Utility-Scale BESS: Recycling and Circular Economy

Second-life applications • Extended Producer Responsibility • and Material Recovery.

Tobias Dertmann (BESS Expert)

ADB

Global Energy Alliance
for people and planet

CESI
Inspired with innovation
IES
INTEGRATION
environment & energy

Tobias Dertmann

Energy Storage Specialist

Focus: grid-scale BESS, storage project development, feasibility, tender/EPC specifications and hybrid storage concepts.

6	years grid-scale BESS
18	years PSH / hydro storage
HYBRID	Floating PV + hydro-storage

BESS feasibility | **Siting & sizing** | **GFM / FFC use cases** | **Tender specs**

Typical scope: feasibility • techno-economics • RFP/tender documents • EPC specifications

BESS PROJECTS **Most relevant utility-scale battery storage assignments**

ADB Pakistan – First grid-scale BESS — 2×500 MW / 2 GWh

Site development • sizing • concept design • EPC specifications

ADB Georgia – First grid-scale BESS (FFC) — 200 MW / 200 MWh

Feasibility • layout • techno-economics • tender documents

ADB Cambodia – Grid-forming BESS (GFM) — 250 MW / 500 MWh

GFM use case • layout/design issues • implementation roadmap

ADB Bangladesh – First grid-scale project (FFC) — 150 MW / 150 MWh

Grid-scale BESS preparation • technical framing

Sri Lanka / CEB – First grid-scale BESS — 2×10 MW / 30 MWh

Feasibility • siting/sizing • RFP and technical specification

GIZ Pakistan – BESS regulatory support — regulatory

Standards • use cases • cost-benefit framing • stakeholder alignment

Positioning: independent BESS specialist supporting development from early screening through tender-ready technical documentation.

Agenda

1. **Second-Life Applications**
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2. **Extended Producer Responsibility**
3. **Material Recovery**
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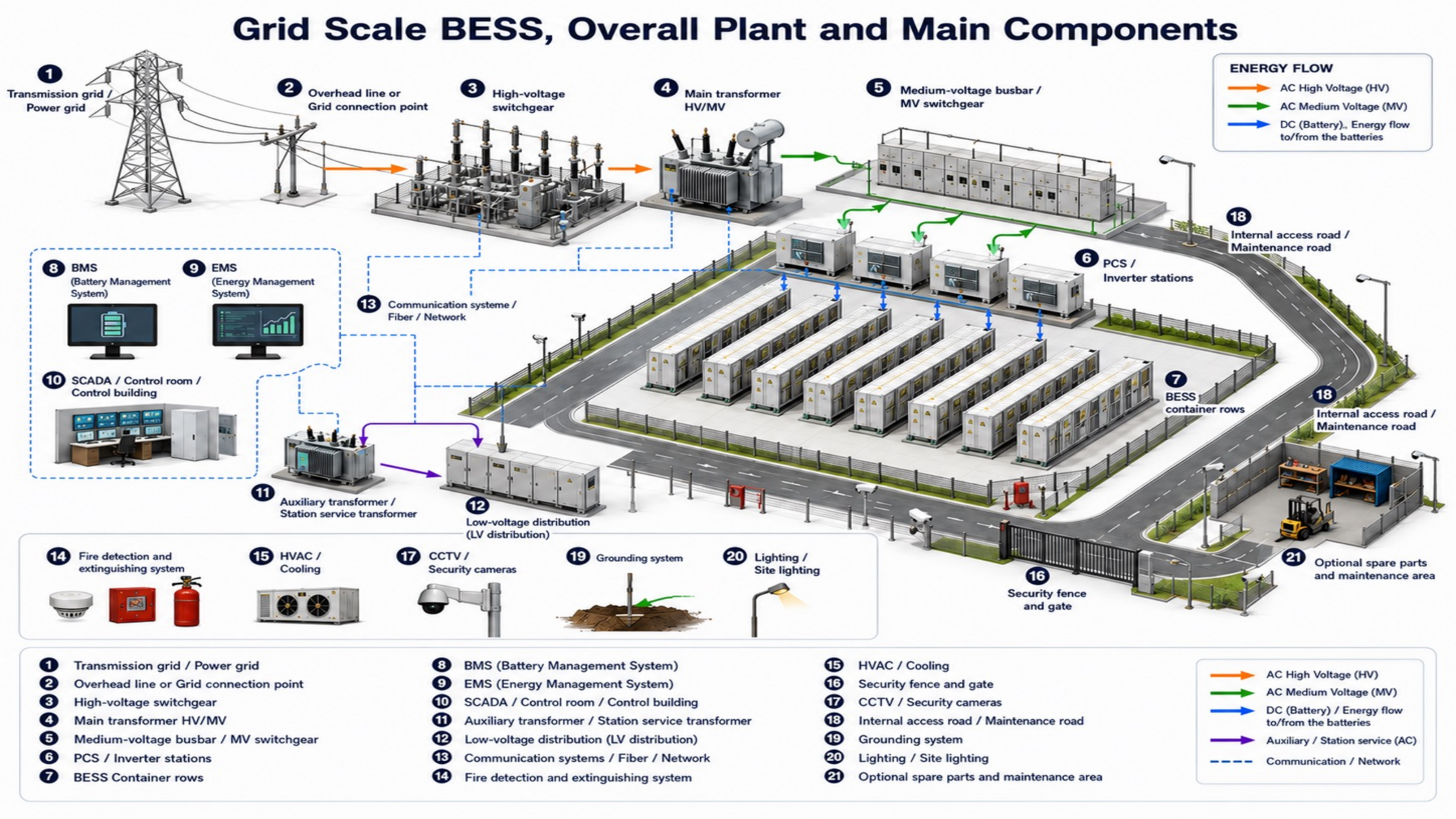
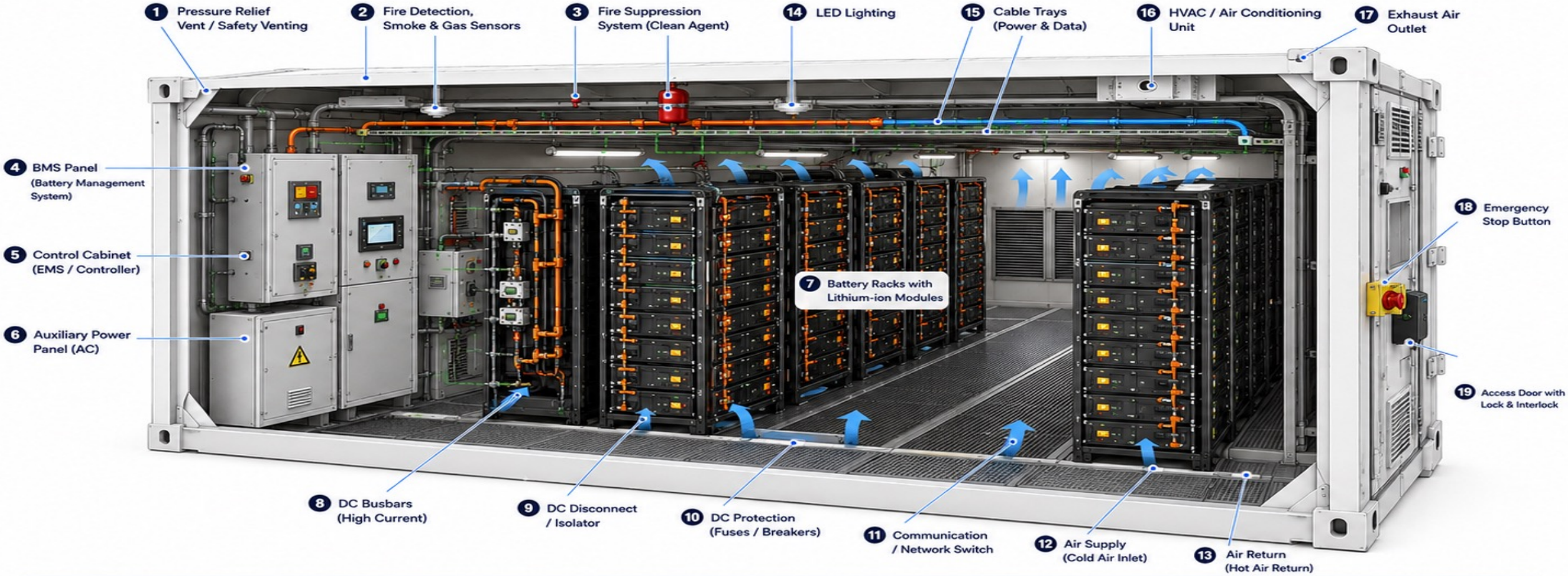
Grid Scale BESS, Overall Plant and Main Components



