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The Sustainable Investor

Power me up, Scotty! Alpha generation in the battery revolution

Three reasons to be excited about batteries: (1) Thanks to innovation, ESS is turning intermittent renewables into baseload at increasingly competitive prices; (2) double-digit growth expectations in ESS additions driven by electrification, data centres and AI; and (3) batteries are an enabling technology for the three single-largest decarbonization levers: solar, wind and EVs.

Ideas galore in equities and credit: We have identified **46 stocks** with material exposure to the battery value chain, **19 are rated OW**. Nearly half of the universe is located in China or South Korea, with a further 10 in the Americas and 4 are Australian stocks. We include deep dives on OW-rated **Aneka Tambang, L&F, Sungrow, LGES, CATL** and **Samsung SDI**. We have also identified **8 credit issuers** with material exposure, with LGES and Nickel Industries rated OW by our analysts.

We identified 60 battery funds, totalling US\$15.2bn in AuM. China, South Korea and the US house 37%, 32% and 16% of AuM, respectively. After halving in 2021-24, battery funds saw inflows of 74% in 2025, driven by China.

Concentration challenges abound but are not insurmountable. Critical minerals account for c.50-70% of battery costs and are subject to price volatility, export restrictions, complex dependencies and concentration. China refines 85% of the world's supply of nickel, lithium, manganese and cobalt, and has a dominant share in the manufacturing of cell components across all key chemistries. NA, Europe, Korea and Japan are increasing efforts to diversify supply but need to secure access to raw materials, know-how and cost-competitive equipment. With the right investments, the emerging sodium-ion battery supply chain could grow to become a diversified alternative to the concentrated LFP chemistries.

Recycling: economics meets environmental action: Recycling will meet an increasing percentage of nickel, lithium and cobalt demand over the next 25 years, alleviating pressures on the supply chain and improving the environmental math of battery production. China today accounts for 85% of material recovery, but this could decline to 75% by 2030 as NA, Japan, Korea and Europe ramp up capacity.

For those dipping their toes into the space for the first time, our primer covers the basics of battery structure, applications (EVs, ESS, grid), chemistries (LFP, NMC, NCA), innovations (sodium-ion, solid state and long-term storage), plus regulation and incentives in the EU, US, China, India, and around the world.

Our sustainability analysis focuses on 13 sectors touched by the battery value chain, where we have identified 20 financially material issues spanning environmental risks, social & human capital, business model & innovation, and governance. We explore key standards and regulations, including the upcoming global battery passport to make supply chains "more visible, traceable, accountable and comparable", and finish with a bank of engagement questions.

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See page 63 for analyst certification and important disclosures, including non-US analyst disclosures.

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Why do investors care? By the numbers

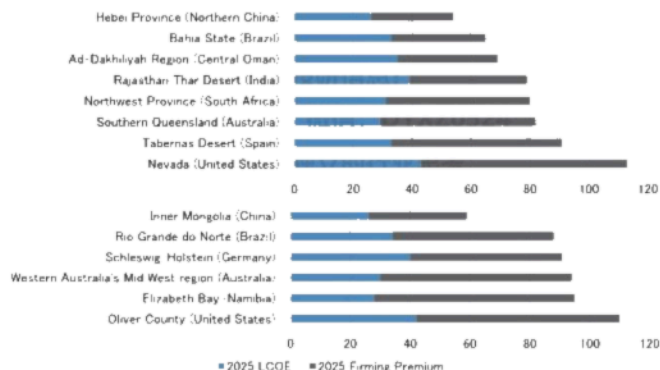
ESS can already turn intermittent renewables into baseload at competitive prices in some geographies, and innovation will make the economics increasingly attractive

Technically, it is possible to turn renewables into a high quality source of baseload energy with average capacity factors of >90% by combining solar PV, wind and battery storage. This level of reliability requires oversizing solar PV and wind installations to manage weather variability. For example, a project with 600 MW of solar PV and 400 MW/1 600 MWh of battery storage should be able to deliver 100 MW firm capacity. Despite the high levels of curtailment, IRENA estimates the LCOE of such an installation would be c. USD 75/MWh in China, USD 135/MWh in the United States and USD 180/MWh in the European Union ([link](#)). These are not extreme examples: many of the utility scale solar PV projects commissioned in 2024 could deliver firm electricity below USD 100/MWh, based on the simulated performance of 252 such projects, with some LCOEs going as low as USD 30/MWh, with a 90% reliability.

Innovation will likely continue to reduce the cost of “baseload renewables”. Even though battery costs have fallen by c. 90% in the past 15 years, strong patent activity suggests costs could continue to come down in the coming years. Energy storage accounted for 40% of energy patents in 2023, and according to the IEA’s analysis this share will likely have been higher in 2024 and 2025. No other energy technology has commanded such a dominant share in the past.

Figure 1: The cost of renewables+ ESS is competitive with baseload fossil fuels

LCOE and firm LCOE for selected solar PV and wind sites

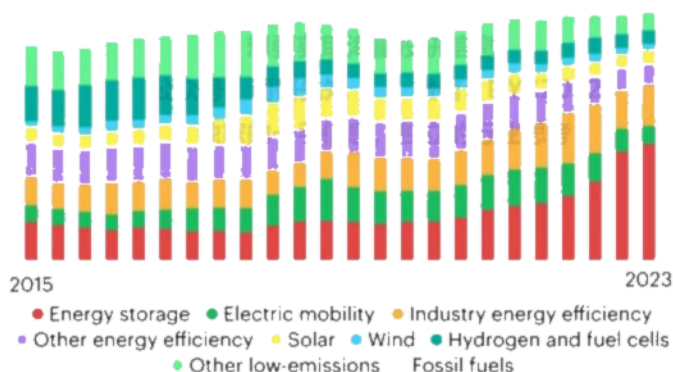


The firming premium refers to the additional costs of storage, as well as the additional renewable capacity needed to take reliability to 90%

Source: 24/7 Renewables: The economics of firm solar and wind, IRENA ([link](#))

Figure 2: Strong patent activity in battery storage suggests further cost declines ahead

Energy patents by technology, global



Source: IEA, the State of Energy Innovation 2026 ([link](#))

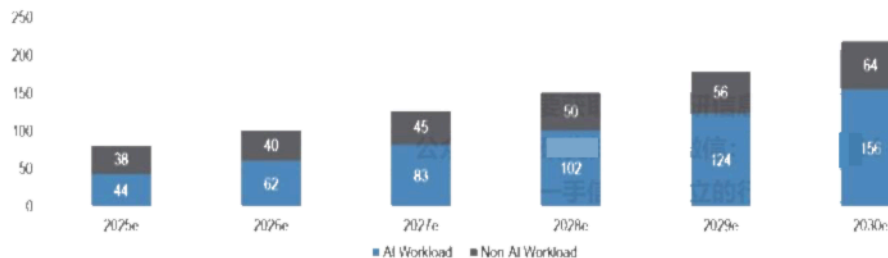
ESS can plug (part of) the demand for baseload energy from AI and datacenters...

The rapid growth registered in the past few years by the AI industry is expected to continue for the rest of the decade, driving up the demand for data centre capacity worldwide (Figure 3).

Data centres are energy-intensive, and continued growth in the industry will likely increase electricity requirements. Deloitte estimates that data centres could account for nearly 4% of global electricity consumption by 2030 ([link](#)), compared to just over 1% in 2024 ([link](#)). Some regions are investing more heavily in the AI revolution though. The US is home to around one-third of data centres ([link](#)), and BNEF estimates that they could account for nearly 9% of US electricity demand by 2035. There are high levels of uncertainty about future demand, though: a meta-study by [4E TCP](#) found that estimates of 2030 electricity use by US data centres ranged from ~200TWh to over 1000TWh.

Figure 3: Demand for data centre capacity could more than double by 2030E

Estimated global data center capacity demand, 'continued momentum' scenario, GW



Source: McKinsey Data Center Demand Model; Gartner reports; IDC reports; Nvidia capital markets reports ([link](#)). The 'Continued momentum' scenario is a balanced energy transition scenario by McKinsey that results in a global temperature increase of 2.3°C in 2100 ([link](#))

... Resulting in strong growth expectations for ESS

ESS demand is accelerating with AI power needs. For example, CATL estimates a 1GW datacenter could require 15-20GWh of ESS, highlighting the scale of storage required for modern AI workloads ([link](#)). Samsung SDI management cited US datacenter-use batteries growing at a ~30% CAGR through 2030E and datacenter-specific ESS at a

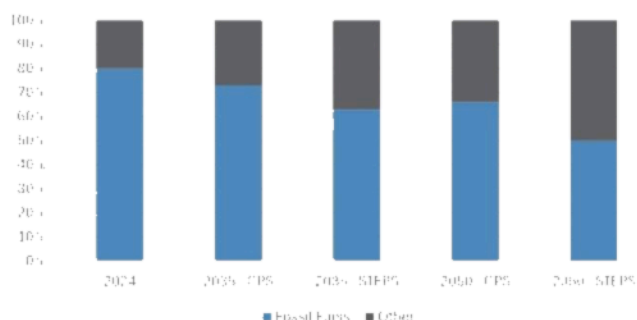
~60% CAGR, with orderbooks now covering 2-3 years of US capacity ([link](#)). Furthermore, data center operators are increasingly ordering BESS not just for speed-to-power and on-site generation, but to manage load fluctuations and ensure power quality stability ([link](#)).

After a very strong 2025, where ESS installations grew by almost 50%, BNEF estimates that *annual global ESS installations* will grow from 112GW in 2025 to 228GW in 2030, representing a 15% CAGR ([link](#)).

Batteries are at the heart of the two single-largest decarbonization levers: renewables and EVs.

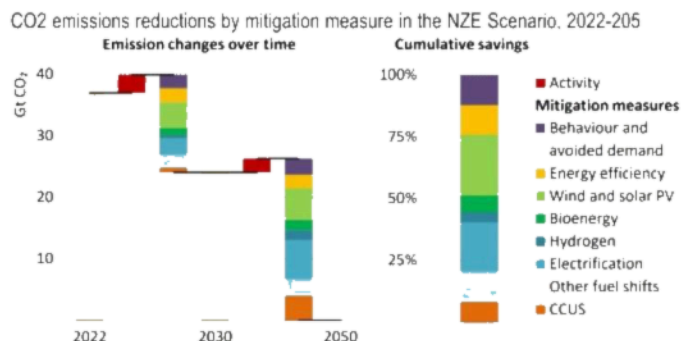
Fossil fuels still accounted for 80% of the global energy matrix in 2024 and, without further action, will continue to dominate for the foreseeable future: under the IEA's Continued Policies Scenario (CPS), fossil fuels would still represent ~65% of the global energy matrix by 2050 (Figure 4). However, accelerated adoption of renewables and EVs, both of which have batteries at their core, can change this. In their Net Zero scenario, wind and solar could deliver the largest emissions reductions (25%), followed by electrification (almost another 25%), with the remainder being accounted for by a tail of measures, such as higher efficiency, behavioural changes, switching to lower-emitting fuels, bioenergy, etc (Figure 5).

Figure 4: The world energy matrix remains dominated by fossil fuels



Source: IEA World Energy Outlook 2025 ([link](#))

Figure 5: Renewables and EVs could deliver almost half of the emissions reductions needed to reach Net Zero



Source: IEA Net Zero Roadmap, 2023 ([link](#))

Batteries 101

Batteries have been in use for over 200 years, but have seen rapid growth in the last decade, driven largely by the transition from internal combustion engine (ICE) vehicles to electric vehicles, along with the increasing need for energy storage solutions (ESS) to support grid stability, resilience and a larger proportion of renewable generation. Lithium-ion batteries account for nearly all of those used in EVs and stationary energy storage, but limitations of the technology have led to increased investment into new battery technologies such as solid-state and sodium-ion. In this section, we review basic battery structure, applications, chemistries and the latest innovations in the space.

Anatomy of a lithium-ion battery

Batteries store energy in the form of chemical potential, which can be converted into electrical energy to power a device. Most batteries consist of four main components:

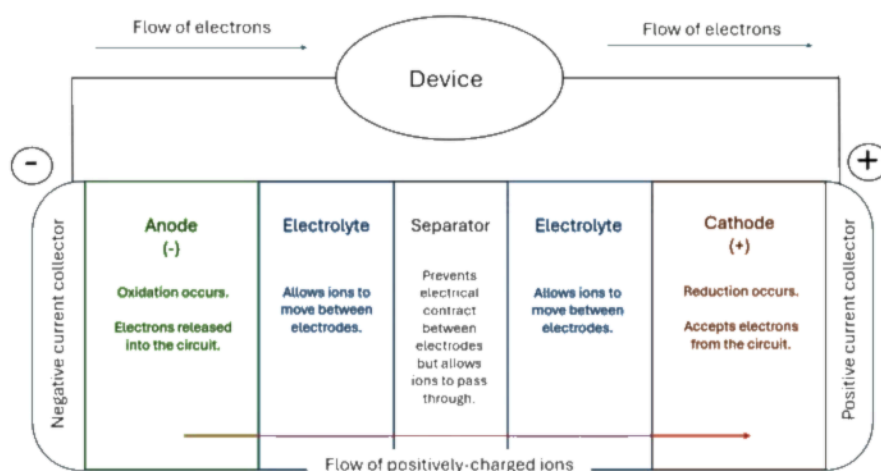
- **Cathode:** the positive electrode of the battery. When a battery has been fully discharged, most of the metal ions are stored here.
- **Anode:** the negative electrode of the battery. When the battery is fully charged, most of the metal ions are stored here.
- **Separator:** a thin, porous membrane that separates the anode and cathode and allows the ions to pass between the electrodes, while blocking the electrons (which move through the powered device instead).
- **Electrolyte:** a medium used to facilitate the movement of ions between the electrodes. Its composition plays a key role in the efficiency, stability and performance of the battery ([link](#)).

In lithium-ion batteries, the cathode is typically made of lithium metal oxides, the anode is composed of graphite and the separator is usually made of polyethylene or polypropylene.

When in use (i.e., discharging), the anode material (graphite with intercalated lithium) undergoes oxidation. This means that the lithium atoms that are intercalated within the graphite structure lose an electron to become positively-charged Li^+ ions, which then move from the anode to the cathode through the separator, which at the same time prevents the released electrons from flowing directly from the anode to the cathode. These are instead forced to move from the negative current collector to the positive one through the device that is being powered.

When a battery is being charged, the process is simply reversed: ions move from the cathode back to the anode, gaining their electrons back (a process known as **reduction**) and intercalating themselves into the graphite, thus allowing the electrical energy to be stored within the anode (Figure 6). An external power source is required for this to happen, as it is not a spontaneous reaction.

Figure 6: Diagram of a battery during discharge



Source: J.P. Morgan.

Types of batteries

Batteries can be split into primary, which are designed to be single-use and cannot be recharged, and secondary, which can be repeatedly recharged. **Primary batteries are mainly found in portable electronics** (cylindrical, coin, button cells), whereas **secondary batteries are used in EVs, energy storage and rechargeable electronics**. Lithium-ion has become the dominant technology used in secondary batteries in the last decade, with costs falling by 90% between 2010 and 2023, and now account for almost all batteries used in EVs and energy storage ([link](#)).

Lithium-iron phosphate (LFP) and lithium nickel manganese cobalt oxide (NMC) are the two most common chemistries used for cathodes in lithium-ion batteries (graphite is consistently used for anodes), but others such as lithium nickel cobalt aluminium oxide (NCA) and lithium cobalt oxide (LCO) are also well established. Below we highlight the major types of primary and secondary batteries currently used.

Primary (non-rechargeable):

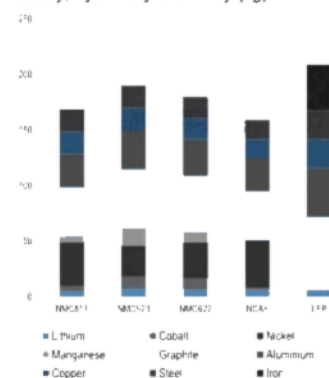
- **Zinc-carbon** batteries are budget-friendly, single-use cells commonly used for low-drain devices, such as wall clocks and calculators, that require a relatively low capacity.
- **Alkaline** (dry-cell) batteries deliver more energy and higher load currents than zinc-carbon, and has become the most commonly-used type of primary battery. Major suppliers include Energizer, Duracell (owned by Berkshire Hathaway), and Panasonic.

Secondary (rechargeable):

- **Lithium-ion batteries** are the most commonly available batteries today. These are usually classified by the composition of their cathodes, the main chemistries being lithium nickel manganese cobalt oxide (NMC), lithium nickel cobalt aluminium oxide (NCA), lithium iron phosphate (LFP), and lithium cobalt oxide (LCO). LCO batteries are typically found in portable electronics, whereas the other three are used in EVs and ESS.

Figure 7: Lithium makes up a small part of lithium-ion batteries

Mineral content of a 60kWh lithium-ion battery, by battery chemistry (kg)



Source: Visual Capitalist ([link](#))

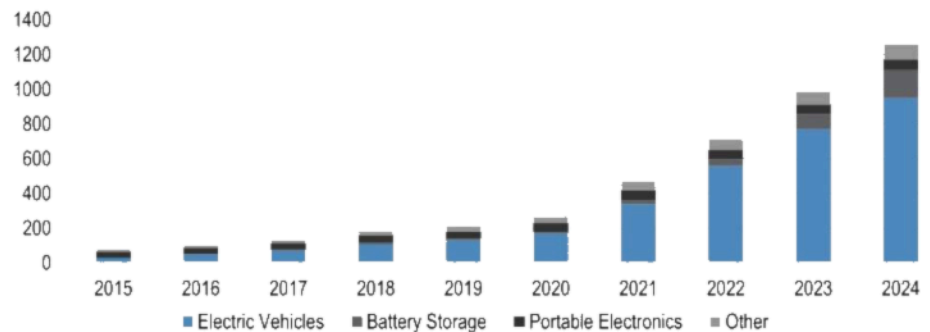
- Lithium-iron phosphate (LFP)** do not require nickel or cobalt. A key advantage of LFP is its ability to be charged to 100% without significant degradation, whereas NMC batteries are typically limited to 80% to maintain performance ([link](#)). LFP batteries are also cheaper and less flammable than those based on nickel chemistries. LFP batteries made up nearly half of global EV batteries in 2024, and over 90% of new stationary energy storage solutions ([link](#)). In China, **CATL is the leader in LFP battery shipments** (44% of total), with **BYD** supplying a further 21%, and **EVE**, **CALB** and **Gotion High-tech** making up the largest players ([link](#)).
- Lithium nickel manganese cobalt oxide (NMC)** is the other common type of lithium-ion battery used in EVs. A key advantage is energy density, which exceeds that of LFP batteries by both volume (Wh/L) and mass (Wh/kg). However, NMC cells were over 30% more expensive than LFP as of August 2025 ([link](#)), largely due to their more-varied mineral requirements (Figure 8), whilst they also suffer from shorter lifespans. **CATL is the dominant provider of NMC batteries**, with 77% market share in the Chinese market, followed by **LG Energy Solution** and **CALB** ([link](#)).
- Lithium nickel cobalt aluminium oxide (NCA)** has a higher energy density but it is more expensive, has a shorter life cycle and lower thermal stability than the other two main lithium chemistries. Nowadays it is used in specialist environments that prioritize a longer driving range (it is the chemistry favoured by Tesla, for example), light weight (drones) or power. Unsurprisingly, NCA lost share in favour of the previous two technologies, which are cheaper and more stable, accounting for just 7% of the global EV sales in 2023 (from over 25% in 2018).
- Lead-acid** batteries were invented in the 19th century ([link](#)) and were the first widely-used battery power system. They are typically made up of lead dioxide cathodes, lead anodes and sulfuric acid acting as the electrolyte. When the battery is discharging, the lead and lead dioxide form lead sulfate on both electrodes, producing electrical energy. When charging, the lead sulfate is converted back into lead and lead dioxide. Lead-acid batteries tend to have lower upfront costs, but a shorter lifespan than comparable lithium-ion batteries ([link](#)), whilst the raw materials used make them heavier and much less energy dense. The relative simplicity of lead-acid technology improves recyclability, with a 99% recycling rate in the US ([link](#)). Starter batteries can provide short bursts of high-surge currents at low costs, making them well suited for use in **automotive starting systems**, whilst deep-cycle and industrial batteries can provide a low, steady supply of power for use in various electrical accessories and back-up power services ([link](#)).
- Flow battery** systems use liquid electrolyte tanks to allow for scalable capacity, allowing them to provide a stable electricity supply over longer-durations, and making them suited to stationary energy storage applications ([link](#)). However, the use of batteries for long-duration energy storage (LDES) remains limited, with just 1GW of installed capacity in 2024, compared to roughly 150GW in pumped hydroelectric storage (PHS) ([link](#)).
- More recently, **sodium-ion batteries** are gaining momentum as a serious alternative for ESS applications, and new advances in **lithium-sulphur**, **iron-air** and **solid-state** chemistries are emerging. We discuss these four technologies in more detail in the last section of this chapter.

