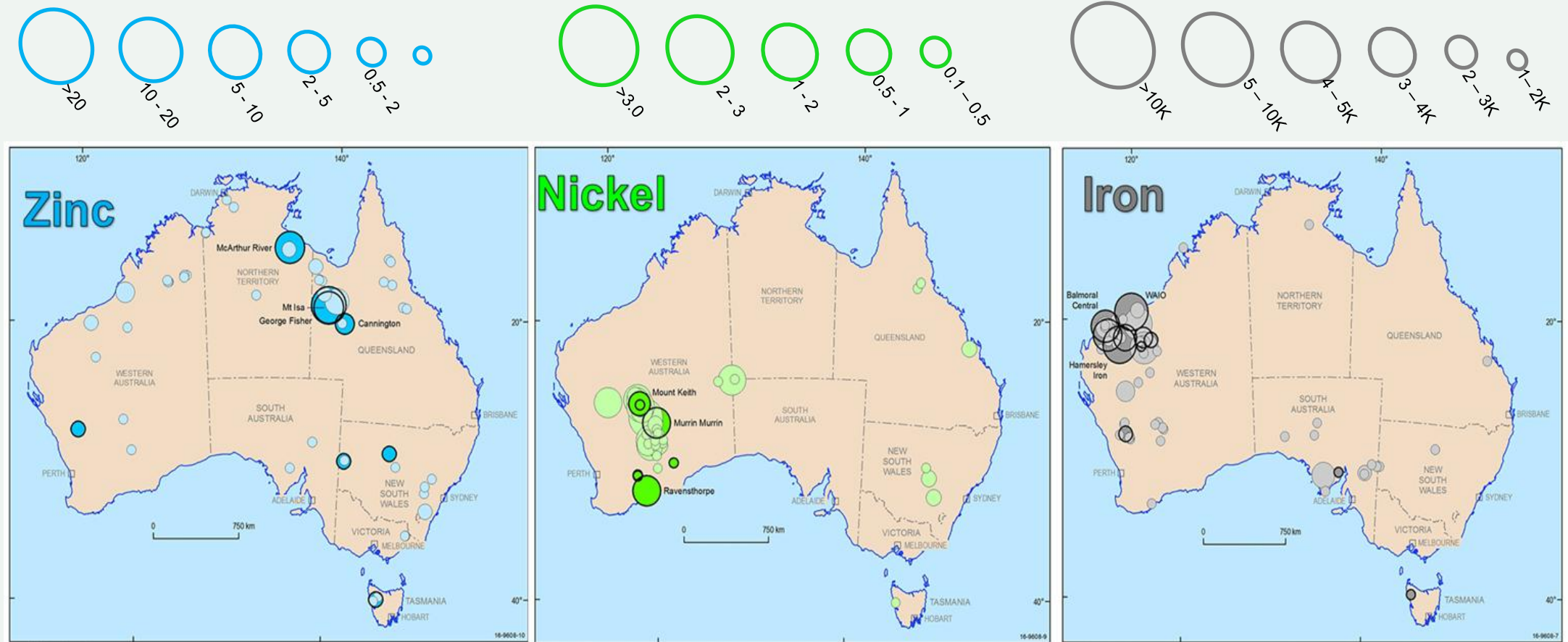


Figure: Major Mineral Deposits (Megatonnes) in Australia

Key takeaways

- 1** BESS enables higher renewable penetration by shifting energy and stabilising systems.
- 2** Chemistry choice must be driven by use case, duration, environment, safety and cost.
- 3** Components and controls are as important as cells for successful BESS projects.
- 4** WA can connect BESS deployment with critical-minerals processing, skills and circular economy.

Thank you