1. Transmission grid / Power grid
2. Overhead line or Grid connection point
3. High-voltage switchgear
4. Main transformer HV/MV
5. Medium-voltage busbar / MV switchgear
6. PCS / Inverter stations
7. BESS Container rows
8. BMS (Battery Management System)
9. EMS (Energy Management System)
10. SCADA / Control room / Control building
11. Auxiliary transformer / Station service transformer
12. Low-voltage distribution (LV distribution)
13. Communication systems / Fiber / Network
14. Fire detection and extinguishing system
15. HVAC / Cooling
16. Security fence and gate
17. CCTV / Security cameras
18. Internal access road / Maintenance road
19. Grounding system
20. Lighting / Site lighting
21. Optional spare parts and maintenance area

- AC High Voltage (HV)
- AC Medium Voltage (MV)
- DC (Battery) / Energy flow to/from the batteries
- Auxiliary / Station service (AC)
- Communication / Network

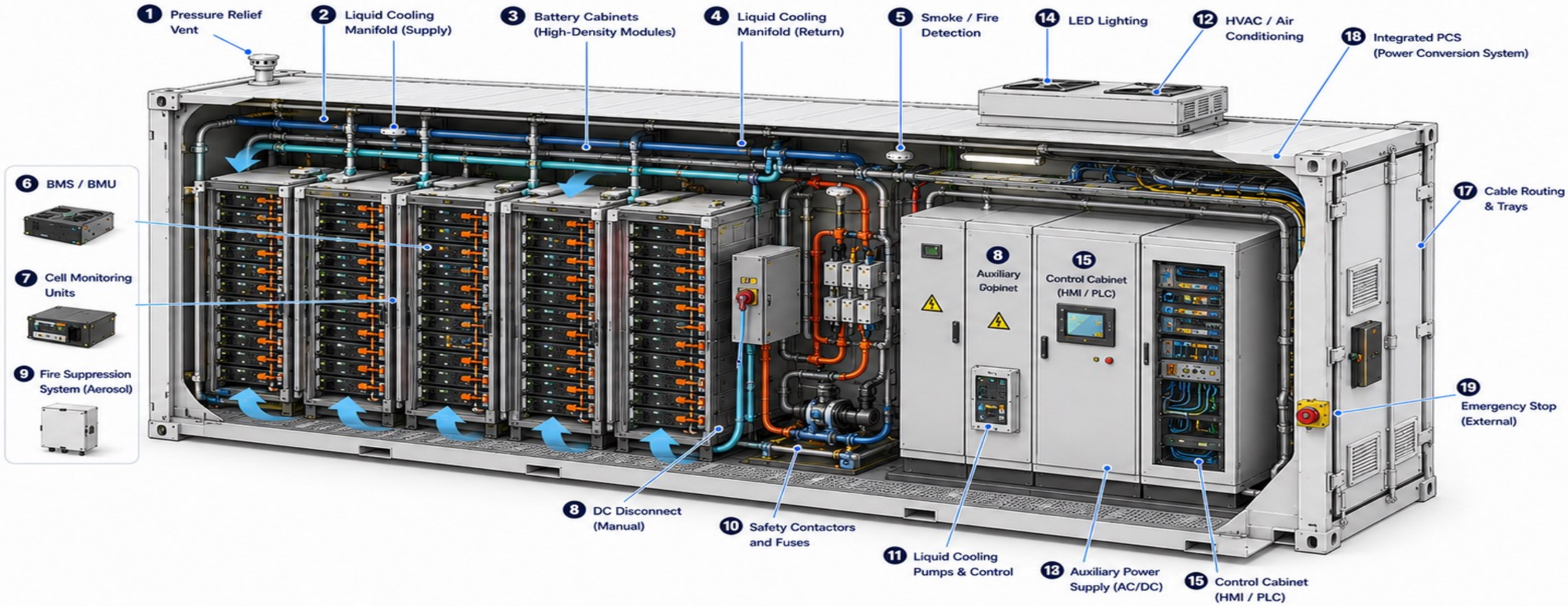
BESS Container, Type A, Rack-Based Walk-In System