What are they used for?

According to the IEA, the market for lithium-ion batteries (which account for the vast majority of batteries produced) grew to over **US\$150 billion** in 2025, with **deployment growing by a factor of six since 2020** ([link](#)). This significant growth has largely been driven by the rise of electric vehicles and battery storage, which accounted for 75% and 13% of demand respectively in 2024, compared to 2015 when they accounted for less than 40% of demand collectively, and nearly half of the deployment went to portable electronics (Figure 8). This growth is set to continue, with our fundamental analysts forecasting global annualized growth rates of 16% for EV shipments and 24% for ESS shipments between 2025 and 2030 ([link](#)).

Figure 8: Electric vehicles accounted for the majority of battery demand in 2024

Lithium-ion battery deployment, by application (GWh)



Source: IEA

Electric Vehicles

Electric vehicles are the most prominent consumer of batteries, with the industry growing rapidly in the last 10 years. In 2014, just 0.3 million electric vehicles (battery and plug-in hybrid) were sold worldwide, whilst in 2024 this grew to over 17 million (Figure 9). China has consistently been the main driver of EV battery demand, accounting for 59% of global demand in 2024, compared to 13% for both the EU and the US (Figure 10).

Figure 9: Over 17 million EVs were sold worldwide in 2024...

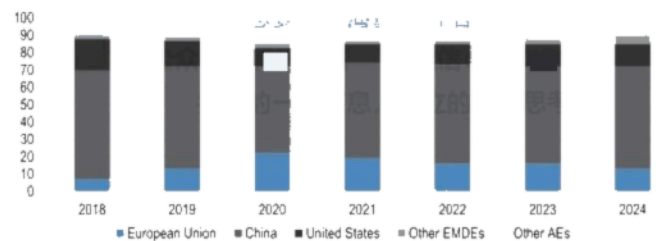
Annual EV sales, million



BEV = battery electric vehicle PHEV = plug-in hybrid electric vehicle.
 Source: IEA

Figure 10: ... with China accounting for 59% of the demand for EV batteries

Global share of EV battery demand, by region (%)



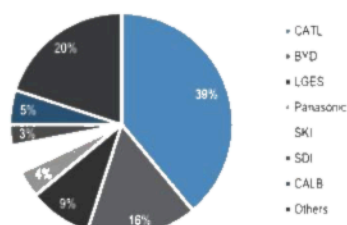
Source: IEA

Government policy has played a significant role in the fast-paced growth of the EV market. In China, an auto trade-in scheme which provides subsidies of US\$2,750 for replacing an old vehicle with a new EV, was utilised by nearly 4 million people in 2024

([link](#)), whilst a purchase tax exemption for EVs equated to over \$30 billion of foregone revenue in 2025, though this will be replaced with a 50% tax reduction from 2026 ([link](#)). Despite direct subsidies waning in the EU in recent years, the use of emissions reduction targets, tax benefits and other financial packages remains an incentive for EV use. Meanwhile, in the US, the Clean Vehicle Tax Credit, which provided a discount of up to US\$7500 for new EVs and US\$4000 for used EVs, accounted for over half of all EV sales in 2024, though this was phased out in September 2025 ([link](#)).

Figure 11: CATL and BYD supply over half of the global EV battery market

Global EV market share, 2025

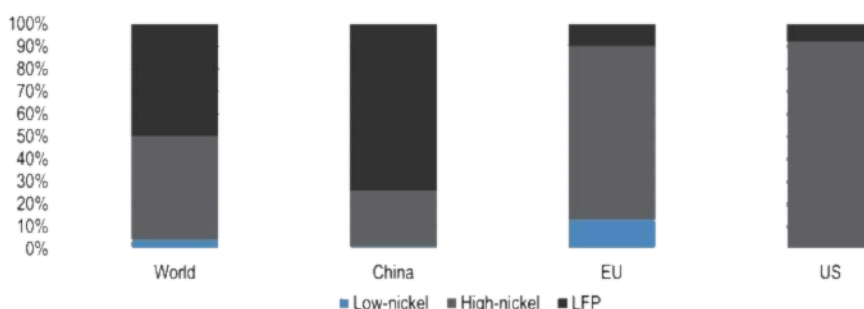


Source: GGII, SNE, ZE Consulting, J.P. Morgan.

CATL and **BYD** are the largest players in EV batteries, with a market share of 39% and 16%, respectively (Figure 11). Interestingly, there is a large dispersion in the chemistry of EV batteries used across regions. In China, three-quarters of EV batteries sold were lithium-iron phosphate (LFP), a technology in which it controls over 98% of the global supply ([link](#)). Whereas EV batteries sold in the EU and US almost exclusively use low- and high-nickel technologies (Figure 5).

Figure 12: EV battery technology differs across regions

EV battery sales share in 2024 by chemistry and region (%)



FP = lithium iron phosphate. Low-nickel includes lithium nickel manganese cobalt oxide (NMC) 333, NMC442, and NMC532. High-nickel includes NMC622, NMC721, NMC811, lithium nickel cobalt aluminium oxide (NCA), and lithium nickel manganese cobalt aluminium oxide (NMCA). LFP also includes lithium iron manganese phosphate (LFMP). Battery chemistry sales share is based on the battery capacity of EVs registered in the different regions. This calculation assumes that 95% of electric trucks, buses and light commercial vehicles sold in China use LFP, and that 70% of electric trucks and electric buses sold outside of China use high-nickel chemistries. Two/three-wheelers are excluded from the analysis. Battery sales reflect the batteries installed in vehicles sold in each region, and not the battery demand for vehicles manufactured in each region. Electric vehicle and battery stockpiling are excluded from the analysis.

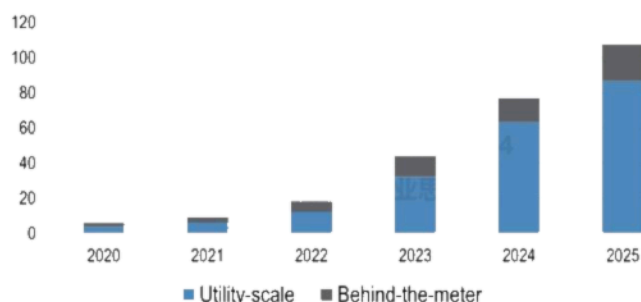
Source: IEA analysis based on data from EV Volumes and Chain Automotive Battery Industry Innovation Alliance

ESS and the Grid

The IEA estimates that the global market for stationary energy storage was valued at US \$29 billion in 2025, and is set to grow to \$89 billion by 2035 under a Net Zero Emissions scenario (NZE) ([link](#)). In 2025, 108GW of new storage capacity was installed worldwide (Figure 13), growing by 40% compared to 2024 and taking the overall installed capacity to roughly 11x higher than in 2021 ([link](#)). Utility-scale storage accounted for 80% of new capacity, while China made up 60% of new utility-scale capacity, and 40% of new behind-the-meter capacity in 2025 (Figure 14). 30% of global ESS battery shipments were supplied by **CATL**, the market leader, with **Hithium**, **EVE** and **BYD** supplying a further 34% (Figure 15).

Figure 13: Battery storage capacity grew by 40% in 2025...

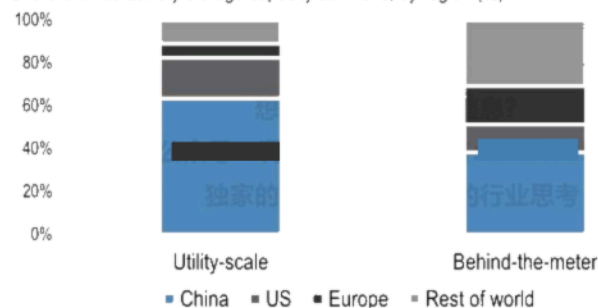
Global battery storage capacity additions (GW)



Source: IEA

Figure 14: ... with China the main driver of new installations

Share of 2025 battery storage capacity additions, by region (%)

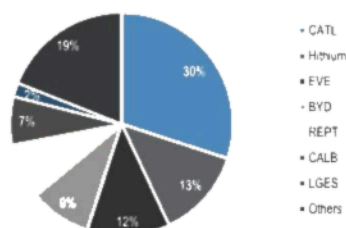


Source: IEA

As we highlighted in our recent [“Make the Grid Great Again”](#) report, energy storage (ESS) within the grid has a number of crucial functions, including:

Figure 15: CATL supply nearly one-third of global ESS batteries

Global ESS battery shipments market share, 2025



Source: SNE Research, J.P. Morgan.

- **Energy shifting:** Smoothing the provision of energy from intermittent sources, which has become increasingly important with the growing share of PV solar and wind. ESS can also be installed directly in homes or industrial facilities to reduce peak demand (“peak shaving”), shifting energy demand to less expensive times of day. According to IRENA, energy shifting drove two-thirds of capacity additions in 2024 (Figure 17).
- **Back-up power:** Energy storage can provide back-up power during outages, which can be particularly crucial in regions with unreliable grids or exposure to natural disasters. Uninterruptible Power Systems (UPS) utilize storage to provide immediate, short-term backup power to critical systems like data centres and emergency services.
- **Storage as a transmission asset (SATA):** System operators can use storage to absorb or inject short bursts of power (“virtual power lines”) at grid congestion points or overloaded substations, allowing the grid to operate much closer to 100% thermal rating and regulating the grid’s frequency and voltage. Reductions in overloads and congestion can also serve to extend the life of grid infrastructure over the long-term.

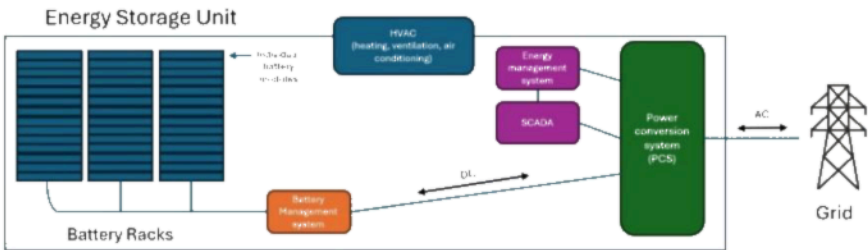
We can typically split the stationary energy storage market into two: **utility-scale** and **behind-the-meter**. Utility-scale systems are connected to transmission or distribution networks or power generation assets, and are used for energy shifting, frequency regulation and other grid management operations. Behind-the-meter systems are typically used by residential, commercial and industrial users to manage consumption and local supply, including providing back-up power and use in **microgrids**.

What does an ESS unit look like?

Battery energy storage systems are essentially scaled-up versions of the individual batteries used in EVs and electronics. To achieve this scaling of capacity, modules of interconnected batteries are stacked together to create a **battery rack**. The battery racks are installed in fire-resistant, weatherproof enclosures, which also house a **battery management system (BMS)** that monitors the status of the battery modules. These storage units also tend to contain some form of fire suppression system, emergency shut-offs, and cooling.

A **power conversion system (PCS)** is used to convert the DC electricity from the batteries into grid-compatible AC power, and vice versa when the batteries are being charged. Finally, an **energy management system (EMS)** manages and optimizes the flow of electricity between the grid and the batteries, whilst the **supervisory control and data acquisition (SCADA)** system works in tandem with the EMS to monitor and control the system, and collect data.

Figure 16: Diagram of a battery energy storage solution

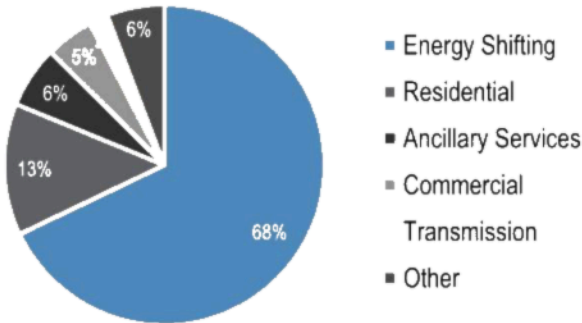


Source: J.P. Morgan

In terms of chemistry, concerns over cost, lifecycle and safety has driven the trend towards lithium-iron phosphate (LFP) in utility-scale grid storage globally over the past few years, increasing from 48% of market share in 2021 to 85% in 2024 (Figure 18).

Figure 17: Energy shifting drove over two-thirds of energy storage additions in 2024

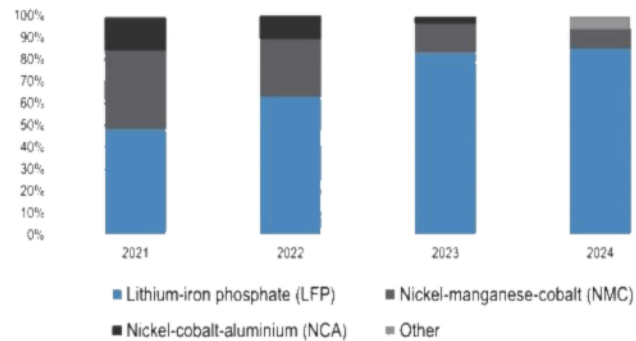
Drivers of ESS capacity additions, 2024 (%)



Source: IRENA based on BNEF

Figure 18: LFP has increasingly dominated utility-scale energy storage systems

Global market share of utility-scale battery technologies (%)



Source: IRENA based on BNEF

Portable electronics and other uses

Despite accounting for just **5% of total battery demand in 2024**, consumer electronics such as smartphones, laptops, cameras, medical devices, power tools and wearable devices still consume billions of batteries annually. **Smartphone production alone reached 1245 million units of global shipments in 2025**, though growth has plateaued in recent years ([link](#)).

Beyond EVs, batteries are heavily involved in the **mobility** sector, particularly **lead-acid batteries**, which are used to start **engines and power electronics** in cars, trucks, agricultural equipment, ships and trains ([link](#)). They are also used in a range of other mobility applications including motorized wheelchairs, mobility scooters, all-terrain vehicles, golf carts, yachts and campervans/RVs. Batteries also play a key role in global

logistics, with roughly **70% of material handling equipment** (forklifts, etc.) using advanced lead-acid batteries in some form ([link](#)).

Batteries also play an important role in modern **aerospace and defense** applications. The growing use of **military drones** has benefitted from the high energy density of lithium-ion batteries, allowing for longer flight times and greater payloads ([link](#)), though many use hybrid-based power systems to enhance these further ([link](#)). Research into **electrified aircraft propulsion** (EAP) for commercial aviation is also on the rise, though the energy densities and cooling requirements of current battery technology present major barriers to large-scale uptake of batteries as a viable alternative to traditional aviation fuels ([link](#)). **Satellites** prioritize battery life and safety of their power systems, often compromising energy density to ensure power can be sustained for long mission times, with off-the-shelf and space-grade lithium-ion batteries the most commonly used within the space ([link](#), [link](#)).

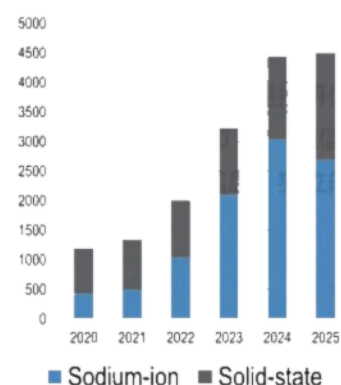
The future

Investments in new types of battery technologies aim to overcome some of the limitations associated with existing batteries, such as the lack of suitability for long-duration energy storage (LDES), risk of thermal runaway, exposure to geopolitical risk in the supply chain ([link](#)), and energy density. Such investment has been growing; from 2018 to 2020, roughly 25% of **early-stage investment in battery start-ups** went to **non-lithium battery chemistries**, but between 2021 and 2023 this had grown to **40%** ([link](#)). Additionally, the share of energy-related **patents focused on energy storage** has **grown from 15% to over 40%** between 2015 and 2023 ([link](#)), with annual patents focusing on sodium-ion or solid-state battery technology nearly quadrupling since 2020 (Figure 19).