1. Pressure Relief Vent / Safety Venting
2. Fire Detection, Smoke & Gas Sensors
3. Fire Suppression System (Clean Agent)
4. BMS Panel (Battery Management System)
5. Control Cabinet (EMS / Controller)
6. Auxiliary Power Panel (AC)
7. Battery Racks with Lithium-ion Modules
8. DC Busbars (High Current)
9. DC Disconnect / Isolator
10. DC Protection (Fuses / Breakers)
11. Communication / Network Switch
12. Air Supply (Cold Air Inlet)
13. Air Return (Hot Air Return)
14. LED Lighting
15. Cable Trays (Power & Data)
16. HVAC / Air Conditioning Unit
17. Exhaust Air Outlet
18. Emergency Stop Button
19. Access Door with Lock & Interlock

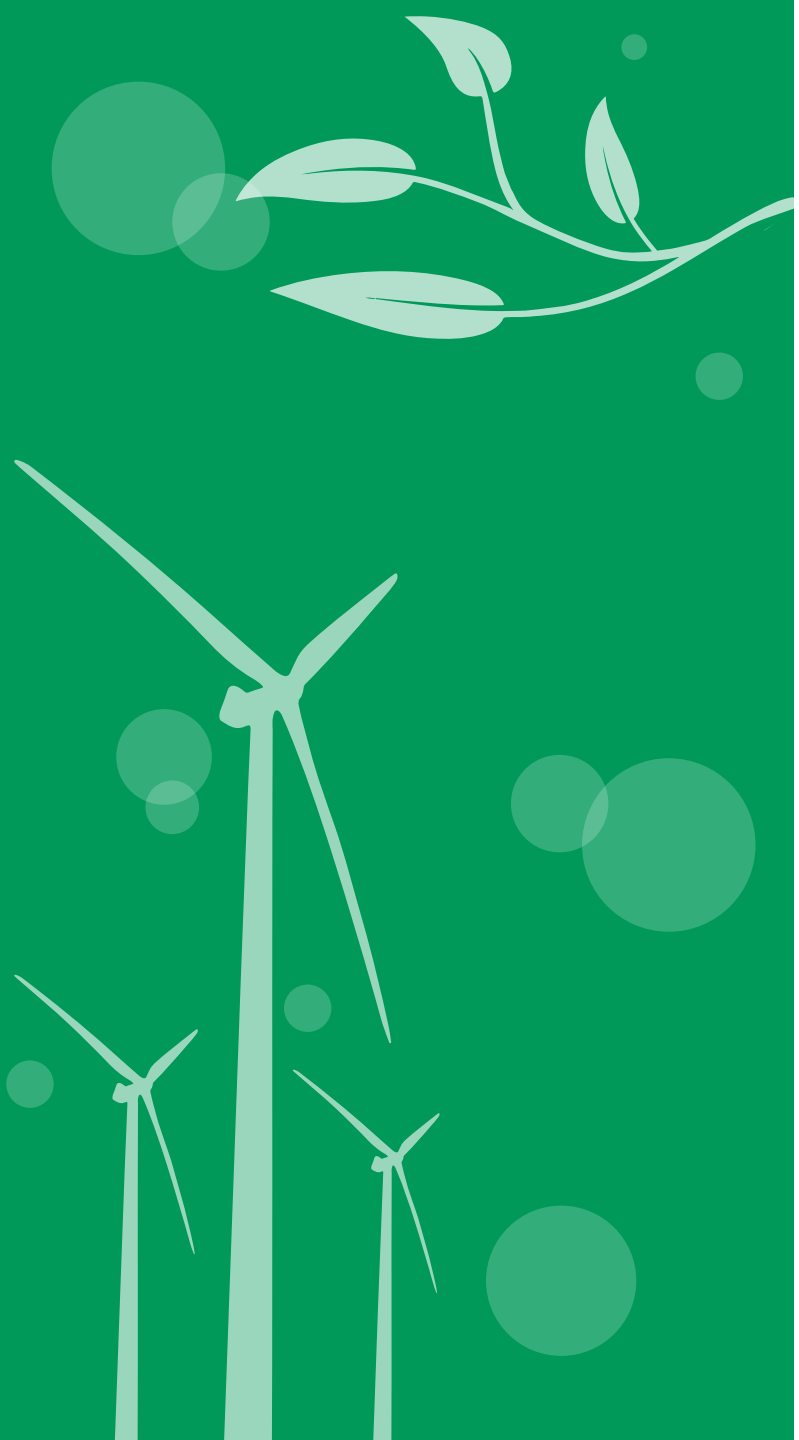
- DC Power (High Current)
- Cooling Airflow
- Data / Communication
- Temperature Monitoring
- Voltage Monitoring
- Safety & Protection Monitoring

BESS Container, Type B, High-Density Integrated System



1. Pressure Relief Vent
2. Liquid Cooling Manifold (Supply)
3. Battery Cabinets (High-Density Modules)
4. Liquid Cooling Manifold (Return)
5. Smoke / Fire Detection
6. BMS / BMU
7. Cell Monitoring Units
8. DC Disconnect (Manual)
9. Fire Suppression System (Aerosol)
10. Safety Contactors and Fuses
11. Liquid Cooling Pumps & Control
12. HVAC / Air Conditioning
13. Auxiliary Power Supply (AC/DC)
14. LED Lighting
15. Control Cabinet (HMI / PLC)
16. Communications Cabinet
17. Cable Routing & Trays
18. Integrated PCS (Power Conversion System)
19. Emergency Stop (External)

- DC Power Path
- Cooling Flow (Liquid / Air)
- Data / Communication



1) Second-Life Applications

Second-life Applications for Grid-scale BESS

From used EV battery modules to stationary grid-scale storage

1 Used EV batteries

2 Testing & sorting

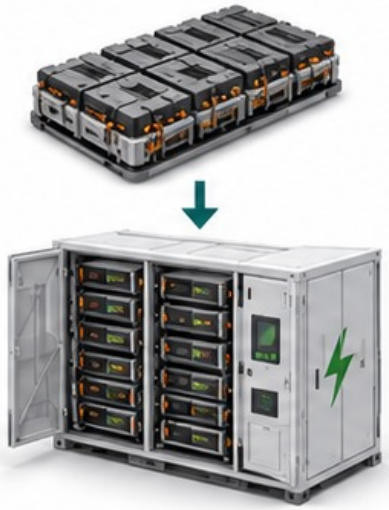
State-of-health check

Usable

Not usable

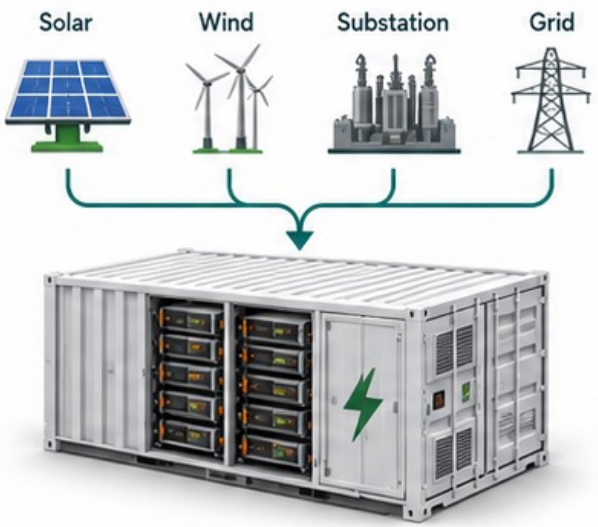
Recycling

3 Repurposing



Modules assembled into racks/cabinets

4 Grid-scale BESS



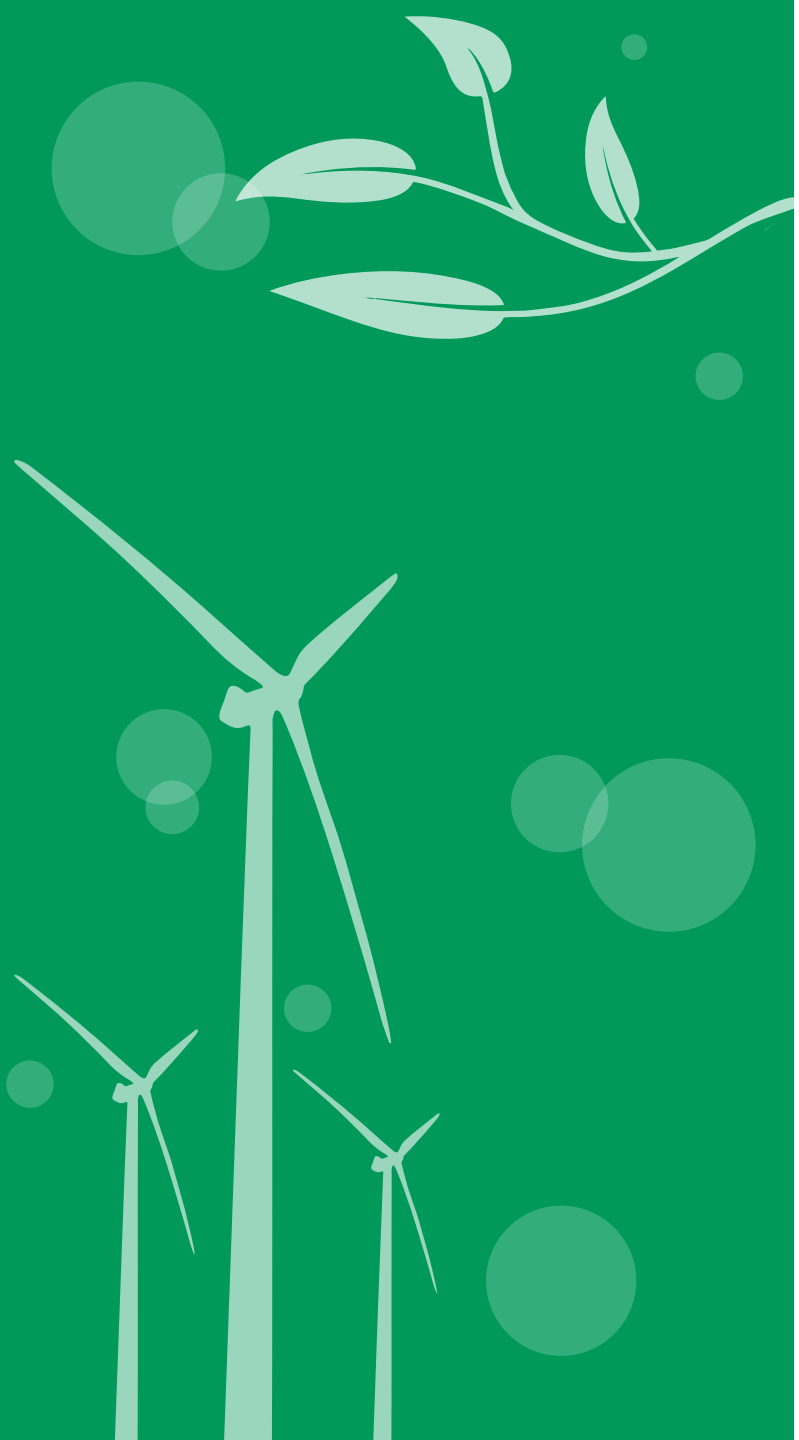
Containerized battery energy storage system

Key applications

- Renewable energy shifting
- Peak shaving
- Backup power
- Grid services

Key benefits

- **Lower material demand**
  Extend the life of valuable resources
- **Reduced CO_2 footprint**
  Cut emissions through reuse
- **Circular economy**
  Keep materials in use for longer



Key Takeaways
Second-Life Applications

- Second-life batteries are not waste, they are valuable assets

- Used EV cells or modules can still provide value in stationary storage systems after proper testing.

- Best suited for lower-stress grid applications
  They are especially suitable for energy shifting, peak shaving, backup power, auxiliary supply and reserve functions.

- Testing and grading are essential
  Only cells with sufficient remaining capacity, safe behavior and stable performance should be reused in grid-scale BESS. They reduce cost, material demand and CO_2 footprint.

- Second-life use extends battery lifetime, reduces demand for new raw materials and can lower overall storage costs.