Below, we highlight the key features of some of the major innovative battery types:

Figure 19: Patents for sodium-ion and solid-state batteries have nearly quadrupled since 2020

Number of patent families, by year and battery technology



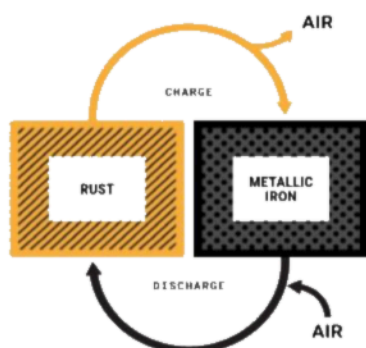
Source: European Patent Office ([link](#))

- Sodium-ion** batteries function in a similar manner to lithium-ion, and gained prominence in 2022 when lithium prices surged. Key to their appeal is the lower volume of critical minerals required, making them cheaper to produce ([link](#)). The use of aluminium anode current collectors rather than copper also reduces cost. Sodium-ion technology is also more resistant to cold temperatures, has less risk of overheating and is less exposed to international supply chains. However, it is roughly 30-40% less energy dense than an equivalent lithium-ion battery ([link](#)). CATL recently announced that it will start mass-production of sodium-ion batteries in 4Q26, with costs approaching parity with LFP ([link](#)). The firm has also recently launched the world's first platform-based sodium-ion energy storage battery with 97% efficiency, a life cycle <15,000 cycles at 80% retention and a -40°C to +70°C operating range. Our analysts believe that **sodium-ion batteries present a compelling case as energy storage solutions for AI data centres**, due to their high charge rate performance, temperature adaptability, superior safety, long life cycle, superior recyclability and improving cost dynamics ([link](#)).
- Solid state** batteries use solid materials, such as polymers, metal compounds and halides to replace the liquid electrolytes used in traditional batteries ([link](#)). The presence of solid material also negates the need for a separator. The benefits compared to lithium-ion batteries include greater thermal capacity and durability, faster charging and reduced risk of thermal runaway. However, **degradation is a key issue in solid-state batteries**, which can occur via a number of mechanisms including buildup of lithium dendrite in the electrolyte, degradation of the

electrolyte material, and instability at the interfaces between the electrolyte and electrodes. Both CATL and BYD are conducting GWh-scale solid-state battery equipment tenders, with CATL seen as the industry frontrunner, though commercial-scale production is unlikely to occur before 2028 ([link](#)).

- **Lithium-sulphur** technology replaces the metal oxide cathode used in conventional lithium-ion batteries with a sulphur cathode, and pairs it with a lithium metal anode. This changes the chemical process, with energy being generated by the formation of lithium sulfide through the reduction of sulphur and the oxidation of lithium. Advantages over lithium-ion include greater energy density ([link](#)), lower cost, potentially lower risk of thermal runaway, and less environmental impact thanks to reduced requirements of critical minerals such as nickel and cobalt ([link](#)). However, more research is required to mitigate **rapid degradation occurring due to the “shuttle effect”**, in which the polysulfides shuttle between electrodes, reducing the active sulphur at the cathode and forming an insulating layer at the lithium anode ([link](#), [link](#)).
- **Iron-air** batteries are being developed to serve as **long-duration energy storage solutions** (LDES). The technology uses reversible rusting, whereby an iron anode and air cathode react to form iron oxide (rust), producing an electrical current. This process is then reversed by applying a current to the rust to convert the rust back into metal iron and oxygen (air). Given the low energy density and high weight associated, it is most suited to long-duration energy storage, with current developments of multi-day batteries in progress by the US-based Form Energy ([link](#)). Meanwhile, Dutch startup Ore Energy successfully connected its iron-air battery to the grid in May 2025 ([link](#)).

Figure 20: Iron-air battery process



Source: Form Energy ([link](#))

Batteries and Sustainability

Our sustainability analysis focuses on 13 sectors touched by the battery value chain, where we have identified 20 financially material issues spanning environmental risks, social & human capital, business model & innovation, and governance. We explore key standards and regulations, including the upcoming global battery passport to make supply chains “more visible, traceable, accountable and comparable”, and finish with a bank of engagement questions.

Material issues in the battery supply chain

The battery value chain spans multiple industries, from metals and mining to chemicals, semiconductors and battery equipment. Using the SASB materiality framework, we identified the following 20 financially material sustainability issues across the battery value chain. Table 1 summarizes the battery value chain and maps each stage to the 13 sectors represented in our Batteries Universe (Fuel Cells & Industrial Batteries, Hardware, Electric & Electronic Equipment, Containers & Packaging, Construction Materials, Chemicals, Air Freight & Logistics, Metals & Mining, Solar Technology & Project Developers, Auto Parts, Industrial Machinery & Goods, Household & Personal Products, and Waste Management).

Table 1: Lithium-ion battery value chain and aligned SASB sectors from our Batteries Universe

Value Chain Stage	Aligned SASB Sectors (Batteries Universe)	Summary
Mining and Extraction	Metals & Mining	Extract and concentrate lithium, nickel, cobalt, manganese and graphite feedstocks from mines and brines so they can enter processing and refining.
Processing and Refining	Chemicals Metals & Mining	Refine and convert mined minerals into battery-grade inputs (e.g., lithium chemicals and refined nickel and cobalt products) ready for active material and cell manufacturing.
Active Materials (Cathode and Anode)	Chemicals	Manufacture cathode and anode active material powders, along with the upstream precursor materials used to produce them.
Battery Components	Containers and Packaging Electric & Electronic Equipment	Produce the enabling cell inputs, such as electrolytes, separators, foils and binders that allow ions/electrons to move safely and efficiently.
Cell Manufacturing	Fuel Cells & Industrial Batteries Electric & Electronic Equipment	Convert metals and components into finished cells via electrode manufacturing, cell assembly and formation/testing to meet spec and safety requirements.
Pack Assembly and Battery Systems	Hardware Auto Parts Electric & Electronic Equipment Fuel Cells & Industrial Batteries	Integrate cells into modules/packs and add system elements such as battery management, thermal management, sensors and protection to deliver a usable product.
End Markets, Recycling and Circularity	Solar Technology & Product Developers Waste Management Air Freight & Logistics Household & Personal Products Industrial Machinery & Goods	Deploy battery packs into end uses (e.g., EVs, stationary storage, aviation) and manage end-of-life (e.g., collection, reuse and recycling to recover materials back into the chain).

Note: Alignment reflects each SASB sector's typical battery value chain exposure. One active materials-exposed company is classified as “Construction Materials”; therefore, that sector is not shown.
Source: J.P. Morgan based on [SASB](#)

Using the SASB materiality framework, we then identify the sustainability topics most likely to be financially material across these sectors. Table 2 summarizes the set of material sustainability issues used for the analysis.

Table 2: Material sustainability issues identified SASB

Environment	Social Capital	Human Capital	Business Model & Innovation	Leadership & Governance
GHG Emissions	Human Rights & Community Relations	Labour Practices	Product Design & Lifecycle Management	Business Ethics
Air Quality	Data Security	Employee Health & Safety	Business Model Resilience	Competitive Behaviour
Energy Management	Product Quality & Safety	Employee Engagement, Diversity & Inclusion	Supply Chain Management	Management of the Legal & Regulatory Environment
Water & Wastewater Management			Materials Sourcing & Efficiency	Critical Incident Risk Management
Waste & Hazardous Materials Management				
Ecological impacts				

Material issues identified across 13 SASB sectors under which our "battery universe" stocks are found

Source: J.P. Morgan based on [SASB](#)

- **Environmental risks:** Energy management is one of the most cross-cutting issues across the battery value chain, flagged as material in nine of the 13 sectors reviewed. In the following section, we focus our environmental risk assessment on three battery value chain pressure points: energy intensity and emissions exposure, water stress and wastewater impacts, and hazardous materials and waste across chemical processing and manufacturing.
- **Social capital:** Battery supply chains are exposed to significant human rights and community relations risks, as flagged by SASB across the relevant sectors. Upstream, scaling up production of battery minerals can increase exposure to community opposition and human rights risks. This is reinforced by the U.S. Department of Labor's 2024 List of Goods Produced by Child Labor or Forced Labor, which [highlights](#) child and/or forced labor risks for several minerals used in industrial applications, including batteries, such as cobalt from the Democratic Republic of the Congo (DRC) and nickel from Indonesia, along with other battery-adjacent inputs including aluminum, copper, lithium, manganese, silicon and zinc.
- **Human capital:** Employee health and safety is classified by SASB as material across seven of the 13 sectors reviewed, reflecting the hazardous nature of work across the battery value chain, from underground mining operations to the chemical handling required in cathode and electrolyte production. OSHA (US Occupational Safety and Health Administration) [flags](#) inorganic lead dust as "the most significant health exposure" in battery manufacturing and notes that workers may also be exposed to other toxic metals and reactive chemicals used in the manufacturing process (e.g., sulfuric acid, solvents and electrolytes).
- **Business model & innovation:** Product design & lifecycle management is the single most cross-cutting issue across the battery value chain, flagged as material in 10 of the 13 sectors reviewed, reflecting how design choices can influence cost, safety, regulatory exposure and end-of-life liabilities. SASB disclosure topics in this category include Product Innovation, Efficiency and Design for Use-Phase Efficiency, alongside End-of-Life Management and Lifecycle Management more broadly. SASB also includes Safety & Environmental Stewardship of Chemicals and Management of Energy Infrastructure Integration & Related Regulations, reflecting the importance of safe deployment and regulatory compliance in manufacturing and downstream applications.
- **Leadership & governance:** The battery value chain includes upstream mining and chemical processing activities for which critical incident risk management is classified as material by SASB, reflecting the potential for severe, high-impact operational events (e.g., a 2025 bridge collapse at a cobalt mine in the DRC that

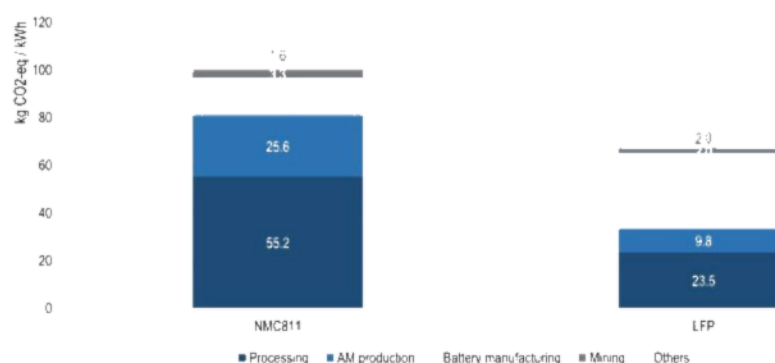
killed at least 32 people, as [reported](#) by BBC) and the need for robust oversight. As a result, frameworks such as the [Global Industry Standard on Tailings Management](#) for mining and hazard process-safety regimes for chemical facilities (e.g., [OSHA Process Safety Management](#) in the US and [Seveso](#) and [COMAH](#) regulations in Europe) aim to reduce the likelihood and severity of these incidents through stronger controls, monitoring and emergency planning.

Zooming in on environmental risks

Lithium-ion batteries have a high energy intensity across their value chain, from mining and materials processing to active material production and battery manufacturing, which creates meaningful GHG emissions exposure when these stages rely on carbon-intensive power and industrial heat. The MIT Climate Portal [highlights](#) that about 77% of the world's supply of lithium-ion batteries "are manufactured in China, where coal is the primary energy source" and notes that manufacturing an 80 kWh lithium-ion battery (found in the Tesla Model 3) can result in between 2.5 and 15 metric tons of CO₂ emissions depending on production conditions. Figure 21 presents two common lithium-ion chemistries (NMC811 and LFP) as illustrative cases and shows how lifecycle emissions are distributed across mining, processing, active material production and battery manufacturing, with most battery lifecycle emissions concentrated in upstream materials.

Figure 21: Battery lifecycle emissions by chemistry

Figure shows 2023 lifecycle emissions only; 2035 scenario results removed for focus



IEA Notes. FP = lithium iron phosphate. NMC811 = lithium nickel manganese cobalt oxide. AM = active material, including both cathode and anode (graphite). Battery manufacturing refers to cell and pack manufacturing. End-of-life options other than recycling are excluded from the analysis, and emissions associated with the transport of materials (which are expected to be low) are not considered. 'Others' refers to emissions associated with other battery pack components like electronics and coolant. See annex B for full assumptions. Source: IEA analysis based on the [Global Energy and Climate Model](#), [IEP](#), [GREET](#), [EV Volumes](#), [Dai et al.](#), [Degen et al.](#), [Frith et al.](#)

As stated in our critical minerals [report](#), over 50% of lithium and copper production is based in water-stressed areas, which can disrupt mineral production and reduce access to water for local communities ([link](#), [link](#)). In the "lithium triangle" spanning parts of Chile, Argentina and Bolivia (home to over half of the world's lithium resources), lithium brine extraction can be highly water intensive, estimated at ~500,000 gallons per ton of lithium ([link](#)). In Chile's Salar de Atacama, mining has consumed ~65% of the total water supply, with detrimental impacts on local ecosystems ([link](#)) and communities ([link](#), [link](#)).

The US EPA [highlights](#) that when lithium-ion batteries are discarded, most are considered "ignitable and reactive hazardous waste" and can catch fire or explode if they are not handled carefully. Mismanaged end-of-life lithium-ion batteries, as the IEA

[states](#), can create environmental risks such as fires and toxic emissions from reactive electrolyte salts and fluorinated materials, as well as contamination pathways to land and water systems.

Sustainability standards for batteries and best practices

The following section summarizes key regulatory frameworks and technical standards that commonly shape battery companies' product design, manufacturing controls, chemical management, transport and end-of-life obligations. This non-exhaustive reference list spans major jurisdictions, particularly the EU, UK, North America and China, and covers both legal requirements and industry standards used for compliance, certification and the safe deployment of batteries and ESS.

Overview of key standards for battery companies

- **EU Battery Regulation:** Entered into force in 2023 as part of the European Green Deal and establishes uniform safety, sustainability and labeling rules across the lifecycle of all new batteries in the EU (with the exception of military and aerospace batteries) from production and supply chain due diligence to recycling and digital passports.
- **REACH Regulation:** REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) is the EU's cross-cutting chemicals law that applies to substances used in batteries, working alongside the EU Battery Regulation by restricting hazardous chemicals and requiring transparency and communication of substances of concern across the battery supply chain.
- **RoHS Directive:** The Restriction of Hazardous Substances (RoHS) in Electrical and Electronic Equipment (EEE) is a set of EU rules that restricts the use of hazardous substances in EEE. The Directive restricts the use of ten substances, including lead, cadmium and mercury, and applies to in-scope EEE categories, subject to defined exclusions.
- **Seveso III Directive:** EU framework directive aimed at controlling major accidents involving dangerous substances at industrial establishments and limiting the consequences for human health and the environment. The initiative is implemented through Member State national laws and applies where dangerous substances exceed threshold quantities.
- **COMAH:** The UK's implementing regulations for the Seveso III regime, apply similar threshold-based controls to prevent and mitigate major accidents involving dangerous substances.
- **UN 38.3 (Lithium metal and lithium ion batteries):** UN-mandated test series required to demonstrate that lithium cells and batteries meet safety requirements for transport.
- **UL Battery Standards:** UL 9540A (Test Method for BESS), UL 9540 (Standard for ESS and Equipment) and UL 1973 (Standard for Batteries for Use in Stationary and Motive Auxiliary Power Applications), among [others](#), are North American safety standards and test methods for energy storage systems and batteries used in stationary and auxiliary power applications.
- **IEC Standards:** The IEC standards (from the International Electrotechnical Commission) regulate the safety and performance of various battery types. IEC 62619, for example, addresses secondary cells and batteries for industrial applications, IEC 62133 targets portable sealed secondary cells used in

consumer electronics, and IEC 60086 specifies testing and requirements for primary batteries.

- **NFPA 855 Standard for the Installation of Stationary Energy Storage Systems:** The NFPA 855 standard (from the National Fire Protection Association) provides guidelines for mitigating the hazards associated with ESS, such as fire propagation, explosions and toxic gas generation.
- **IEEE Standards:** The Institute of Electrical and Electronics Engineers (IEEE) has developed a variety of standards for battery system reliability, safety and grid interconnection, including key standards such as IEEE 1725 (for the design, qualification and reliability of rechargeable battery systems for cellular phones) and IEEE 1547 (for interconnecting distributed energy resources).
- **SAE Standards:** SAE International provides standards for battery safety, performance, testing and labeling, such as SAE J2929 for lithium battery safety, J537 for lead-acid batteries, J1772 for charging connectors and J2464 for electric and hybrid EV RESS safety and abuse testing.
- **EU Low Voltage Directive (2014/35/EU):** EU product-safety framework for electrical equipment within specified voltage limits (relevant to chargers, power supplies, inverters and ESS equipment) supporting CE marking and EU conformity assessment.
- **China GB/T Standards:** National “recommended” technical standards that establish commonly used test methods and performance and safety requirements for battery cells, modules, packs and systems in China.
- **OECD guidance for mineral due diligence and responsible business conduct**

The “FSC of batteries”: the Global Battery Passport

As seen in the previous section, there is no single framework to evaluate the sustainability of battery manufacturing holistically, akin to FSC for timber or RSPO for palm oil. A battery passport certification is currently being developed to fulfill that function ([link](#)).

The Global Battery Passport is a global sustainability reporting and certification scheme for batteries that aims to make battery supply chains “more visible, traceable, accountable and comparable”. The scheme is being developed by a group of more than 140 international organizations, governments, NGOs and private sector companies across the value chain, including CATL, Umicore, Panasonic, SQM, Glencore and Tesla. Launch is planned for 2027, following a pilot in 2024 that included ten case studies with battery producers representing >80% of the market, and operational trials currently underway, with results expected in June.

Central to this certification scheme are the “battery benchmarks” that cover 18 ESG issues aligned with existing frameworks, such as the EU Batteries Regulation or the OECD guidance for mineral due diligence and responsible business conduct, and include data assurance guidelines and the “greenhouse gas rulebook” for battery carbon footprint calculations. A free-to-use digital platform, the “GBA gateway” will ensure that smaller companies can participate in the passport ecosystem.

Figure 22: The battery passport encourages a holistic disclosure of environmental, social and governance issues

ESG issues covered in the Battery Passport

Core modules		
1 Risk and Sustainability Management Systems 2 Supply Chain Due Diligence 3 Stakeholder Engagement		
Environment	Social & Economic	Governance
Energy And GHG	Human Rights	Compliance & Good Governance
4 GHG Emissions	13 <i>Child Labour</i>	25 <i>Business integrity & transparency</i>
5 GHG Reduction And Energy Efficiency	14 <i>Forced Labour</i>	26 <i>Product quality and safety</i>
Environmental Safeguards		
6 Biodiversity Loss	15 <i>Use of Security Forces</i>	
7 Pollution	16 Employment Terms	
8 Waste Management	17 Freedom Of Association And Collective Bargaining	
9 Mine Waste Management	18 Occupational Health And Safety	
10 Natural Resource Stewardship	19 Diversity And Non-discrimination	
Circularity	Social & Community Engagement	
11 Circular Design	20 Community Impacts	
12 Resource And Material Efficiency	21 Indigenous Peoples' Rights	
	Local Economy	
	22 Local Economic Development	
	23 Sourcing From Artisanal And Small-scale Miners	
	Product Cost	
	24 Total Cost Of Ownership	

Bold: ESG modules corresponding to risk categories of Annex X of the EU Battery Regulation (2023); Italics: ESG issues corresponding to Annex II links of the OECD minerals guidance

Source: Global Battery Alliance ([link](#))

What does “best practice” look like?