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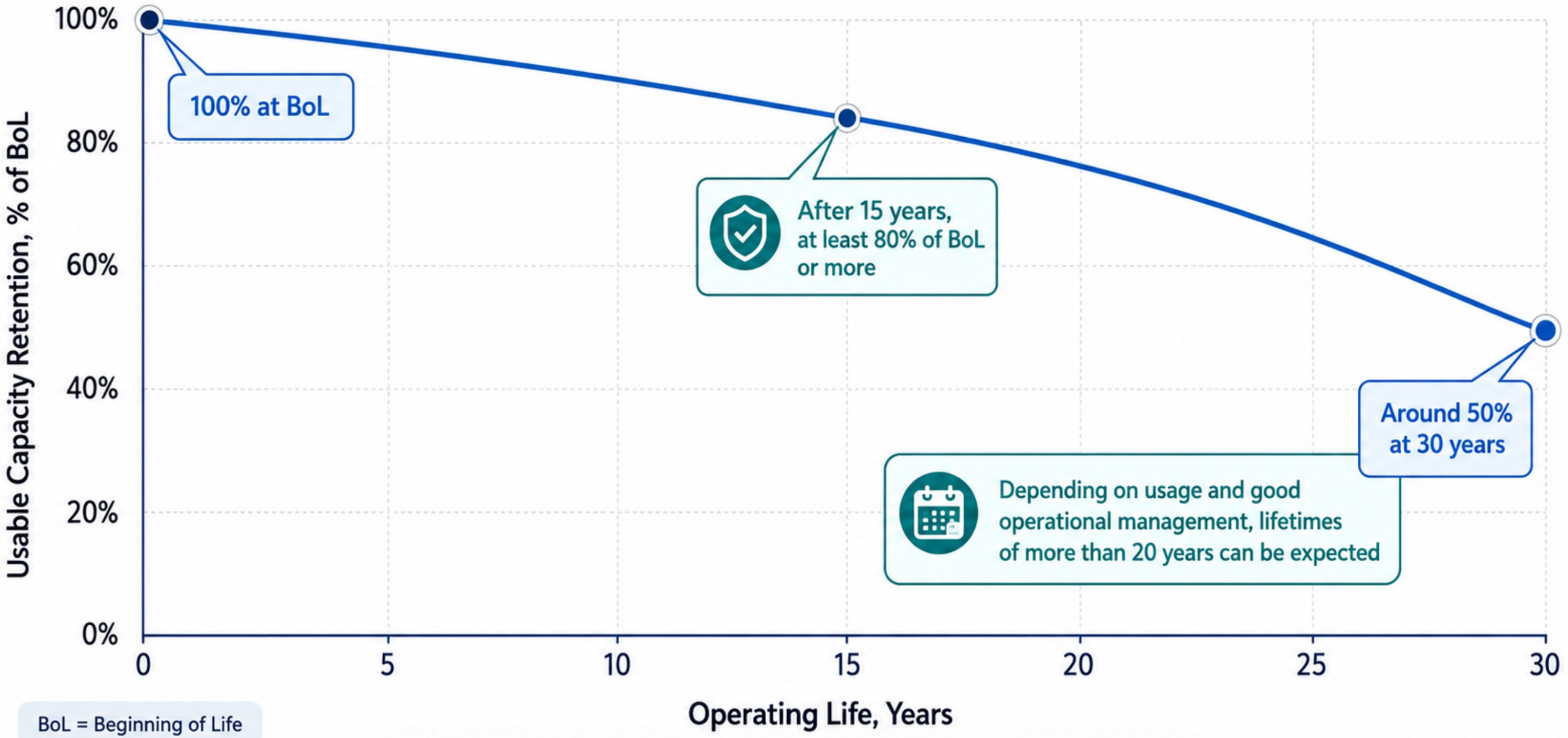
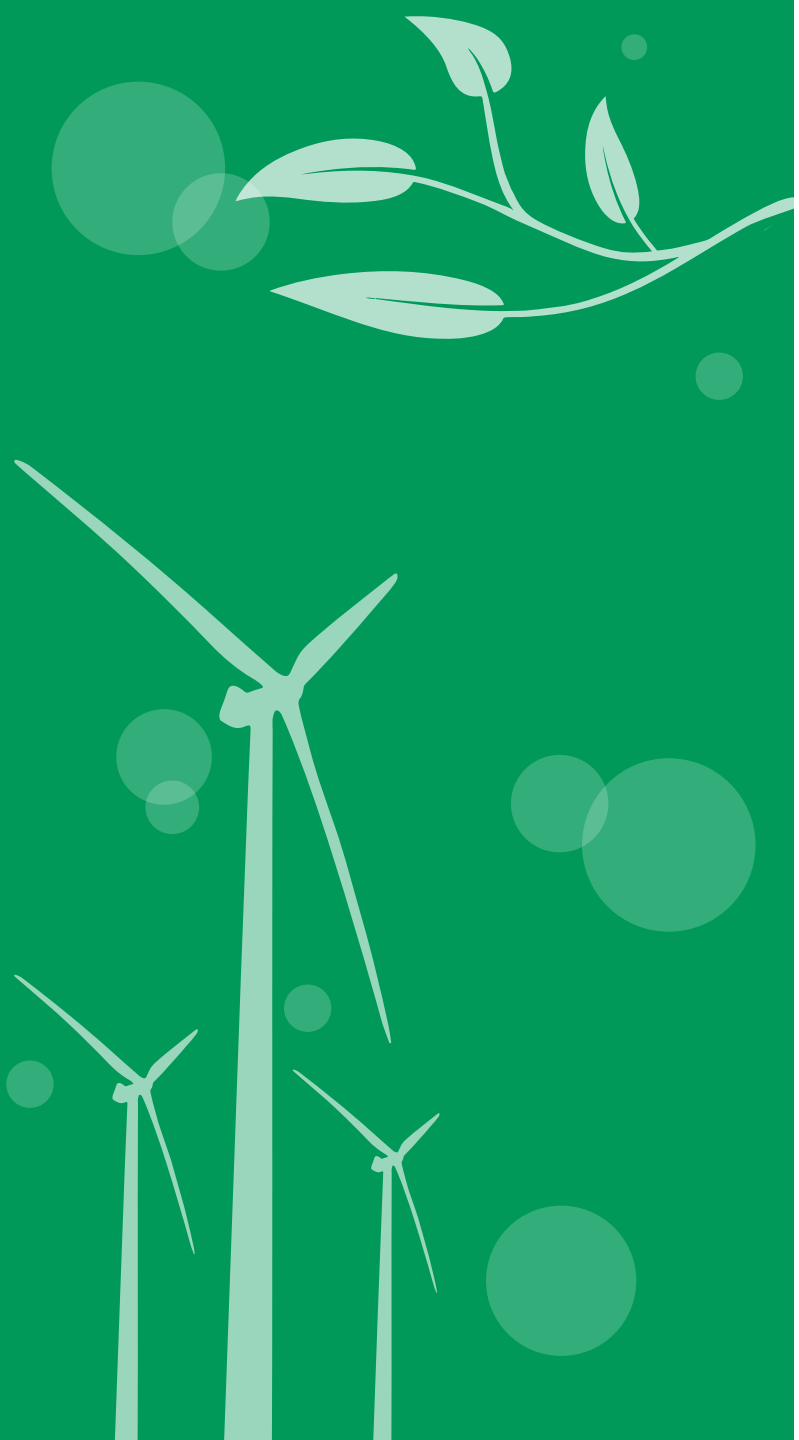
Modern BESS Degradation Curve Over 30 Years



BoL = Beginning of Life



2) Extended Producer Responsibility

Extended Producer Responsibility for Grid-Scale BESS

How producer responsibility extends from delivery to end-of-life, worldwide.

Global status

EU / EEA — STRONG
Strong EPR framework, industrial batteries covered, battery passport from 2027.

UK — STRONG
Industrial battery take-back and producer reporting.

India — DEVELOPING
Comprehensive battery waste rules for all battery types.

China — STRONG
Strong traceability for EV batteries, relevant for second-life BESS.

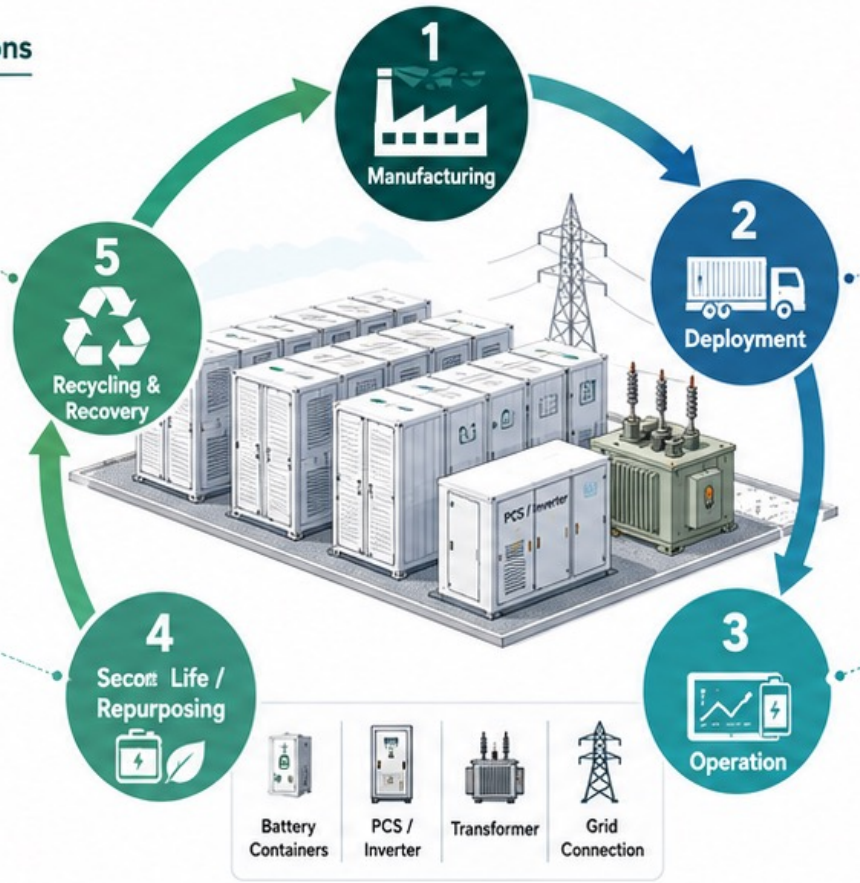
USA — PARTIAL
Fragmented, no unified nationwide EPR for grid-scale BESS.

Australia / Canada — DEVELOPING
Emerging or partial stewardship schemes.

Core EPR obligations

1. Take-back responsibility
Producer or importer remains responsible at end of life.

2. Traceability & reporting
Battery data, chemistry, serial tracking, compliance reporting.



3. Safe treatment
Transport, dismantling, fire safety, certified handling.

4. Recycling & recovery
Material recovery, circular economy, controlled disposal.

Real-world examples

Germany, TESVOLT + GRS
Producer-backed take-back and recycling.