We summarize below some of the most common “best practices” highlighted in the standards in the previous section:

- **Supply chain traceability and documented due diligence:** Conduct risk-based supply chain audits focused on environmental and social risk exposures (e.g., critical minerals sourcing), supported by supplier verification and enforcement of responsible sourcing policies.
- **Restricted substances governance:** Operate a restricted substances program with supplier material declarations, substances of concern tracking and risk-based verification testing (especially for high-risk components and change events).
- **Labeling, documentation and disclosure control:** Maintain controlled, accurate product documentation and disclosures (e.g., composition and substance information, labeling and marking, instructions, declarations and digital records) that are version-controlled and regulator-ready on request.
- **Transport readiness:** Ensure UN 38.3 compliance prior to shipment, supported by controlled test summaries (CTS), appropriate packaging instructions and shipper documentation, with triggers for revalidation following material or design changes.
- **Manufacturing safety:** Apply threshold-based hazardous inventory screening and implement process safety controls (training, emergency planning, incident response and management of change) appropriate to the site and process risk.
- **BESS deployment and emergency readiness:** Ensure stationary storage systems are ready for deployment by aligning design and installation with fire codes and test evidence (e.g., UL 9540, UL 9540A and NFPA 855), including siting and spacing, ventilation and gas detection, commissioning and maintenance procedures and first-responder coordination and documentation.
- **Product safety engineering, testing and certification:** Build safety into design with hazard analysis and abuse testing, complete design validation, control design and material changes with triggers for re-qualification and maintain a clear certification and compliance plan (e.g., aligned with UL, IEC, SAE, IEEE, GB/T Standards)
- **Design for circularity:** Design and document products to support end-of-life

outcomes (repair, disassembly, recyclability), including the information needed to support customer and regulatory disclosures).

- **Field performance monitoring and incident response:** Operate an end-to-end quality and field action program with full traceability, stop-ship and containment authority, standardized investigations and corrective actions, and clear customer and regulator notification and closure steps.

Engagement questions for battery manufacturers

- How does the board oversee critical raw material sourcing (exposure to geopolitical risk, environmental and social controversies and price volatility)? What are the key controls (e.g., supplier qualification, dual sourcing, escalation triggers) and how are management KPIs tied to compensation and major capital allocation decisions?
- What is the governance model for quality and safety (manufacturing defects, thermal incidents, and field failures) and how frequently are these reviewed at the board or executive level? How do you detect, escalate and remediate issues end-to-end (traceability, supplier quality, independent testing)?
- In the event of a thermal incident or field defect, what is your process to trace affected production batches and shipped units back through the supply chain, contain impacted inventory and shipments, and validate and close corrective actions (including any independent testing)? What are your expected and worst-case timelines for each step?
- How do you ensure supplier quality for materials and components and what qualification and ongoing monitoring do you require? What independent assurance, whether it be a separate internal team or third-party testing, is used to challenge results?
- How do you ensure compliance with evolving battery regulations and standards across key markets? How do you monitor and adapt to changes that could impact your product design, certification timelines or market access?
- How do you measure and disclose the product's carbon footprint, including system boundaries, key assumptions and third-party assurance? What are your levers and milestones to reduce it in the next 12-24 months and 3-5 years?
- What is your circular economy strategy for manufacturing scrap and end-of-life batteries, including current and target recycled content for key materials? How do you manage collection and secure contracted recycling capacity? How do you verify recovery rates and re-qualify materials for reuse in new products?
- What are your most material water and wastewater risks, what KPIs do you track and what thresholds trigger escalation or capex?

Mapping the supply chain: vulnerabilities and opportunities

Concentration challenges abound but are not insurmountable. Critical minerals account for c.50-70% of battery costs and are subject to price volatility, export restrictions, complex dependencies and concentration. China refines 85% of the world's supply of nickel, lithium, manganese and cobalt, and has a dominant share in the manufacturing of cell components across all key chemistries. NA, Europe, Korea and Japan are increasing efforts to diversify supply but need to secure access to raw materials, know-how and cost-competitive equipment. With the right investments, the emerging sodium-ion battery supply chain could grow to become a diversified alternative to the concentrated LFP chemistries.

Critical minerals are a substantial portion of battery weight...

Lithium-ion batteries used in EVs and energy storage are composed of battery cells housed in battery modules, which in turn make up a battery pack. Cells represent approximately 70-85% of the battery's weight, much of which comes from critical minerals such as lithium, nickel, cobalt and manganese in the cathode, and graphite in the anode. In practice, which critical minerals are needed, and their relative proportions, depend on the type of chemistry: for example, NMC 111 batteries have eight times as much cobalt as nickel-cobalt-aluminium oxide (NCA+) batteries, but only half as much nickel. Lithium iron phosphate (LFP) batteries do not contain any nickel, cobalt or manganese, but require approximately 50% more copper than NMC batteries. The remaining modules and pack components consist mostly of aluminium and steel, as well as coolant and electronic parts.

...and today account for the majority of a battery's costs

Technological innovation over the past 15 years has considerably reduced battery manufacturing costs, to the point that raw materials represent the lion's share of battery costs (50-70% today, vs. 40-50% five years ago). Cathode and anode materials account for the largest portion (25%-30%, and 8-12%, respectively), while labour costs are almost immaterial (2-4%). As a result, battery costs have become increasingly more sensitive to commodity prices: a doubling of lithium or nickel prices would translate into a 6% increase in battery costs, and if the 2010 ten-fold surge in lithium prices were to repeat itself, battery pack prices could increase by 40-50% globally, on average, according to the IEA.

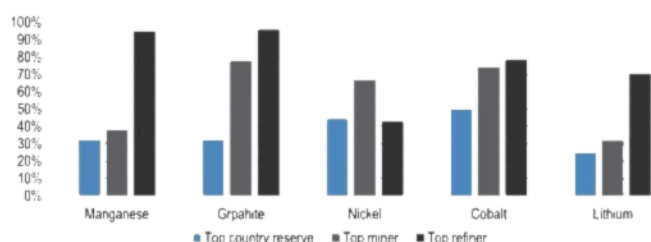
The supply of these minerals is subject to multiple vulnerabilities: concentration, price volatility, export restrictions and complex dependencies

The supply chains of battery minerals are heavily concentrated: this is not apparent if we focus on reserve market shares or where they are located, where no country dominates: Australia hosts the largest reserves of manganese, but these are only one third of the global total. Chile is the top lithium producer globally but its share is shy of 25%. Indonesia holds slightly under 45% of global nickel reserves, and the largest reserves of graphite are located in China, with 32% of the global share. Cobalt reserves are more concentrated, with the DRC hosting as much as all other countries combined ([USGS](#)).

Concentration is more apparent if we focus on mined output and evident once we look at refined output (Figure 23 and Figure 24): China is the top refiner of four of the five

metals mentioned before, with an average share of 85%, according to IEA data ([link](#)). Nickel is the exception, where Indonesia retains the top spot with a share close to 40%. This degree of concentration introduces a key vulnerability: for most critical minerals, if we exclude production from the top supplier, there would not be enough material to meet demand from outside of such top supplier. The IEA estimates that, by 2035, supply outside the leading producer of battery metals and rare earths would only be able to meet half of the demand from countries outside the top supplier.

Figure 23: The battery minerals supply chain is particularly concentrated in refining



Source: USGS ([link](#)), IEA ([link](#))

Figure 24: China is the top refiner for several battery minerals

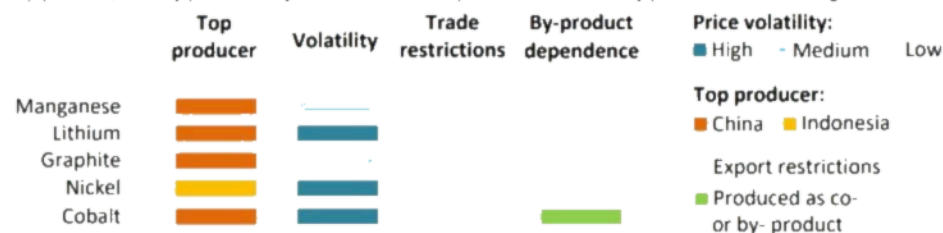
	Top country reserve	Top miner	Top refiner
Manganese	Australia	South Africa	China
Graphite	China	China	China
Nickel	Indonesia	Indonesia	Indonesia
Cobalt	DRC	DRC	China
Lithium	Chile	Australia	China

Source: IEA ([link](#))

Another concern is price volatility. According to the IEA, manganese, nickel, cobalt and lithium have all seen higher price variability than crude oil. Separately, the ability of reconfiguring the supply chains of these minerals in response to shocks is limited because their production is often dependent on by-products of other mining activities. Finally, several of these materials are subject or have in the past been subject to export restrictions.

Figure 25: Concentration, price volatility, export restrictions and complex dependencies characterize the supply chains of key battery minerals

Top producer, monthly price volatility, trade restrictions exposure and status as by-product of select strategic minerals



Source: IEA World Energy Outlook 2025 ([link](#))

Efforts are underway to diversify the very concentrated LFP and NMC supply chains

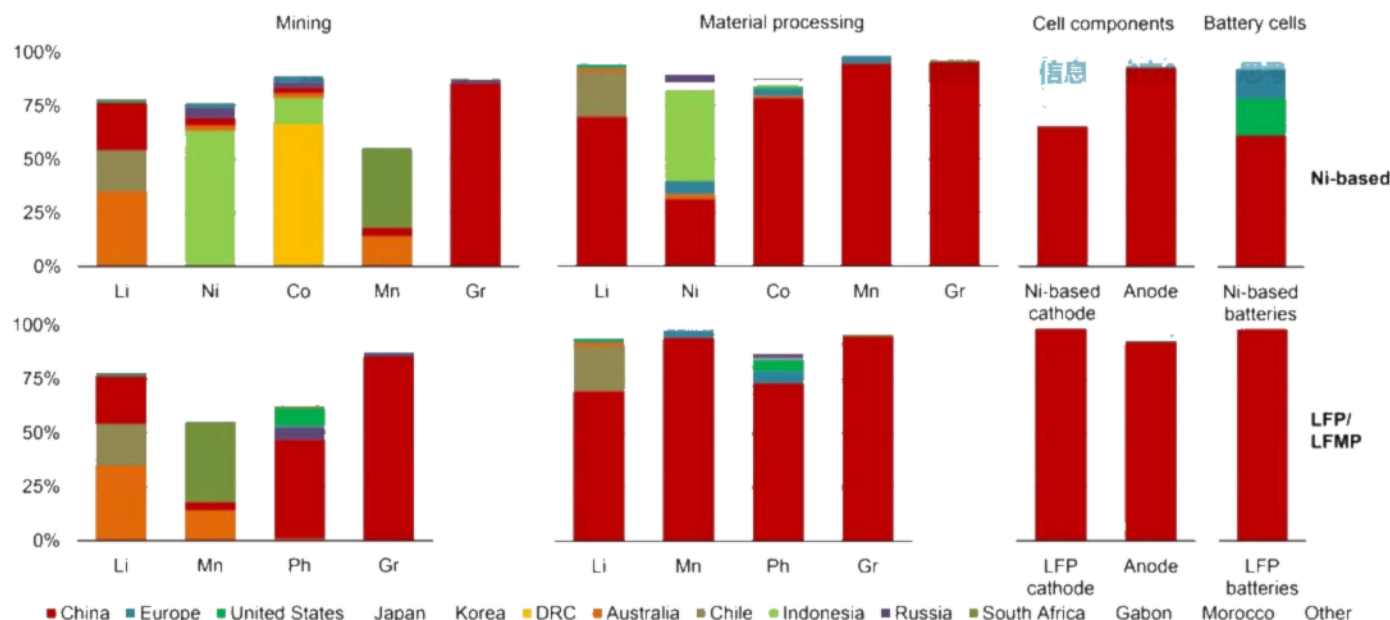
Lithium iron phosphate (LFP) and lithium nickel cobalt manganese oxide (NMC) chemistries dominate the global battery market. Unsurprisingly, and in light of the information in the previous section, both of them have very concentrated supply chains (Figure 26).

- NMC batteries require lithium, nickel, cobalt and manganese for their cathode, and use a graphite anode. Not only is refining of these materials heavily concentrated, China also commands the largest share in downstream activities, such as manufacturing of cell components and battery cells.
- LFP batteries require a lower number of critical minerals as they use phosphorous

but do not require nickel or cobalt. However refining is as concentrated as in their NMC counterparts, and downstream activities are carried out almost exclusively by China.

Figure 26: Lithium-ion battery supply chains are dominated by China

Geographical distribution of the LFP and nickel-based lithium-ion battery supply chain, 2025



Source: IEA, Global Critical Minerals Outlook, 2025 ([link](#))

As LFP technology gains in popularity, North America, Europe, Korea and Japan are increasing efforts to diversify supply away from China. This requires addressing three key challenges, none of which have a straightforward solution: access to raw materials, manufacturing of cost-competitive equipment, and access to needed technology:

- LFP and NMC cathode materials from China are exceptionally cheap due to the country's highly integrated supply chain. This is compounded by the significant oversupply of LFP cathode materials, which has driven prices down to the point that c. 85% of their cost is accounted for by the raw materials themselves. Outside of China, processing and energy costs are typically higher, which limits the ability of other countries to compete.
- Even though equipment to produce cell and cathode material can be found outside of China, Chinese machines are reportedly more efficient, significantly cheaper, with prices between half and one third lower than those available from elsewhere, and their delivery has shorter lead times.
- Finally, China has by far the largest number of patents in advanced LFP materials, which could limit access to the technology to outside players. Several initiatives have been launched to produce LFP without precursors, which could potentially bypass part of the Chinese supply chain.

Sodium-ion batteries: the promise of a simpler and more diversified supply chain

Sodium-ion has emerged as the first viable non-lithium chemistry for both EVs and ESS. A key advantage over lithium chemistries is its lower critical mineral reliance. Within this group of batteries, layered oxide, which uses manganese, soda ash,

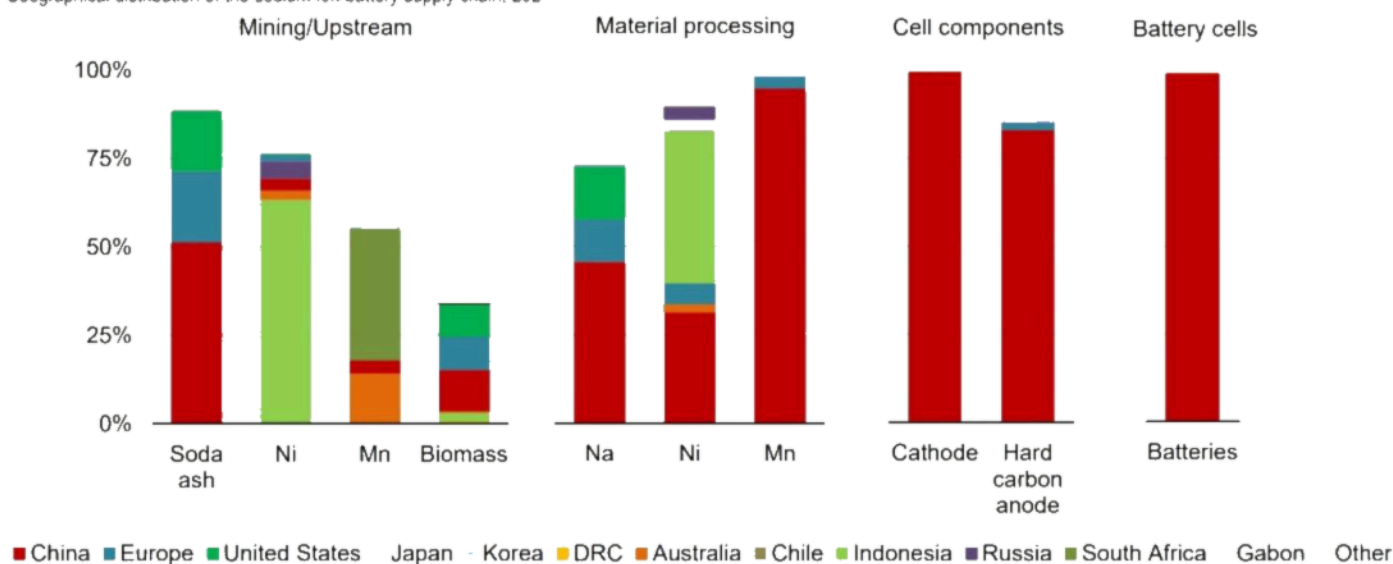
significantly less nickel and no lithium or cobalt, is emerging as the dominant cathode chemistry. Soda ash is abundant worldwide.

Anodes use hard carbon instead of graphite. Although it requires significant processing, hard carbon can be manufactured out of low-cost, and often renewable precursors that are widely available, such as coconut shells, wood, sugar, agricultural waste (corn stover, rice husks), phenolic resins, and other biomass. Even though the majority of this processing capability currently resides in China, volumes are still very low and the technology is straightforward enough that countries can catch up. In principle, hard carbon could be produced almost anywhere with access to biomass and pyrolysis equipment.

Battery-grade graphite is still cheaper than hard carbon on a per-kilogram basis currently due to economies of scale and decades and accumulated optimization. By contrast, production volumes of hard carbon are limited and manufacturing scale-up is in very early stages. Hence, as sodium-ion becomes more mainstream and hard carbon manufacturing scales to meet rising demand, costs should decline substantially.

Figure 27: Upstream, sodium-ion battery supply chains are more diversified than lithium chemistries

Geographical distribution of the sodium-ion battery supply chain, 2025



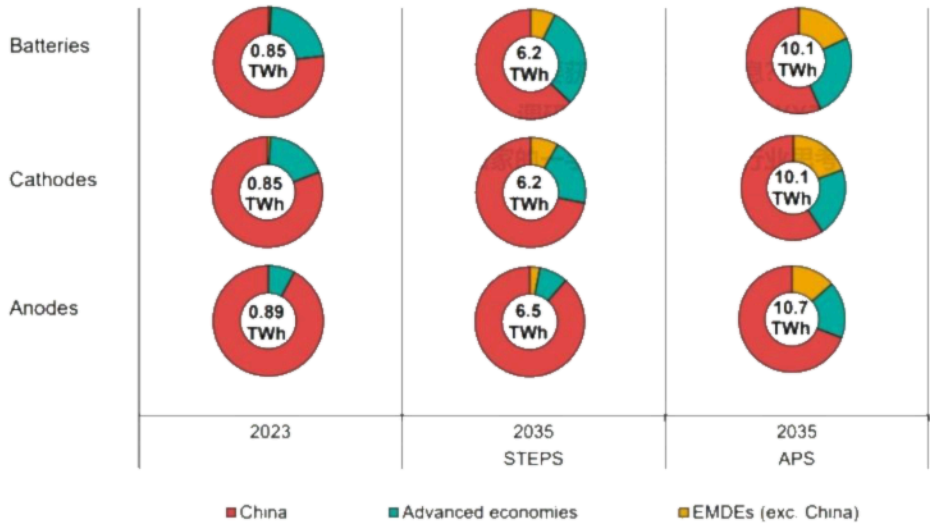
Source: IEA, Global Critical Minerals Outlook, 2025 ([link](#))

With the right policy and support, there is significant scope to diversify the battery supply chain

Under the IEA's STEPS scenario, roughly one-third of batteries and over a quarter of cathodes could be produced outside China by 2035. These shares would be larger in their Announced Pledges scenario, highlighting that supply chains could be further diversified if countries follow through with their decarbonization commitments. The difference is even starker in the anode market, where ex-China could represent roughly one-third of supply in the APS scenario, versus less than 10% today.

Figure 28: Decarbonization can help further diversify the battery supply chain

Battery and selected component production by country or region in the Stated Policies Scenario and Announced Pledges Scenario, 2023-203



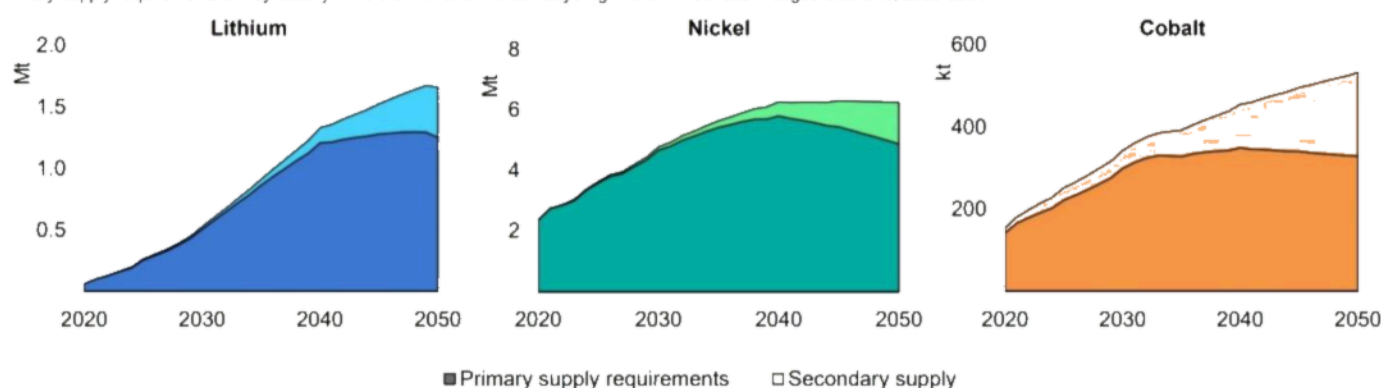
STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; EMDEs (exc. China) = emerging markets and developing economies excluding China. Battery refers to battery cells and includes EV and battery storage. A negative (anode) to positive (cathode) electrode ratio of 1.05 is assumed for the final cells, which implies 5% more anode capacity than cathode capacity per cell
Source: IEA 2024, EV Supply Chain Sustainability ([link](#))

Spotlight on battery recycling

The past few years have seen a global push to increase battery recycling, i.e. converting manufacturing scrap and end-of-life batteries into reusable raw materials. This is motivated by safety and environmental considerations with respect to the disposal of spent LIBs, as well as rising concerns about the vulnerabilities posed by the very concentrated supply chains of the critical raw materials needed for batteries. As a result, recycling is expected to meet a significant proportion of demand for these key raw materials in the next few decades (Figure 29). In this section we will look at the different recycling processes in detail, the outlook for recycling capability, sustainability considerations and emerging constraints and priorities for the subsector.

Figure 29: Recycling is expected to meet a significant proportion of nickel, lithium and cobalt demand

Primary supply requirements of key battery minerals with and without recycling in the Announced Pledges Scenario, 2020-2050



Primary supply requirements = total demand net of expected contributions from secondary supply and reuse. Primary supply requirements are calculated as "total demand net of secondary supply", also accounting for losses during refining operations. Lithium is defined on a lithium content basis. Includes total demand and secondary production from all sectors except for nickel, where secondary production from steel is excluded

Source: IEA (2024), Recycling of Critical Minerals ([link](#)).

Lithium-ion battery recycling 101

The recycling process for lithium-ion batteries consists of two broad steps: **pretreatment** and **material recovery**. In the pre-treatment phase, the packs are disassembled into cells and the batteries are discharged so they can be safely handled. Batteries are then hammered, shredded or crushed (referred to as "comminution" in the industry), resulting in a dark, powdery mixture of materials called "black mass", consisting of cathode active material, anode graphite, binder residues and some impurities (electrolyte residue, copper, aluminium, etc).

Raw materials such as cobalt, nickel, lithium, etc are then recovered from the black mass, usually through either hydrometallurgy or pyrometallurgy:

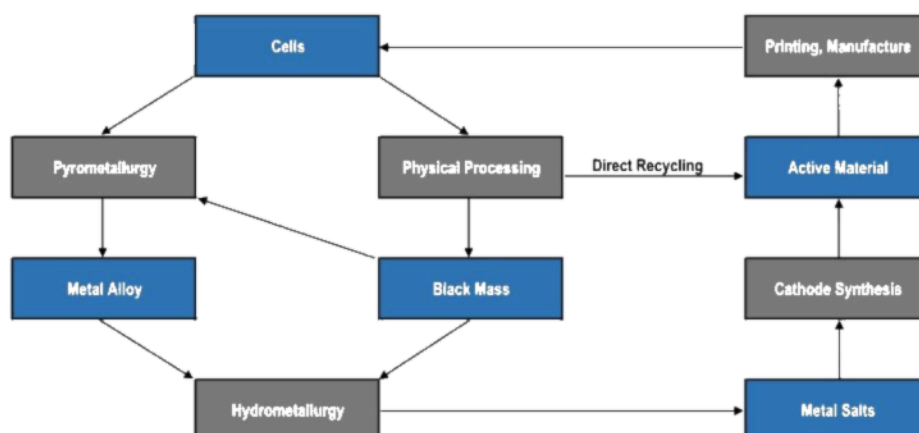
- **Hydrometallurgy** uses aqueous solutions (often acids or alkalis) to leach target metals from shredded battery materials so they can be separated and purified.
- **Pyrometallurgy** uses high heat to smelt batteries or concentrates into metal-alloys and slag, which require downstream refining to recover usable materials.

The direct **recycling approach** skips the conversion into metal salts by hydro- or pyrometallurgy and instead recovers the cathode material through a more controlled disassembly process.

Today, most commercial recycling uses pyrometallurgy and/or hydrometallurgy processes, while direct recycling is still emerging ([link](#)). Figure 13 provides a simplified view of these pathways, illustrating how physical pre-processing produces black mass that can be routed to hydrometallurgy, while pyrometallurgy produces a metal alloy and direct recycling targets recovered active material. While the exact flow varies by recycler and battery chemistry, most processes are designed to convert mixed battery inputs into standardized, higher-purity materials suitable for reintroduction into the battery supply chain.

Figure 30: Lithium-ion battery recycling loop

Generalized recycling loop, showing processes in gray and intermediate products in blue



Source: Sommerville et al. ([link](#))

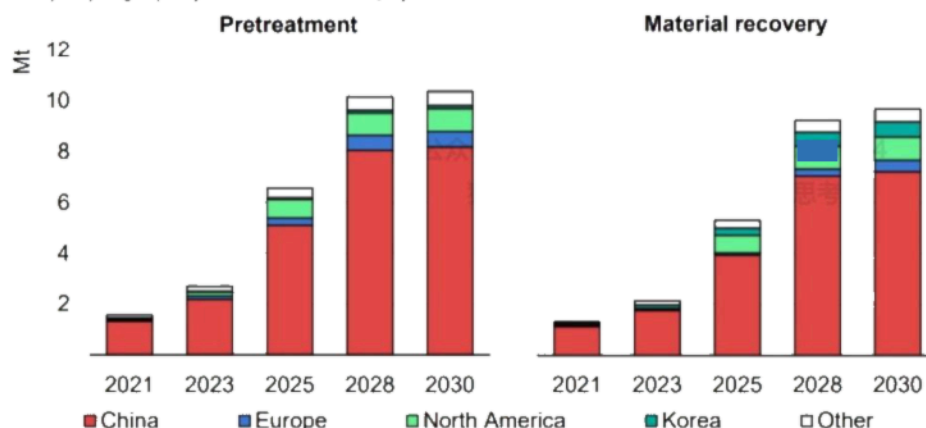
Battery recycling by the numbers: who does what?

China is, and will likely remain, the global battery recycling leader

With 80% of the global capacity for battery pretreatment and almost 85% for material recovery, China is the global leader in battery recycling today. Looking at the announced projects as of 2024, the IEA projects some degree of diversification in recycling activity over time, although it still estimates that China would still account for 80% of global pretreatment and 75% of global material recovery capacity in 2030. By then, North America would reach a 10% share of recycling capacity, and Japan and Korea, 5% each (Figure 31).

Figure 31: China is, and will likely remain, the global battery recycling leader

Battery recycling capacity based on announced projects, 2021-2030



Capacity in megatonnes of cell-equivalent mass of total recyclable material. Announcements include both those that are committed (i.e. under construction or having reached final investment decision) and preliminary announcements (i.e. those that have not reached final investment decision).

Source: IEA (2024), Recycling of Critical Minerals ([link](#)).

CATL and GEM amongst the largest names in battery recycling

Given China's leadership in the space, it is unsurprising that many of the leading battery recyclers in the coming years are likely to be Chinese ([link](#)) with **CATL** (through its subsidiary **Brup**) and **GEM** leading the way, according to the IEA. Both of these have integrated battery recycling operations into their battery and battery materials production chains.

However, we found that **battery recycling spans across sectors**, with companies within **metals and mining, utilities and chemicals** also operating recycling facilities. We identified 7 companies, which are covered by our fundamental analysts, that have battery recycling operations (Table 3), though most of these represent minor business segments with no reported revenues attributed solely to battery recycling.

Table 3: Integrated battery recyclers

Company	Ticker	Country	Sector	Analyst	Description	Exposure
GEM	002340 CH	China	Electrical Components & Equipment	Pansley Ong	GEM recycles battery metals, including nickel and cobalt, which accounted for 15.7% and 6.7% of revenue respectively. It also recycles lithium-ion batteries from both electric vehicles and electronics, which combined accounted for a further 5% of revenue. In H125, they processed 22.4k tons of power batteries, and achieved recovery rates of 96.5% for lithium, 99.5% for nickel and cobalt, and 95% for graphite. It is set to have the second-largest pre-treatment capacity globally by 2030, according to the IEA.	27%
Brup	300750 CH	China	Electrical Components & Equipment	Rebecca Wen	Subsidiary Brup operates a battery recycling business in China and Indonesia, which is integrated into the CATL battery production chain. In 2025, they recycled 210k tons of used batteries and materials, recovering 24k tons of lithium salts. CATL's "battery materials and recycling" segment accounted for 5.2% of revenue in 2025. According to the IEA, it could account for over 5% of global pre-treatment capacity by 2030, making it a global leader, based on announced projects.	5%
Ganfeng Lithium	002460 CH	China	Specialty Chemicals	Avery Chan	Operates battery recycling sites across eight cities in China. Market-leader in China for LFP recycling, with a nickel-cobalt metal recovery rate of 99%.	-
Glencore	GLEN LN	United Kingdom	Diversified Metals & Mining	Dominic O'Kane	Major recycler of lithium-ion batteries and critical minerals. It acquired Li-Cycle in August 2025, which had five battery recycling facilities (4 in the US, 1 in Germany) with a combined capacity of 40k tons of batteries each year.	-
Umicore	UMI BB	Belgium	Specialty Chemicals	Chetan Udeshi	Umicore has an annual capacity to recycle 7k tonnes of batteries at their facility in Hoboken, Belgium, though the segment was loss-making in 2025. According to the IEA, Umicore is set to have the largest pre-treatment capacity in Europe by 2030.	-
Fortum	FORTUM FH	Finland	Electric Utilities	Pavan Mahbubani	Provides recycling services in Europe for lithium-ion batteries and battery production scrap, with facilities in Germany and Finland.	-
BASF	BAS GR	Germany	Diversified Chemicals	Chetan Udeshi	In June 2025, started operation of a battery recycling plant at their Schwarzheide site in Germany, with an annual capacity of 15k tons of lithium-ion batteries.	-

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.

Source: J.P. Morgan.

We have also identified a handful of pure-play battery recycling companies that are not covered by our analysts, but represent important parts of the battery supply chains in various regions, including the US, Korea, India and the UK (Table 4).

Table 4: Pure-play battery recyclers

Company	Ticker	Description
Ecobat	Private	The world's largest producer of lead and lead alloys via the recycling of lead-acid batteries in the US. It also has lithium-ion battery pre-treatment facilities in the US, Germany and the UK.
Redwood Materials	Private	Redwood processes and recycles over 70% of lithium-ion batteries recycled in North America, and produces over 60k tons of critical materials each year.
American Battery Technology	ABAT US	Based in Nevada, the firm operates a battery recycling facility with a processing capacity of 20k tons of lithium-ion batteries. Has an agreement with BASF who both supply end-of-life batteries to, and purchase recycled metal from the firm. The firm is also looking to begin primary lithium extraction from its claystone deposits in Tonopah Flats.
Sungeel HiTech	365340 KS	Pure-play lithium-ion battery recycler based in Korea, with facilities in Korea, India, China, Malaysia, Hungary, Poland and the US.
Cirba Solutions	Private	US-based pure-play recycler of alkali and lithium-ion batteries, with a 95% recovery rate in the latter. They produce black mass, battery-grade metal sulfates and lithium carbonate from lithium-ion batteries, whilst the zinc-manganese concentrate extracted from alkali batteries is used in dietary supplements and fertilizers.
Ascend Elements	Private	Produces active cathode active materials and critical minerals using input from recycled batteries and manufacturing scrap. Set to have the largest pre-treatment capacity in the US by 2030, according to the IEA.
Altium Metals	Private	UK-based recycler of batteries and battery production scrap, with >99% recovery rate for graphite and >95% recovery rate for lithium and nickel. Uses recycled material to produce precursors and cathode active materials.
Recyclus	Private	UK-based pure-play industrial-scale lithium-ion battery recycler, which have an end-of-life battery supply agreement with Jaguar Land-Rover.
BatX Energies	Private	Major battery recycler in India. Signed a partnership agreement with VinFast Auto India in July 2025.

Source: J.P. Morgan.

Battery recycling and sustainability

Recycling can substantially improve the environmental math of battery production

A 2025 Stanford lifecycle analysis [found](#) that, compared with conventional production from mined inputs, lithium-ion battery recycling reduced environmental impacts by roughly 58-81% for GHG emissions, 72-88% for water use and 77%-89% for energy use, with results varying by electricity mix. These ranges are reported for the refining step because the study had detailed industrial operating data for refining, while upstream extraction and transport “did not have the same granular primary data as refinement” and are treated separately. The study also [highlights](#) that electricity consumption is the principal driver of recycling impacts, implying that outcomes can vary significantly by facility location and power mix. Finally, the study [finds](#) that producing mixed nickel-cobalt salts (instead of fully separating nickel and cobalt into discrete salts) can further reduce impacts and that upstream steps such as extraction and transport are a relatively small share of impacts in circular supply chains ($\leq 4.1\%$ of circular CO₂-eq compared to 7.8-30.4% in conventional). Additionally, according to [NREL's](#) median published lifecycle emissions factors, solar PV (43 gCO₂e/kWh) combined with lithium-ion storage (33 gCO₂e/kWh) yields a combined intensity of ~76 gCO₂e/kWh, a fraction of coal-fired generation (1,001 gCO₂e/kWh).

The EU batteries regulation: pedal to the metal on recycling

In 2023 the EU introduced its Batteries Regulation with four key objectives: reduce the carbon footprint of batteries, increase recycling rates at battery and raw material level (Table 5 and Table 6), foster traceability and responsible sourcing by reinforcing environmental and social due diligence raw materials' supply chains, and promote sustainable battery design with minimum performance standards and labelling requirements.

Table 5: The EU batteries regulation introduces ambitious recycling targets...

Minimum material recovery efficiency by material in the EU Batteries Regulation

	By 31st December 2027	By 31st December 2031
Cobalt	90%	95%
Copper	90%	95%
Lithium	50%	80%
Nickel	90%	95%

Source: EU Batteries Regulation ([link](#))

Table 6: ... as well as recycled content targets in battery manufacturing

Minimum quota of recycled content by material in the EU Batteries Regulation

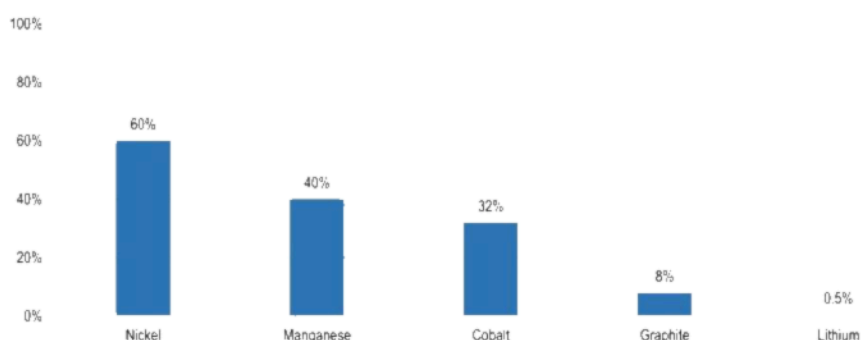
	18th August 2031	18th August 2036
Cobalt	16%	26%
Lithium	6%	12%
Nickel	6%	15%

Source: EU Batteries Regulation ([link](#))

The future of battery recycling: constraints and emerging priorities

Lithium-ion battery recycling faces several practical constraints that can limit scale and consistency. A key constraint is variability in battery chemistries and designs, as different chemistries yield different recovery outcomes and economics. NMC packs, for example, have been reported to achieve high cobalt and nickel recoveries, while lithium is often harder to recover in a usable form because it typically requires additional separation and purification steps ([link](#)). Figure 32 displays the end-of-life recycling rates for battery metals, as estimated by the IEA and the European Commission Joint Research Center (JRC). LFP batteries contain little to no nickel or cobalt, so the potential revenue from recovering these high-value metals is lower, which can weaken recycling economics even when technical recovery is feasible ([link](#)). As a result, emerging priorities include improved chemistry identification and sorting, more chemistry-flexible processing, and battery designs that are easier to disassemble and recycle.