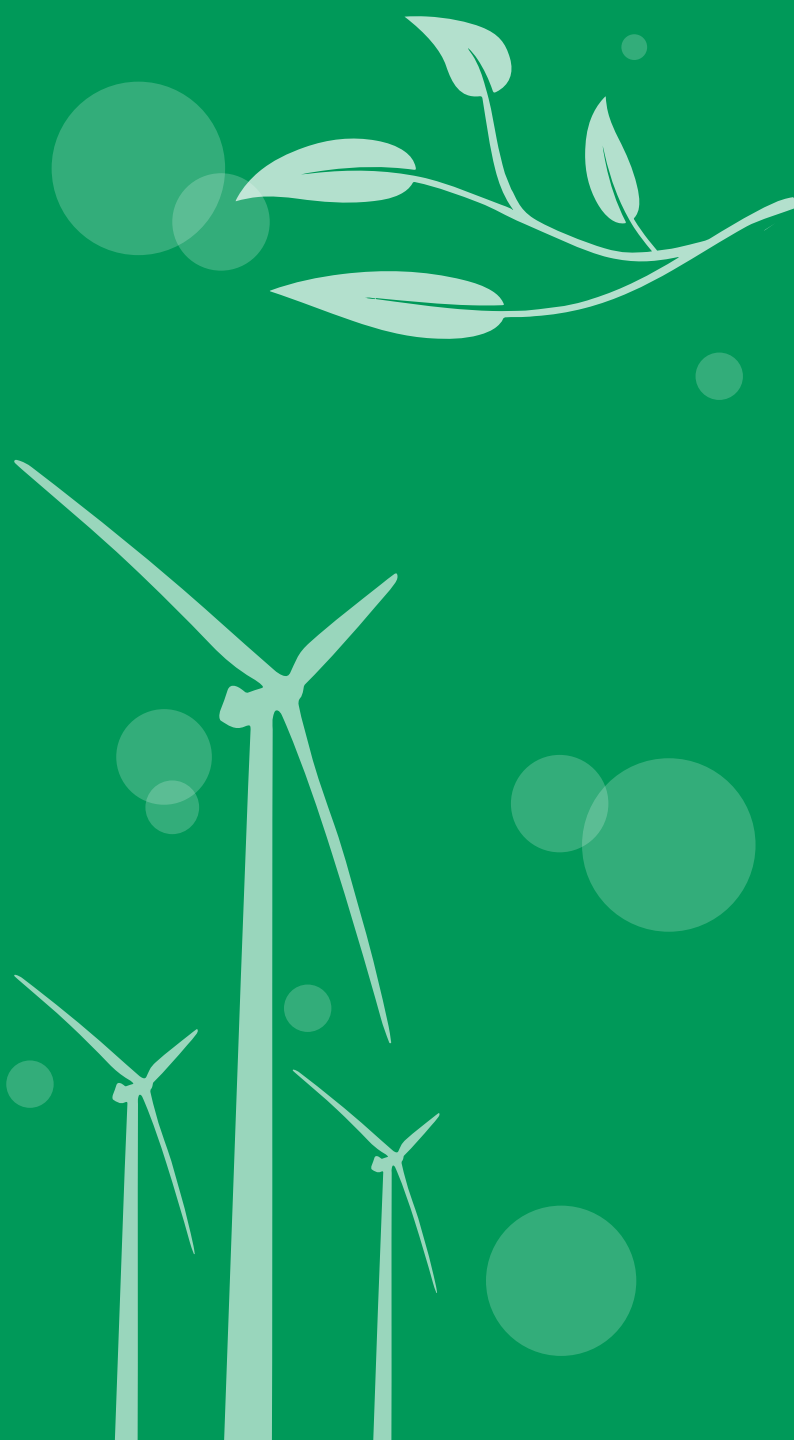
UK, Tesla
Industrial lithium-ion battery take-back.

Australia, B-cycle
Stewardship model, grid-scale still emerging.

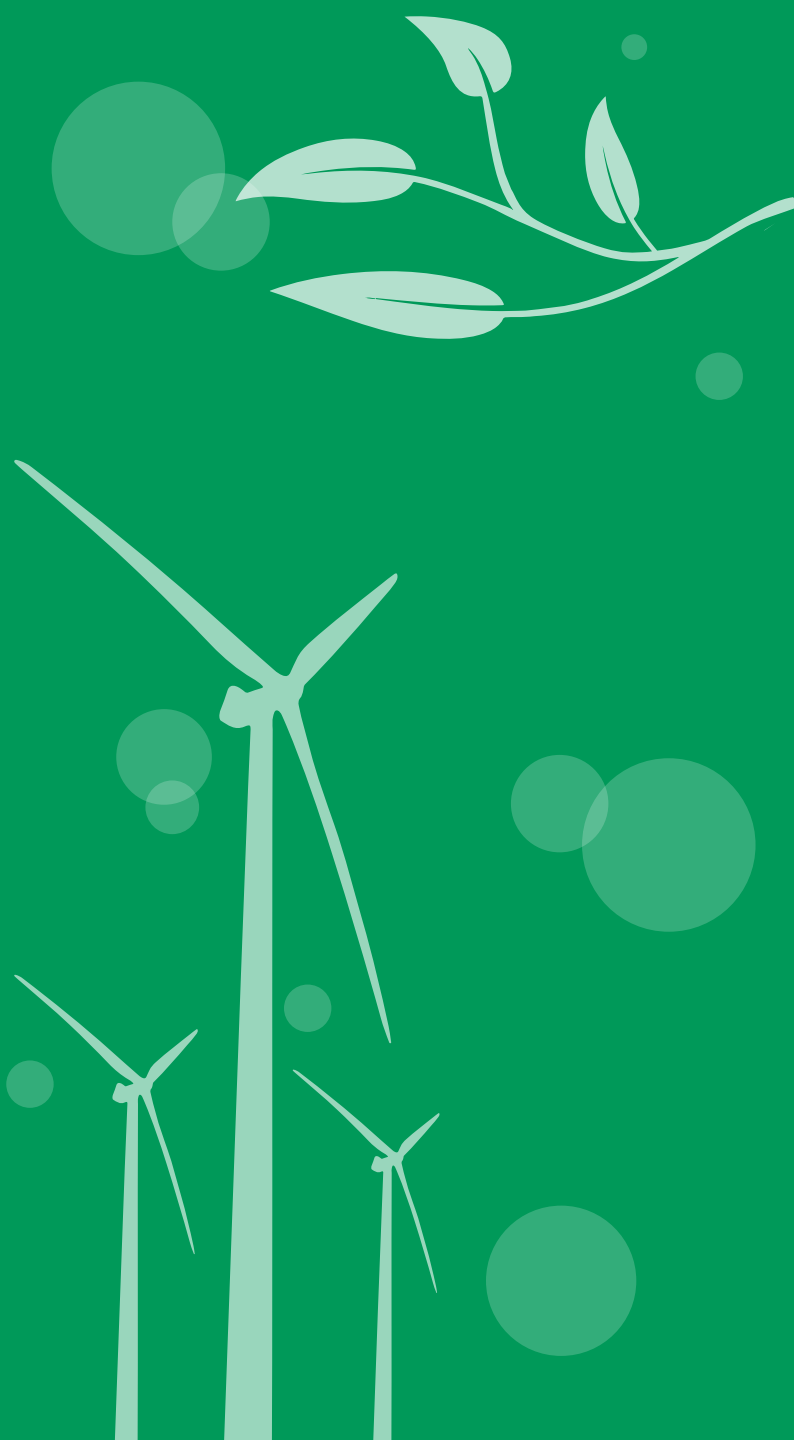
USA, Redwood
Second-life battery use before final recycling.