Figure 32: End-of-life recycling rates for battery metals

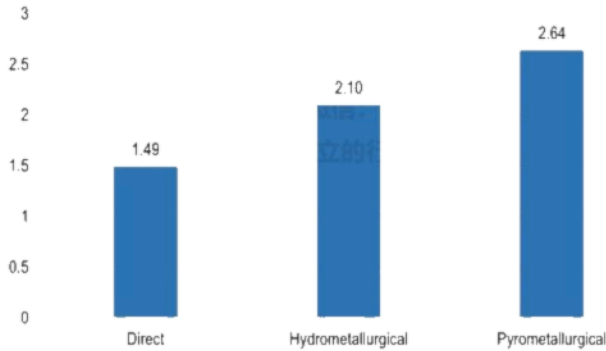


Source: IEA, The Role of Critical Minerals in Clean Energy Transitions ([link](#)) for nickel, cobalt and lithium; European Commission JRC for manganese and natural graphite ([link](#))

Additionally, existing lithium-ion battery recycling routes can be energy and resource intensive, depending on the process used. The IEA states that “traditional pyrometallurgical methods are highly energy-intensive, and although hydrometallurgical processes typically require less energy, they require reagents (acids) and wastewater treatment” ([link](#)). Similarly, a 2025 [study](#) notes that “compared to direct recycling, pyrometallurgical recycling processes have much higher emission and energy consumption” and that hydrometallurgical recycling processes can require higher capex due to specialized equipment as well as “intense chemical use and the production of more waste.” In an analysis of the environmental impacts of lithium ion battery recycling routes, Peixoto et al. (2026) [report](#) 1.49 kg CO₂ eq per kg of feedstock processed for direct recycling (for mixed battery chemistries), 2.10 for hydrometallurgical recycling and 2.64 for pyrometallurgical recycling (Figure 33). Additionally, in a review of the techno-economical and socio-environmental impacts of lithium-ion battery recycling, Das et. al (2026) [report](#) cost ranges of US\$0.9-4.1 per kg for direct recycling, US\$2-4.1 for pyrometallurgy and US\$2.4-6.2 for hydrometallurgy. Emerging priorities therefore include reducing energy intensity, improving reagent and wastewater management, and aligning facility siting and utilities with the chosen process type.

Figure 33: Reported emissions of lithium-ion battery recycling processes

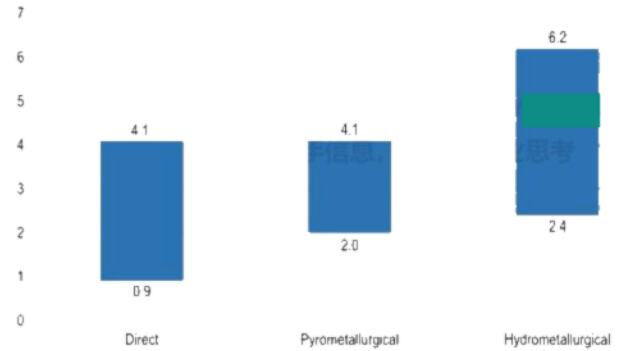
in kg CO2 eq per kg of feedstock processed: for mixed battery chemistries



Source: Peixoto et al. ([link](#))

Figure 34: Reported cost ranges of lithium-ion battery recycling processes

in USD per kg recycled



Source: Das et al. ([link](#))

Another key challenge is insufficient end-of-life feedstock: being relatively new technologies, most batteries have not reached their end of life. In a 2026 report, the IEA [highlights](#) that production scrap currently “accounts for nearly all of the recycling feedstock” and the aforementioned Stanford lifecycle analysis [notes](#) that “90% of the recycled supply studied” came from the scrap stream. This trend will remain for the rest of the decade, with the IEA estimating that two-thirds of recycling feedstock in 2030 will still come from manufacturing scrap and only after 2035 will spent batteries represent the majority of the feedstock. Given near-term reliance on scrap, emerging priorities include expanding safe collection and logistics for end-of-life batteries, securing contracted feedstock and building flexible capacity that can adapt as end-of-life volumes rise.

The power of policy

Table 7: Key policies, regulations and fiscal incentives designed to enable energy storage systems at scale

Country / Region	Key Policies, Regulations and Financial Incentives
United States	The Section 48E Clean Electricity Investment Tax Credit (ITC) (6% base, 30% if prevailing wage/apprenticeship requirements are met, plus bonus adders) and standalone storage eligibility are the primary federal supports, while eligible projects may alternatively elect the technology-neutral Section 45Y Clean Electricity Production Tax Credit (PTC), which provides a per-kWh credit for electricity produced instead of claiming the 48E ITC. These incentives are complemented by Section 45X manufacturing credits (US\$35 / kWh for battery cells, US\$10 / kWh for battery modules). Additional support comes from DOE funding, FERC Orders 841 and 2222 enabling storage participation and state procurement programs, with Morgan Lewis reporting 13 states adopting storage procurement targets and 17 with energy storage policy measures as of March 2026.
China	The NDRC and NEA's 2025–2027 Special Action Plan targets >180 GW of new-type storage by 2027, "expected to drive" 250 billion yuan (US\$32.5bn) in direct investment, with cumulative installed capacity reaching 144.7 GW at the end of 2025 (+85% YoY, CNESA). Policy support includes Document 136 (early 2025) clarifying storage is not a prerequisite for renewable approval/grid connection, a Jan 2026 capacity-pricing mechanism for standalone grid storage, and Dec 2025 market rules expanding storage/VPP access and contracting. Additional measures include provincial tariff/compensation reforms (including 11 provinces removing administratively fixed C&I TOU tariffs per Climate Corporation China) and tighter national safety standards for storage and EV batteries (e.g., GB 44240, CNESA).
India	India's Ministry of Power (MoP) issued the National Framework for Promoting Energy Storage Systems in 2023, projecting ~82 GWh of storage needed by FY26–27 and ~411 GWh by FY31–32, and requiring utilities to source 1% of energy from storage (rising to 4% by FY29–30). Support includes two battery capital-subsidy (viability gap funding, VGF) schemes (Mar 2024: 13,220 MWh; Jun 2025: 30 GWh via the Power System Development Fund), transmission-charge waivers for eligible pumped storage and co-located batteries through June 30th, 2028 (conditions apply), contracted offtake tenders from central agencies (e.g., SECI/NHPC), and March 2026 tariff rules from the Central Electricity Regulatory Commission clarifying storage treatment. Domestic supply is supported by the ACC manufacturing incentive program (~US\$2 billion for 50 GWh; ~40 GWh awarded and ~1 GWh installed as of March 2026).
European Union	The 2024 electricity market reform strengthens long-term contracting (PPAs and CfDs) and elevates non-fossil flexibility, supporting storage and demand response. The Net-Zero Industry Act designates batteries and storage as strategic technologies with a 550 GWh EU battery manufacturing capacity benchmark and faster permitting timelines. Additional capex support flows through EU-ETS backed instruments including the Innovation Fund and Modernization Fund, alongside Commission-approved member state aid (e.g., Romania's ~US\$176 storage scheme under CISA, financed by the Modernization Fund, to support at least 2,174 MWh awarded via competitive tenders). Member states also make complementary efforts such as Germany's 20-year network charge exemption for storage and Italy's MACSE long-duration contracts.
United Kingdom	The United Kingdom has developed a cap-and-floor certainty mechanism for long-duration electricity storage (LDES) systems, announced in October 2024. The mechanism received 171 initial applications and 77 have moved to the project assessment stage, with Ofgem aiming to approve the first projects by Q2 2026 and make final decisions on awards in Summer 2026. The mechanism provides a floor (minimum revenue support) and a cap (limits upside and provides returns to customers) over a set period (25 years), with eligibility targeting "true" LDES (minimum 8-hour duration and 400 MWh for the first application round) and procurement in the first application round in the range of 2.7-7.7GW. Additionally, the UK's Clean Power 2030 objectives include 4-6 GW of LDES and 23-27 GW of battery capacity by 2030. LDES capacity in the UK reached 2.8 GW in September 2025 (as published by Ofgem) and battery storage capacity in the UK reached 6.8 GW at the end of 2024 (as published by the House of Commons Library).
Chile	Chile has progressively enabled storage through Law 20,936 (2016) and Law 21,505 (2022), allowing standalone BESS to participate in wholesale markets and access capacity remuneration, or payment for being available to deliver power. The capacity value of storage is further clarified by Supreme Decree No. 70 (DS 70) (issued in 2023 and published in 2024), which sets a tiered accreditation methodology for storage's power capacity contribution (up to 100% for 5+ hour systems). Proposed amendments to DS 125 and DS 88 would further modernize dispatch, letting the grid operator decide when standalone batteries charge and discharge. Smaller batteries below 9 MW would be able to operate based on their own submitted schedules. The proposals would also allow small distributed projects ("PMGD," up to 9 MW) to add storage, but would remove the regulated price stabilization benefit for PMGD projects that add storage. Both proposals were under review as of April 2026.
Australia	Australia is supporting storage through a mix of consumer rebates and loans, utility-scale revenue underwriting (government-backed guaranteed minimum revenue floor), manufacturing incentives and state long-duration contracts. The federal Cheaper Home Batteries Program (2025) provides eligible households, businesses and community organizations with a ~30% discount on small-scale battery installation costs and was expanded to ~US\$5bn over four years, targeting ~40 GWh of additional storage. Western Australia's Residential Battery Scheme provides rebates for a 10 kWh battery (about US\$3.6k to US\$5.4k, depending on the utility) and no-interest loans up to ~US\$7.2k for eligible households (income <~US\$150k), typically tied to VPP participation and repayable over up to 10 years. For grid-scale buildout, the Capacity Investment Scheme (CIS) underwrites revenues for renewables and clean dispatchable capacity (storage target increased to 14 GW by 2030, with 4 GW of battery storage awarded under CIS Tender 3 in September 2025). On supply, the Battery Breakthrough Initiative (2024-25 Federal Budget) provides ~US\$358 million in grants/production incentives for domestic battery manufacturing.

Source: J.P. Morgan

US: Standalone energy storage eligibility, ITC bonus adders and 45X manufacturing support

The US supports utility-scale energy storage primarily through the technology-neutral Clean Electricity Investment Tax Credit (ITC) (Section 48E). Under Section 48E, the credit is 6% by default and increases to an effective 30% (a 5x multiplier) if prevailing wage and apprenticeship requirements are met ([link](#)). Projects may also qualify for stackable bonus adders of +10pp for domestic content and +10pp for energy community siting. A separate bonus adder of up to +20pp is available through the low-income allocation program and is most relevant to smaller, customer-sited projects ([link](#)). The 48E credit for energy storage is in effect for energy storage projects that begin construction before YE33, and then gradually steps down to 75% of the credit in 2034, 50% in 2035, and then 0% in 2036. The credit for energy storage was extended by a year with the OBBBA compared to the IRA, unlike the solar and wind 48E credits which were curtailed sooner, which we believe shows bipartisan support for energy storage.

The technology-neutral Clean Electricity Production Tax Credit (Section 45Y) provides a per-kWh credit for electricity produced for eligible facilities, offering an alternative to claiming the Section 48E investment tax credit. The IRA also made standalone energy storage ITC-eligible, eliminating the prior need to pair storage with generation.

The IRA also [established](#) the Section 45X advanced manufacturing production credit, which provides manufacturer-level per-unit credits for domestically produced battery components (including US\$35 per kWh for battery cells and US\$10 per kWh for battery modules) which manufacturers can monetize through transferable or direct-pay mechanisms ([link](#)).

In March 2026, the US Department of Energy's (DOE) Office of Critical Minerals and Energy Innovation also [announced](#) a Notice of Funding Opportunity for up to US\$500 million to "expand critical mineral and materials processing and derivative battery manufacturing and recycling." In parallel, FERC Order 841 (issued in 2018) [allows](#) grid-scale batteries to participate in wholesale markets and earn capacity, energy and ancillary-services revenues, while FERC Order 2222 (issued in 2020) [allows](#) aggregated smaller distributed resources (including batteries) to participate in RTO/ISO wholesale markets as a single resource. Alongside federal support, various states have driven deployment through procurement targets and utility solicitations that can create long-term contracted revenues, such as California's AB 2514 [framework](#) and New York's NYSEDA bulk storage [procurements](#) towards its 6 GW by 2030 [target](#). Morgan Lewis [reports](#) that as of March 2026, 13 states have adopted energy storage procurement targets and 17 have adopted some form of energy storage policy.

China: National storage targets, market reform and provincial compensation schemes

China's Special Action Plan for Large-Scale Construction of New Energy Storage (2025-2027), [released](#) in September 2025, includes 21 key measures to support the country's [aim](#) of achieving more than 180 GW of installed new-type energy storage by 2027. This is expected to funnel ~250 billion yuan (~US\$32.5 billion) in direct project investment. New energy storage in this context is defined as "electricity storage [processes](#) that use electrochemical, compressed air, flywheel and supercapacitor systems but not pumped hydro". For context, China's cumulative installed capacity of such storage reached 144.7 GW by YE 2025(+85% y/y), according to [CNESA](#).

In December 2025, NDRC and NEA [issued](#) the Basic Rules for the Medium- and Long-Term Electricity Market, clarifying market access for storage/Virtual Power Plants (VPPs), expanding flexible forward contracting, and strengthening coordination with spot-market operation and cross-provincial transactions. Additionally, 11 provinces have implemented or announced the removal of administratively fixed commercial and industrial time-of-use tariffs ([link](#)). These measures increase formal market access pathways for storage/VPPs and reduce the role of administratively set commercial and industrial time-of-use pricing in the provinces implementing the reform. Various provinces have also utilized local compensation schemes to support energy storage development, such as Jiangsu, which [allowed](#) user-side storage to earn peak-shaving demand-response payments up to ~US\$0.7 per kWh during the winter peak window, and Xinjiang, which [introduced](#) a capacity compensation of ~US\$0.03 per kWh discharged for independent storage, alongside separate peak-shaving/ancillary compensation rates and a capacity-lease reference price of ~US\$44 per kWh before 2025 with long-term leases (>10 years).

Separately, in 2025-26, China introduced a series of national standards for energy storage and electric vehicle batteries, including GB 44240, which upgrades the safety requirements of energy storage lithium batteries from “recommended” to “mandatory” ([CENESA](#))

Looking ahead, China’s 15th Five-Year Plan (2026-2030) [calls for](#) building a “new power system” and directs authorities to “scientifically deploy pumped-storage hydropower” and “vigorously develop new-type energy storage,” although it does not specify a BESS target.

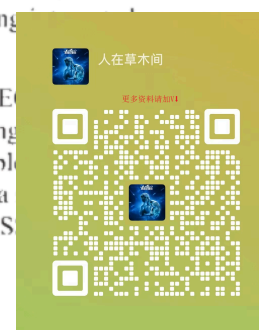
India: Mandated storage offtake, government capex subsidies (VGF) and tendered contract revenues

India’s MoP issued the National Framework for Promoting Energy Storage Systems in 2023, aiming to support national targets (e.g. 50% cumulative installed capacity from non-fossil fuel-based energy sources by 2030) and ensure a reliable and affordable energy supply. The [Framework](#) states that India’s energy storage capacity requirement will be ~82 GWh of storage by 2026-27 and ~411 GWh by 2031-32 and reiterates a target that utilities procure at least 1% of their energy from storage in 2023-24, which rises by 0.5pp annually to 4% by 2029-30.

In addition to the policy framework, India has rolled out capex support via two Viability Gap Funding [schemes](#) for BESS: in March 2024, a ~US\$398 million scheme to support 13,220 MWh at ~US\$28,500 per MWh, and in June 2025, a 30 GWh scheme funded through ~US\$571 million from the Power System Development Fund (PSDF) at ~US\$19,047 per MWh. Network cost relief is also [provided](#) through the 100% Inter-State Transmission System (ISTS) charge waivers covering PSPs where construction work is awarded on or before June 30, 2028, and co-located BESS projects commissioned on or before June 30, 2028 (subject to conditions), with graded waivers in grid-delay cases.

On the regulatory side, the Central Electricity Regulatory Commission (CERC) issued [tariff rules](#) in March 2026 that formally recognize storage, including storage systems, and clarify tariff treatment.

Central agencies such as the Solar Energy Corporation of India (SECI) and Hydroelectric Power Corporation (NHPC) have also been procuring large tenders that provide contracted offtake terms. Notable examples include a 1.5 GWh assured peak [tender](#) using a contract for difference with a 10 year term and a 12 year term (launched in 2026) and NHPC’s Tranche II BES



/ 1 GWh of standalone intra-state transmission system-connected battery storage, with a 12 year term (launched in 2025).

The government has also taken [steps](#) to accelerate PPA signing and as of December 31st, 2025, Renewable Energy Implementing Agencies (REIAs) had issued ~69 GW of Letters of Awards and signed ~24.3 GW of PPAs. On the supply side, the Production Linked Incentive (PLI) scheme for Advanced Chemistry Cell (ACC) battery storage, approved by the Ministry of Heavy Industries in 2021, provides ~US\$2bn to establish 50 GWh of domestic ACC manufacturing capacity. As of March 2026, 40 GWh of capacity has been [awarded](#) to four firms, with ~1 GWh of capacity installed.

EU: Long-term contracts, flexibility reform, NZIA-driven manufacturing scale-up and funding support

As highlighted in our Make the Grid Great Again [piece](#), the EU's 2024 electricity market reform strengthened the framework for long-term contracting (including PPAs) and introduced non-fossil flexibility provisions requiring Member States to assess flexibility needs and enabling support schemes to remunerate storage and demand response where markets alone are insufficient.

The Net-Zero Industry Act, which came into force in 2024, designates batteries and energy storage as strategic net-zero technologies, sets a 550 GWh EU battery manufacturing capacity benchmark for 2030 and includes faster permitting timelines of 12-18 months for standard manufacturing projects and 9-12 months for "strategic" projects.

The Recovery and Resilience Facility (2021) also [allocates](#) ~US\$29 billion to "supporting electricity networks, storage and smart meters" and ~US\$20 billion to "tackling critical energy-system bottlenecks, such as insufficient grid capacity, lack of cross-border interconnections and limited storage capabilities." Additional EU capex support is available through EU-ETS-backed instruments such as the [Innovation Fund](#) and the [Modernization Fund](#). The Commission has also approved member-state state aid to accelerate storage deployment, such as a ~US\$176 million Romanian [scheme](#) (under CISA, financed by the EU Modernization Fund) to support at least 2,174 MWh of new electricity storage, the beneficiaries of which will be selected through competitive tendering. Earlier, the 2019 Clean Energy Package [defined](#) energy storage as distinct from generation and final consumption, creating a clearer legal basis for storage market participation and rules on ownership and operation.

At the EU member state level, storage-enabling policies to either support capex or provide long-tenor contracted revenues are taking shape. We detail a few examples:

- Germany provides a 20-year [exemption](#) from network access charges for electricity used to charge storage systems under the Energy Industry Act (EnWG §118(6)) for projects commissioned by August 4th, 2029. However, post-2029 treatment of storage within Germany's network tariff framework remains under regulatory review, with [consultations](#) ongoing on potential reforms to storage network changes.
- In Italy, the MACSE scheme introduces centralized auctions for long-duration storage, offering 15-year availability-based contracts, and [awarded](#) 10 GWh of grid-scale battery storage to be operational by 2028 in its first auction in 2025.
- In Spain, European Regional Development Fund (ERDF)-backed funding is supporting grid-scale storage deployment through the Institute for the Diversification and Saving of Energy (IDAE)-administered grant programs, with the Ministry for the Ecological Transition and the Demographic Challenge (MITECO)

finalizing awards for 126 storage projects representing ~2.2 GW of additional storage power and ~9.4 GWh of storage capacity and ~US\$1bn under the 2021-2027 ERDF program.

Investing in Batteries

We identified 46 stocks with material exposure to the theme of batteries, of which 19 are rated OW by our covering analysts. Our stock ideas are spread across the battery value chain, but are heavily skewed towards Asia, with nearly half of all companies domiciled in China or South Korea. Vale Indonesia, Aneka Tambang, Merdeka Copper Gold, LG Energy Solution and CATL are the OW companies with the most attractive valuations. We also identified 8 credit ideas aligned to the theme of batteries, of which two are rated OW, and four are rated Neutral.

Switching to funds, we found 60 open-ended or exchange-traded funds aligned with the battery theme, with assets of US\$15.2bn. Assets more than doubled in 2025, largely due to flows of 74%. The fund universe also has a heavy skew towards Asia, and three-quarters of assets are not considered sustainable by Morningstar.

Building the battery taxonomy

To capture companies exposed to the batteries theme, we have looked for exposure to the following stages of the battery production chain:

- **Mining/refining of raw materials:** we use the IEA's scope of battery metals when screening for raw material exposure - Lithium, Nickel, Cobalt, Graphite and Manganese, which are deemed critical for battery performance, longevity and energy density ([link](#)). Whilst other minerals such as copper and aluminum are used in battery technologies, they only account for a minor share of global demand for these metals, so are not included.
- **Battery materials**, such as cathode and anode materials, precursors and separators
- **Manufacture of batteries and related components**
- **Manufacturers and/or providers of energy storage systems (ESS)**

We manually screened the public disclosures of companies with potential exposure to one or multiple stages of the battery value chain, from the following areas: a) our recent [critical minerals](#) and [grid resilience](#) stock universes, b) companies held by battery funds (see fund landscape section below), and c) companies covered by J.P. Morgan fundamental analysts within the following sectors: electronic equipment, electrical components & equipment, electronic manufacturing services, electric utilities, electronic equipment & instruments, semiconductors, semiconductor materials & equipment, consumer electronics, commodity chemicals, specialty chemicals, diversified chemicals, industrial machinery & supplies & components, automobile manufacturers, heavy electrical equipment, household products, household appliances, renewable electricity, independent power producers & energy traders, multi-utilities, and electric utilities, which in our view are most likely to host battery solutions providers.

We applied a 10% threshold for alignment with the theme of battery solutions to be deemed material. As our screening was done at the company level, it is valid for both equity and credit instruments.

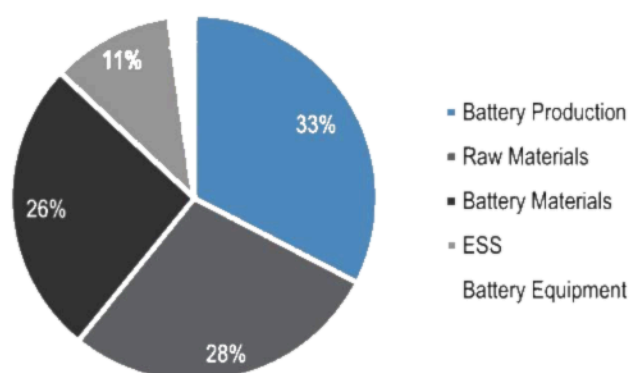
Please note that due to the manual nature of our screening and the dynamic nature of J.P. Morgan's coverage, some companies may have slipped through our net. Our universe should therefore be viewed as a non-exhaustive guide, and a company not featuring on it should not be viewed as a negative judgment on its exposure to our batteries theme.

Equities

We have identified **46 stocks** covered by our analysts spread across the battery value chain, of which **19 are rated OW** by our covering analysts, and 17 are rated Neutral. 15 of the companies we identified are involved primarily in the production of batteries, 13 are providers of raw materials, and 12 are producers of battery materials (Figure 35). However, **our battery universe is heavily skewed towards Asia**, with nearly half of the stocks located in China or South Korea, with a further 6 US and 4 Australian stocks (Figure 36).

Figure 35: Our equity universe is split fairly evenly across the battery supply chain...

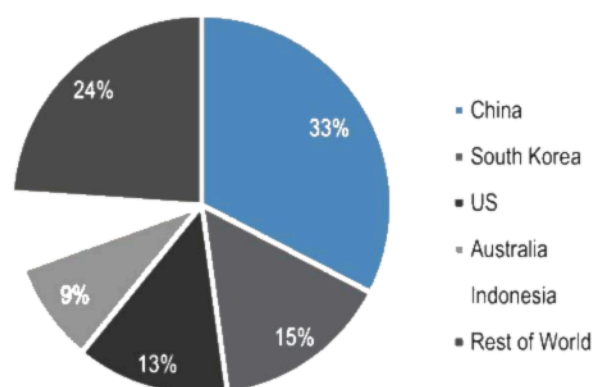
Breakdown by solution



Source: J.P. Morgan.

Figure 36: ... but is heavily skewed towards Asia

Breakdown by domicile



Source: J.P. Morgan.

We have created a number of summary tables to help our readers navigate the batteries universe:

- Table 8 summarizes the universe by region, sector and recommendation. We have shaded the stocks with an MSCI Environmental, Social or Governance controversy score of 2 or below, with the exception of those where such controversies have concluded or are in the process of concluding.
- Table 9 summarizes the universe by region, battery solution and recommendation. We have applied the same shading based on controversy scores as in the previous table.
- Table 10 summarizes the revenue alignment of each stock in the universe to their predominant battery solution.
- Table 11 ranks the OW battery equities based on the upside to our analysts' target prices and the discount of the PE multiple relative to the long-term median, expressed as a z-score. Vale Indonesia, Aneka Tambang, Merdeka Copper Gold, LG Energy Solution and CATL are the OW companies with the most attractive valuations under this lens.
- Table 12 - Table 15 show more detailed explanations of the exposure to battery solutions for companies in each stage of the battery supply chain.

Table 8: Our batteries universe by sector

	APAC				EMEA			Americas		
	OW	N	UW	NR	OW	N	UW	OW	N	UW
Electrical Components & Equipment	AT Eaton SI NXP Stamps	EVE Energy Hunan Yuneng Advanced Energy Solutions Amara Raja Energy and Mobility Ecopro BM	Gotion High-tech POSCO Future-M Rohbly						Fluence Energy Eos Energy	Envision
Electronic Components	AT SI NXP Stamps									
Commodity Chemicals	Eastman Chemical Dow Chemical		SKC Dychem							
Industrial Machinery & Supplies & Components	Stamps					Wartsila				
Specialty Chemicals		Putailai Ganfeng Lithium Tianqi Lithium						Albemarle		
Diversified Metals & Mining	Freeport-McMoan Liontown Resources Metals and Mining							Lithium Americas		
Consumer Electronics		Panasonic								
Automotive Parts & Equipment		CALB								
Semiconductor Materials & Equipment								SolarEdge Technologies		
Semiconductors										Canaccord Solar
Household Products								Energizer		
Gold	Antares									
Steel										

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray. We have shaded the non-Indian stocks with an MSCI Environmental, Social or Governance controversy score of 2 or below, with the exception of those where such controversies have concluded or are in the process of concluding.
Source: J.P. Morgan.

Table 9: Our batteries equity universe by solution

	APAC				EMEA			Americas		
	OW	N	UW	NR	OW	N	UW	OW	N	UW
ESS	Stamps					Wartsila			Fluence Energy Eos Energy	Canaccord Solar
Battery Production	AT Siemens Advanced Energy Solutions Ecopro BM Stamps	EVE Energy Panasonic CALB Advanced Energy Solutions Amara Raja Energy and Mobility	Gotion High-tech					SolarEdge Technologies Energizer		Envision
Battery Materials	L&T Eastman Chemical NXP	Putailai Hunan Yuneng Ecopro BM	POSCO Future-M SKC Dychem Rohbly		Albemarle					
Battery Equipment	Wartsila									
Lithium	Freeport-McMoan	Ganfeng Lithium Tianqi Lithium Liontown Resources						Albemarle Lithium Americas		
Nickel	POSCO Manganese Antares Vale									

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray. We have shaded the non-Indian stocks with an MSCI Environmental, Social or Governance controversy score of 2 or below, with the exception of those where such controversies have concluded or are in the process of concluding.
Source: J.P. Morgan.

Table 10: Batteries universe: revenue alignment

Company	Ticker	Sector	Region	Primary revenue alignment solution	Alignment
L&F	066970 KS	Industrials	Asia Ex	Battery Materials	100%
Vale Indonesia	INCO IJ	Materials	Asia Ex	Nickel	100%
LG Energy Solution	373220 KS	Industrials	Asia Ex	Battery Production	100%
Pilbara Minerals	PLS AU	Materials	Australia	Lithium	100%
Liontown Resources	LTR AU	Materials	Australia	Lithium	100%
Putailai	603659 CH	Materials	Asia Ex	Battery Materials	100%
Tianqi Lithium	002466 CH	Materials	Asia Ex	Lithium	100%
CALB	3931 HK	Consumer Discretionary	Asia Ex	Battery Production	100%
Advanced Energy Solutions	6781 TT	Industrials	Asia Ex	Battery Production	100%
EVE Energy	300014 CH	Industrials	Asia Ex	Battery Production	100%
Eos Energy	EOSE US	Industrials	North America	ESS	100%
Lithium Americas	LAC CN	Materials	North America	Lithium	100%
Enovix	ENVX US	Industrials	North America	Battery Production	100%
Hunan Yuneng	301358 CH	Industrials	Asia Ex	Battery Materials	98%
Ecopro BM	247540 KS	Industrials	Asia Ex	Battery Materials	98%
Dynanonic	300769 CH	Materials	Asia Ex	Battery Materials	97%
Ronbay	688005 CH	Industrials	Asia Ex	Battery Materials	97%
Simplo Technology Co Ltd	6121 TT	Information Technology	Asia Ex	Battery Production	97%
CATL	300750 CH	Industrials	Asia Ex	Battery Production	96%
Fluence Energy	FLNC US	Industrials	North America	ESS	96%
Gotion High-Tech	002074 CH	Industrials	Asia Ex	Battery Production	95%
Amara Raja Energy and Mobility	ARENM IN	Industrials	Asia Ex	Battery Production	>94%
Samsung SDI	006400 KS	Information Technology	Asia Ex	Battery Production	93%
Ganfeng Lithium	002460 CH	Materials	Asia Ex	Lithium	92%
Changsheng	002340 CH	Industrials	Asia Ex	Battery Materials	86%
CNGR	300919 CH	Industrials	Asia Ex	Battery Materials	84%
Yunnan Energy	002812 CH	Materials	Asia Ex	Battery Materials	81%
Albemarle	ALB US	Materials	North America	Lithium	77%
IGO	IGO AU	Materials	Australia	Nickel	76%
Meitika Copper Gold	MDKA IJ	Materials	Asia Ex	Nickel	76%
Energizer	ENR US	Consumer Staples	North America	Battery Production	71%
Wuxi Lead	300450 CH	Industrials	Asia Ex	Battery Equipment	66%
SQM	SQM US	Materials	Latin America	Lithium	60%
POSCO Future M	003670 KS	Industrials	Asia Ex	Battery Materials	54%
LG Chem	051910 KS	Materials	Asia Ex	Battery Production	54%
TDK	6762 JP	Information Technology	Japan	Battery Production	53%
Sungrow	300274 CH	Industrials	Asia Ex	ESS	42%
SKC	011790 KS	Materials	Asia Ex	Battery Materials	27%
Canadian Solar	CSIQ US	Information Technology	North America	ESS	25%
SolarEdge Technologies	SEDG US	Information Technology	North America	Battery Production	24%
Aneka Tambang	ANTM IJ	Materials	Asia Ex	Nickel	18%
Umicore	UMI BB	Materials	Europe	Battery Materials	12%
Panasonic	6752 JP	Consumer Discretionary	Japan	Battery Production	12%
Vale	VALE3 BZ	Materials	Latin America	Nickel	11%
Wartsila	WRT1V FH	Industrials	Europe	ESS	10%
Minerals Resources	MIN AU	Materials	Australia	Lithium	10%

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.
Source: J.P. Morgan.

Table 11: Vale Indonesia. Aneka Tambang. Merdeka Copper Gold. LG Energy Solution and CATL have the most attractive valuations amongst the OW-rated stocks in our batteries universe

Company	Ticker	Sector	Country	Upside	Historical PE Z-score
Vale Indonesia	INCO IJ	Diversified Metals & Mining	Indonesia	86.3	-1.7
Aneka Tambang	ANTM IJ	Gold	Indonesia	93.5	-0.7
Merdeka Copper Gold	MDKA IJ	Diversified Metals & Mining	Indonesia	71.5	-0.4
LG Energy Solution	373220 KS	Electrical Components & Equipment	South Korea	38	0.8
CATL	300750 CH	Electrical Components & Equipment	China	25.4	-0.5
Umicore	UMI BB	Specialty Chemicals	Belgium	9.2	-1.4
SQM	SQM US	Specialty Chemicals	Chile	16.8	-0.4
Sungrow	300274 CH	Electrical Components & Equipment	China	26.8	0.0
Yunnan Energy	002812 CH	Commodity Chemicals	China	24.1	-0.1
Simplo Technology Co Ltd	6121 TT	Electronic Components	Taiwan, China	11.7	-0.1
L&F	066970 KS	Electrical Components & Equipment	South Korea	96.3	1.5
IGO	IGO AU	Diversified Metals & Mining	Australia	0.7	-0.4
LG Chem	051910 KS	Commodity Chemicals	South Korea	40.2	1.0
Wuxi Lead	300450 CH	Industrial Machinery & Supplies & Components	China	20	0.5
Pilbara Minerals	PLS AU	Diversified Metals & Mining	Australia	4.5	0.0
Samsung SDI	006400 KS	Electronic Components	South Korea	36.3	2.2
Vale	VALE3 BZ	Steel	Brazil	22.2	1.6
CNGR	300919 CH	Electrical Components & Equipment	China	-20.9	0.7
TDK	6762 JP	Electronic Components	Japan	8.7	2.3

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.

Source: J.P. Morgan, Bloomberg Finance L.P.

Table 12: Energy storage solutions providers

Company	Ticker	Description	Exposure
Sungrow	300274 CH	Sungrow is the second-largest ESS integrator globally, selling ESS to residential, commercial and industrial (C&I) and utility-scale clients. ESS accounted for 41.8% of revenue in 2025.	42%
Eos Energy	EOSE US	100% of Eos Energy's revenue is tied to stationary battery energy storage.	100%
Fluence Energy	FLNC US	In FY25, energy storage products and solutions accounted for 96% of revenue.	96%
Canadian Solar	CSIQ US	Production of battery energy storage solutions accounted for 24.5% of revenues in 2025.	25%
Wartsila	WRT1V FH	The firm's Energy Storage segment accounted for 10.1% of revenues in FY25.	10%

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.

Source: Company reports and J.P. Morgan estimates.

Table 13: Battery and related equipment production

Company	Ticker	Description	Exposure
LG Energy Solution	373220 KS	One of the largest EV battery suppliers in the world, as well as supplying batteries for consumer electronics and ESS applications. Largest US ESS order backlog as of 2026.	100%
Singapore Technology Ltd	6121 TT	Produces lithium-ion batteries used in notebooks, battery energy storage solutions, drones and smartphones. Lithium battery modules accounted for 96.6% of revenue in 2025.	97%
CATL	300750 CH	CATL is a major producer of batteries for electric vehicles, which accounted for 74.7% of 2025 revenue, and provider of energy storage solutions, which accounted for 14.7% of 2025 revenue. It also produces battery materials such as lithium salts, precursors and cathode materials, and directly sources raw materials via mining operations and battery recycling via its subsidiary, Brunp, which combined accounted for 6.6% of 2025 revenue.	96%
Samsung SDI	006400 KS	In 2025, production of batteries for EVs, energy storage and electrical products accounted for 93.3% of revenues.	93%
Wan Li	300450 CH	Produces equipment used in the manufacture of lithium-ion batteries, which accounted for 65.6% of revenues in 2025.	66%
LiGchem	051910 KS	Parent of LG Energy Solutions, which accounted for 51.4% of 2025 revenue. Also a major producer of cathode materials with increasing semiconductor/electronic material exposure, accounting for a further ~3% of revenue.	54%
TDK	6762 JP	TDK's "Energy Application Products" segment, which produces lithium-ion batteries and power supplies, accounted for 53.4% of FY25 revenues.	53%
CALB	3931 HK	CALB is the third-largest battery maker in China based on battery installation, with ~68% of revenue in 2025 attributed to EV batteries, and the rest attributed to "ESS products and others".	100%
EVE Energy	300014 CH	Major producer of consumer, power and energy storage batteries, with combined revenues of 99.8% in 2025.	100%
Advanced Energy Solutions	6781 TT	Produces battery modules for a range of e-bike and industrial purposes, as well as battery back-up unit.	100%
Amara Raja Energy and Mobility	ARENMI IN	The second-largest lead acid battery producer in India, supplying battery modules for a range of automotive and industrial purposes, which accounted for 94% of revenues in FY26. The "New Energy Business" segment, which accounted for the remaining 6% of revenue, includes lithium battery packs, EV charging infrastructure and stationary energy storage solutions.	>94%
Energizer	ENR US	Batteries accounted for 71% of total sales in 1Q26.	71%
SolarEdge Technologies	SEDG US	The company produces batteries for solar PV applications, which accounted for 22.7% of revenue in 2025, whilst revenue from energy storage systems contributed a further 1.4%.	24%
Panasonic	6752 JP	Panasonic Energy is a supplier of dry-cell and lithium-ion batteries, supplying the automotive industry, data centers, and industrial customers. These accounted for 12.2% of Panasonic's revenue in FY25.	12%
Enovix	ENVX US	Enovix develops and manufactures advanced lithium-ion batteries, including proprietary silicon-anode architectures, for smartphones, smart eyewear, defense, industrial and emerging edge-AI applications.	100%
Gotion High-Tech	002074 CH	Fully integrated battery producer, supplying lithium batteries to the EV and ESS market, which accounted for 72.5% and 22.1% of 2024 revenue respectively.	95%

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.

Source: Company reports and J.P. Morgan estimates.