Why it matters for new BESS projects

- Contractual take-back
- Licensed recycler
- Battery passport
- Decommissioning plan
- Financial security



- Extended Producer Responsibility shifts end-of-life responsibility from the project owner to the producer, importer or supplier.
- For grid-scale BESS, Extended Producer Responsibility means more than recycling, it includes traceability, reporting, safe transport, dismantling and certified treatment.
- The EU, UK and India already have strong or developing battery Extended Producer Responsibility rules that are directly relevant for large stationary BESS.
- In the USA, Australia and Canada, Extended Producer Responsibility for grid-scale BESS is still fragmented or emerging, so contractual obligations are especially important.
- New BESS projects should include clear take-back guarantees, licensed recyclers, battery passport data, decommissioning plans and financial security from the start.



3) Material Recovery

Material Recovery

Materials in an LFP Cell, Raw Material Value and Recyclability

1 

LFP Cathode Material ($LiFePO_4$)

Raw material value: approx. 1–3 USD/kg

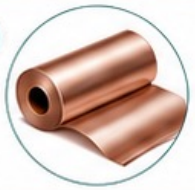
Recyclability: medium, Li/Fe/P recoverable

2 

Graphite Anode

Raw material value: approx. 3–8 USD/kg

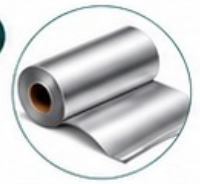
Recyclability: medium

3 

Copper Foil

Raw material value: approx. 9–14 USD/kg

Recyclability: very high

4 

Aluminum Foil

Raw material value: approx. 2–4 USD/kg

Recyclability: very high

5 

Electrolyte ($LiPF_6$ + solvent)

Raw material value: approx. 8–20 USD/kg

Recyclability: medium to difficult

6 

Separator (PE/PP)

Raw material value: approx. 2–5 USD/kg

Recyclability: limited

7 

Binder & conductive additives (PVDF, Carbon Black)

Raw material value: low value

Recyclability: low to limited

8 

Housing / Tabs / Structural parts

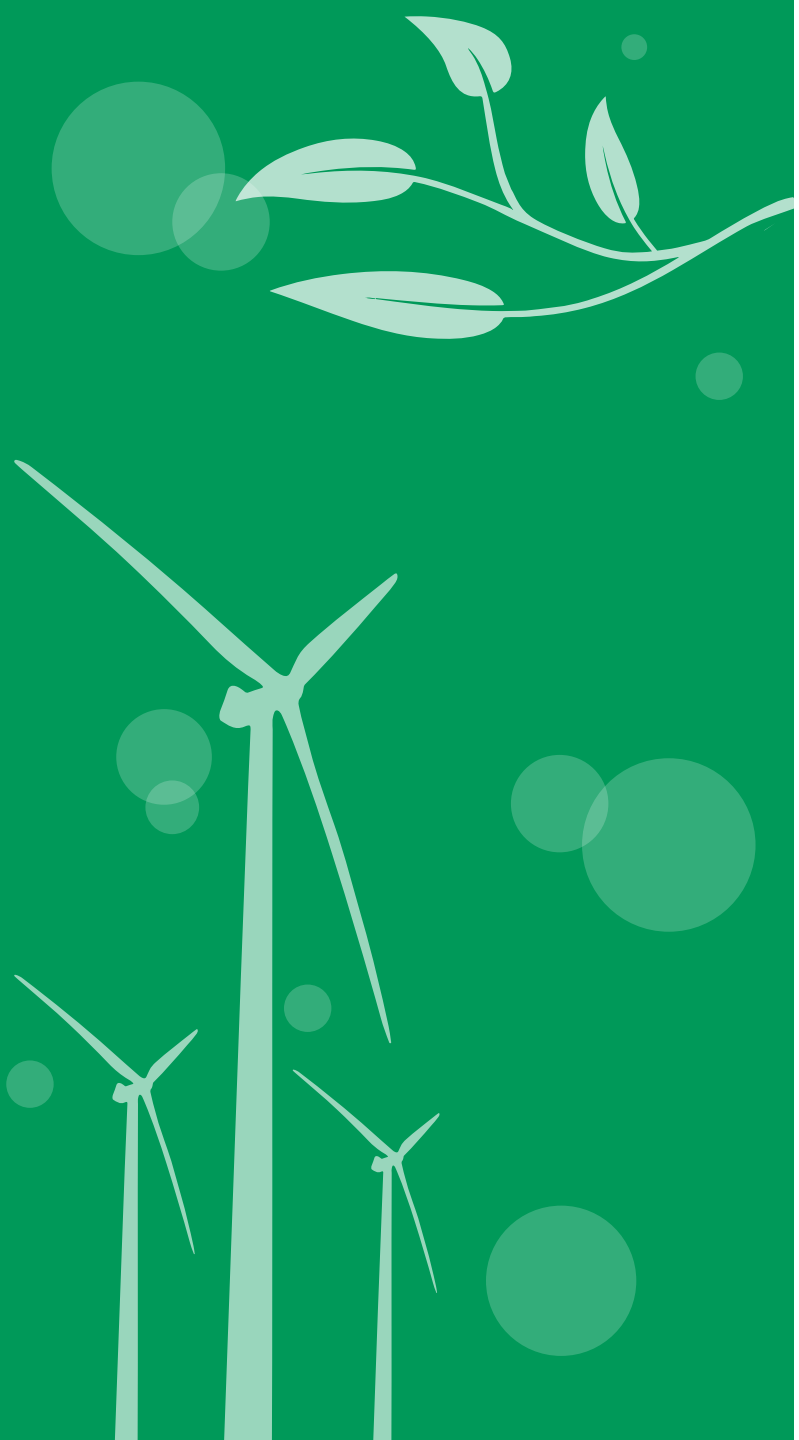
Raw material value: depends on Al/steel

Recyclability: high

Key Messages

- The highest recovery value often lies in copper, aluminum, and lithium.
- LFP contains no nickel and no cobalt, therefore the direct material value is lower than for NMC cells.
- Recycling still remains important, especially for lithium, graphite, and electrolyte management.

Note: Values are indicative and depend on purity, market price, and recycling process.



- LFP cells contain no nickel and no cobalt, so their direct material recovery value is lower than NMC batteries.
- Copper, aluminum and lithium are the main value drivers in LFP cell recycling.
- Metals are highly recyclable, especially copper foil, aluminum foil, housing parts and tabs.
- Graphite, electrolyte, separator and binders are harder to recover, but they are important for environmental and safety management.
- Material recovery becomes highly relevant at grid-scale, because large BESS projects contain many tons of recoverable materials and require clear end-of-life planning.