Table 14: Battery materials producers

Company	Ticker	Description	Exposure
Li & F	066970 KS	Produces cathode active materials mainly for EVs.	100%
CNCR	300919 CH	CNCR is the largest global supplier of NCM precursors, with a market share of 23%. It has an integrated supply chain, with mining assets in China, Argentina and Indonesia, as well as battery recycling sites in China, Morocco and Germany. Sales of battery materials, including precursors and tricobalt tetroxide, accounted for 47.1% of total revenues in 2025, whilst sales of "new energy metals", which was comprised mainly of nickel intermediaries and electrolytic nickel, accounted for a further 37%.	84%
Yumex Energy	002812 CH	Major producer of lithium-ion battery film separators, which accounted for 81.2% of 2024 revenue.	81%
Umicore	UMI BB	Umicore's Battery Materials division, which comprises of battery cathode materials and battery recycling, accounted for 12.1% of revenues in 2025.	12%
Putailai	603659 CH	Putailai is a global leader in the production of artificial graphite anodes. It also produces battery film materials and coating, as well as equipment used in battery manufacturing, and coating-as-a-service (CAAS).	100%
Hunan Yuneng	301358 CH	Hunan Yuneng is the largest LFP cathode producer globally, with a ~30% market share. 98.3% of revenues were attributed to battery materials in 2024.	98%
Ecopro BM	247540 KS	Produces cathode active materials for EVs (65.9% of 2025 revenue), power tools (16.4%) and energy storage solutions (15.3%).	98%
Dynanonic	300769 CH	Dynanonic is a leading global supplier of LFP cathodes, accounting for 96.7% of revenue in 2024.	97%
Ronbay	688005 CH	Ronbay is primarily engaged in the production of cathode materials, accounting for 95.7% of revenue in 2025, whilst precursors accounted for a further 0.9%.	97%
POSCO Future M	003670 KS	Producer of cathode and anode active materials, which collectively accounted for 53.6% of 2025 revenue.	54%
SKC	011790 KS	SKC's Mobility Material segment, which accounted for 27% of revenue in 2025, produces copper foil for high-capacity batteries.	27%
	002340 CH	GEM manufactures ternary precursors, ternary cathode materials for power batteries, and cobalt tetroxide materials for 3C digital batteries, which collectively accounted for 58.2% of revenues in 1H25. They also recycle battery metals, including nickel and cobalt, which accounted for 15.7% and 6.7% of revenue respectively, as well as recycle lithium-ion batteries, which accounted for a further 5% of revenue.	86%

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.

Source: Company reports and J.P. Morgan estimates.

Table 15: Suppliers of raw materials

Company	Ticker	Description	Exposure
Vale Indonesia	INCO II	Pure-play nickel matte producer, operating one of the world's largest integrated laterite nickel mining and processing facilities in Indonesia.	100%
Pitcair Minerals	PLS AU	Pure-play lithium producer operating in Western Australia.	100%
Menzies Copper Gold	MDKA II	Diversified metals and mining company with the majority of revenue derived from nickel (76%).	76%
SQM	SQM US	Vertically integrated chemicals company with around 60% of its revenue derived from lithium.	60%
IGO	IGO AU	IGO is a Western Australian lithium producer via its 25% interest in Greenbushes Lithium mine and 49% stake in Kwinana Lithium Hydroxide Refinery, with ~50% exposure in FY25. Post divestment in its Nova asset, it will be a pure-play lithium producer.	50%
Pt Antam Tambang	ANTM II	Diversified mining company with nickel ore open pit mines and ferronickel processing operations, which accounted for a combined revenue of 17.5% in 2025.	18%
Vale	VALE3 BZ	Global diversified mining company with 2025 revenue from nickel of 11.2%.	11%
Liontown Resources	LTRAU	Pure-play lithium developer and explorer company based out of Western Australia.	100%
Lithium Americas	LAC CN	The Thacker Pass lithium mine in Nevada is in the construction phase, with commercial production due to begin in 2028.	100%
Tianqi Lithium	002466 CH	One of the largest lithium producers globally, with all its revenue coming from the extraction and processing of lithium.	100%
Ganfeng Lithium	002460 CH	One of the largest lithium producers globally, with stakes in multiple assets and an estimated 92% revenue exposure to lithium. It also operates battery recycling facilities for retired lithium batteries.	92%
Albemarle	ALB US	Albemarle produces lithium compounds including lithium carbonate, lithium hydroxide and lithium specialties, with brine extraction sites in the US and Chile, hard rock sites in Australia, and conversion assets in the US and China. Approximately 77% of revenue is derived from lithium-based compounds and 23% from bromine and related derivatives.	77%
	MIN AU	Diversified mining company with significant lithium exposure via its Western Australian assets Mt Marion, Wodgina and Bald Hill.	10%

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.

Source: Company reports and J.P. Morgan estimates.

Credit

Using the same screening process as equities, we identified **8 credit issuers with at least 10% exposure to the battery value chain**, of which **2 are rated OW** by our fundamental credit analysts, 4 are rated N and two are Not Rated. Within our credit universe, five issuers are providers of raw materials, and three are primarily involved in battery production.

Table 16 summarizes the universe by region, sector and recommendation. We have shaded the stocks with an MSCI Environmental, Social or Governance controversy score of 2 or below, with the exception of those where such controversies have concluded or are in the process of concluding. Table 17 provides a more detailed description of the exposure of each issuer to battery solutions.

Table 16: Our batteries credit universe by solution

	APAC				EMEA			Americas			
	OW	N	UW	NR	OW	N	UW	OW	N	UW	NR
Battery Production	LG Energy Solution	LG Chem						Energizer			
Raw Materials	Nicke Industries				Eramet			Vale			

Source: Company reports and J.P. Morgan estimates.

Table 17: The credit universe explained

Company	Ticker	Region	Solution	Description	Exposure
Nickel Industries	NICAU	Australia	Raw Materials	Operations consist of Hengjaya Nickel, Oracle Nickel and Ranger Nickel rotary kiln electric furnace (RKEF) at the Indonesia Morowali Industrial Park (IMIP) and the Angel Nickel RKEF Project within the Indonesia Weda Bay Industrial Park (IWIP); the Hengjaya Mine, a large tonnage, high grade nickel laterite deposit in close proximity to the IMIP. Also holds a 10% interest in the Huayue Nickel Cobalt HPAL project (HNC) and a 46% interest in the Excelsior Nickel HPAL project (ENC). RKEF accounted for 75.7% of 2025 revenue, whilst 11.8% came from nickel ore mining and 12.5% from HPAL.	100%
LG Energy Solutions	LGES	Asia Ex	Battery Production	One of the largest EV battery suppliers in the world, as well as supplying batteries for consumer electronics and ESS applications. Largest US ESS order backlog as of 2026.	100%
Energizer	ENR	North America	Battery Production	Batteries accounted for 71% of total sales in 1Q26.	71%
LG Chem	LGCHM	Asia Ex	Battery Production	Parent of LG Energy Solutions, which accounted for 51.4% of 2025 revenue. Also a major producer of cathode materials with increasing semiconductor/electronic material exposure, accounting for a further ~3% of revenue.	54%
Eramet	ERAFP	Europe	Raw Materials	Global miner and refiner of critical minerals, with approximately 20% exposure to nickel. We expect Lithium (new operations started in 2025) to represent ~5% of revenue in 2026.	25%
Vale	VALEBZ	Latin America	Raw Materials	Global diversified mining company with 2025 revenue from nickel of 11.2%.	11%
	SQM	Latin America	Raw Materials	Vertically integrated chemicals company with around 60% of its revenue derived from lithium.	60%
	MINAU	Australia	Raw Materials	Diversified mining company with significant lithium exposure via its Western Australian assets Mt Marion, Wodgina and Bald Hill.	10%

OW-rated stocks are displayed in green, UWs in red, Ns in black, and stocks Not Rated are in gray.
Source: Company reports and J.P. Morgan estimates.

Fund landscape

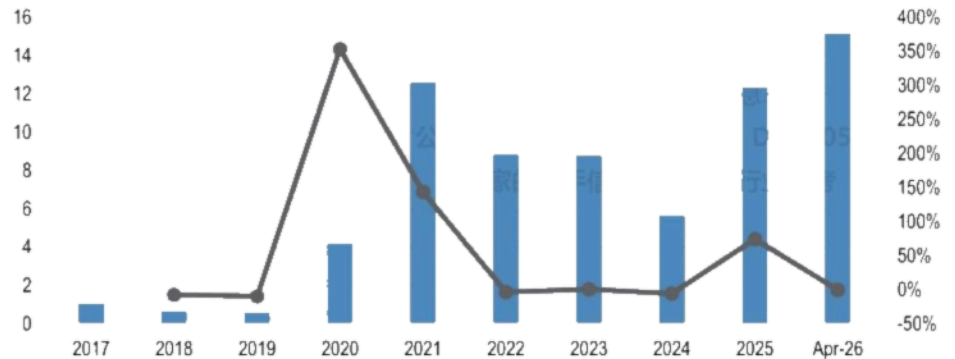
To identify funds aligned with the theme of batteries, we simply filtered Morningstar's fund universe for open-ended or exchange-traded funds that either a) were assigned the theme of "battery technology" funds by Morningstar, or b) had "battery" or "batteries" in the fund name. We then manually screened the resulting funds to ensure that they were truly aligned with the theme, excluding leveraged funds. **We found a total of 60 battery funds, with assets under management of US\$15.2bn.**

Battery funds under the microscope

After shrinking by over 50% between 2021 and 2024, the battery fund universe saw **inflows of 74% in 2025** (Figure 37), almost all of which came into China-domiciled funds. Despite such large growth, the battery fund universe remains relatively small compared to Morningstar's sustainable fund universe, which totalled US\$3.5tn in March 2026 ([link](#)).

Figure 37: Battery fund assets more than doubled in 2025

AuM (US\$bn, LHS) and flows (% , RHS) of battery funds over time

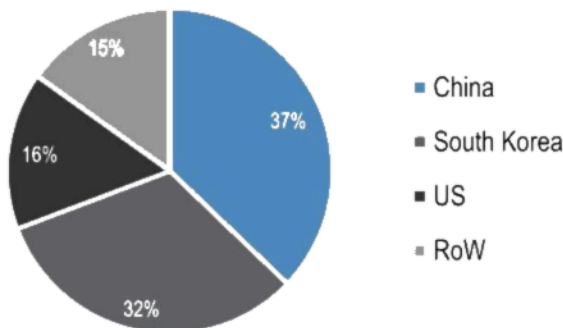


Source: J.P. Morgan, Morningstar.

Similar to our universe of battery-related stocks, **battery funds are largely skewed towards China and South Korea**, which account for 37% and 32% of assets, respectively, whilst US-domiciled funds make up a further 16% (Figure 38). Meanwhile, nearly three-quarters of the assets in our battery universe are not considered sustainable by Morningstar. All 15 of the funds that are classed as sustainable are considered to be climate action funds (Figure 39).

Figure 38: Chinese and South Korean funds account for nearly 70% of assets collectively

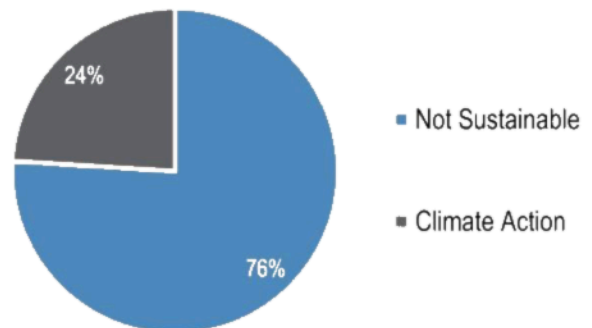
Breakdown of AuM by domicile



Source: J.P. Morgan, Morningstar.

Figure 39: Three quarters of assets are not considered sustainable by Morningstar

Breakdown of AuM by sustainable theme



Source: J.P. Morgan, Morningstar.

The 10 largest funds in our battery universe account for over three-quarters of assets, and are all passive equity funds (Table 18). The largest fund, the **Global X Lithium & Battery Tech ETF (LIT US)**, has assets of US\$2.1bn, and invests in the full battery supply chain, from lithium mining and refining through to battery producers. The **GF New Energy Vehicles Battery ETF (159755 CH)**, has assets of US\$1.7bn and tracks the CNI NEV Battery Index, which targets Chinese EV battery producers. Similarly, the **KODEX Secondary Battery Industry ETF**, which also has assets of US\$1.7bn, targets Korean companies within the battery value chain.

Table 18: Largest battery funds

Name	Domicile	Asset Class	Style	Sustainable Theme	Inception	AuM (US\$bn)
Global X Lithium & Battery Tech ETF	United States	Equity	Passive	-	22/07/2010	2.1
GF New Energy Vehicles Battery ETF	China	Equity	Passive	Climate Action	15/06/2021	1.7
KODEX Secondary Battery Industry	South Korea	Equity	Passive	-	11/09/2018	1.7
China Universal CSI Power Battery ETF	China	Equity	Passive	-	03/03/2022	1.1
E Fund CNI New Energy Battery ETF	China	Equity	Passive	Climate Action	31/01/2024	1.1
L&G Battery Value-Chain ETF	Ireland	Equity	Passive	-	18/01/2018	1.0
TIGER Secondary Cell	South Korea	Equity	Passive	-	11/09/2018	1.0
CMF CSI Power Battery ETF	China	Equity	Passive	-	04/08/2021	0.6
TIGER Secondary Battery TOP10	South Korea	Equity	Passive	-	06/10/2020	0.6
Global X Battery Tech & Lithium ETF	Australia	Equity	Passive	-	30/08/2018	0.6

Source: J.P. Morgan, Morningstar.

Battery funds are heavily exposed to China and Korea

The most owned stocks come from all stages of the battery production value chain, such as lithium extraction (Ganfeng Lithium, SQM), battery materials (Yunnan Energy, Ecopro BM), battery production (CATL, EVE Energy) as well as battery-related equipment (Wuxi Lead). Of the 20 most-owned stocks, 15 are domiciled in China, and three in Korea. Fourteen of the 20 most-owned stocks are covered by our fundamental analysts, of which **5 are currently rated OW**, 7 are rated N, one is rated UW and one is Not Rated (Table 19). **CATL (OW) is the most owned stock in our universe, present in 38% of battery funds.**

Table 19: Most owned stocks by battery funds

Name	Ticker	Analyst	Rating	Sector	Production stage	Number of funds	% of funds	Average weight (%)
CATL	300750 CH	Rebecca Wen	OW	Electrical Components & Equipment	Battery Production	23	38%	9.2
EVE Energy	300014 CH	Rebecca Wen	N	Electrical Components & Equipment	Battery Production	20	33%	4.7
Guangzhou Tinci Materials	002709 CH	-	-	Commodity Chemicals	Battery Materials	19	32%	3.5
Ganfeng Lithium	002460 CH	Avery Chan	N	Specialty Chemicals	Raw Materials	19	32%	3.7
Gotion High-Tech	002074 CH	Rebecca Wen	UW	Electrical Components & Equipment	Battery Production	18	30%	2.5
Sunwoda	300207 CH	-	-	Electrical Components & Equipment	Battery Production	18	30%	2.3
Yunnan Energy	002812 CH	Rebecca Wen	N	Commodity Chemicals	Battery Materials	17	28%	1.9
Putailai	603659 CH	Rebecca Wen	N	Specialty Chemicals	Battery Materials	16	27%	1.6
Samsung SDI	006400 KS	Sonny Lee	OW	Electronic Components	Battery Production	15	25%	10.9
Canmax Technologies	300390 CH	-	-	Commodity Chemicals	Battery Materials	15	25%	1.9
Ecopro BM	247540 KS	Sonny Lee	N	Electrical Components & Equipment	Battery Materials	15	25%	8.3
Shenzhen Kedali	002850 CH	-	-	Automotive Parts & Equipment	Battery Equipment	15	25%	2.1
Shenzhen Capchem	300037 CH	-	-	Specialty Chemicals	Battery Materials	15	25%	1.5
SQM	SQM US	Lucas Ferreira	OW	Specialty Chemicals	Raw Materials	15	25%	3.8
Albemarle	ALB US	Jeffrey J. Zekauskas	N	Specialty Chemicals	Raw Materials	14	23%	5.3
LG Energy Solution	373220 KS	Parsley Ong	OW	Electrical Components & Equipment	Battery Production	14	23%	6.7
Wuxi Lead	300450 CH	Rebecca Wen	OW	Industrial Machinery & Supplies & Components	Battery Equipment	14	23%	3.2
GEM	002340 CH	Parsley Ong	NR	Electrical Components & Equipment	Battery Materials	14	23%	2.4
Hunan Yuneng	301358 CH	Rebecca Wen	N	Electrical Components & Equipment	Battery Materials	14	23%	1.7
Beijing Easpring	300073 CH	-	-	Electrical Components & Equipment	Battery Materials	14	23%	1.4

Source: J.P. Morgan, Morningstar, Bloomberg Finance L.P.

Fifty-six of the 60 battery funds in our universe are passive, and 15 of those track the **CSI Battery Thematic Index**, totalling US\$2.4bn in AuM (Table 20). In fact, 85% of assets are benchmarked to thematic indices targeting the entire battery supply chain or a specific stage, such as lithium production or battery recycling, whilst just four funds are benchmarked to broad market indices. The CSI and CNI indices solely target Chinese stocks exposed to the battery industry.

Table 20: One quarter of battery funds are benchmarked to the CSI Battery Thematic Index

Benchmarks of battery funds by family

Benchmark Family	Provider	Number of funds	AuM (US\$bn)
CSI Battery Thematic	CSI	15	2.4
CNI NEV Battery	CNI	7	2.0
MSCI ACWI	MSCI	1	2.1
FnGuide Secondary Battery Industry	FnGuide	2	1.7
Solactive Battery Value-Chain	Solactive	2	1.6
CNI New Energy Battery	CNI	5	1.2
Other	-	28	4.1

Source: J.P. Morgan, Morningstar

Battery indices

Table 21 provides a comparison of 10 selected equity indices and one commodity index, which target the battery industry and can vary widely in scope and approach.

Table 21: Comparison of selected battery Indices

Index	Ticker	Solutions	Region	Asset	Launch date	Constituents	Selection Criteria	Exclusions	Related Products
BITA Global Lithium and Battery Metals Select	BGI ISI	Raw materials	Global	Equity	10/11/2023	45	Companies with at least 30% revenue from involvement in the mining, exploration, refining or royalties of lithium, cobalt, nickel, cadmium, vanadium, manganese or graphite. Companies who rank in the top five of dollar revenue from these activities are also included. Minimum market cap of \$100mn. Minimum 3M ADTV of \$100k.	Companies with a BITA assigned country of India, Indonesia, Malaysia, Philippines, Russia, South Korea, Sri Lanka, Thailand, Vietnam or Zimbabwe	Themes Lithium & battery Metal Miners ETF
S&P Global Core Battery Metals	SPGRMUT	Raw materials	Global	Equity	27/06/2022	52	Positive revenue and production exposure to cobalt, lithium or nickel in the past year. Minimum float-adjusted market cap of \$100mn. Minimum 3M ADTV of \$1mn.		ProShares S&P Global Core Battery Metals ETF
Solactive Battery Value Chain	SOLBATT	Lithium, battery production, ESS	Global	Equity	15/11/2021	45	For energy storage providers, companies must have 5MW of active installed capacity with at least 50% coming from battery-related technologies, or the company must have at least 500MW of installed EV battery capacity in current calendar year. For mining companies, any company that produces lithium, and is classified as "battery grade" by Lastmarkets. Minimum free float market cap of \$200mn. Minimum 3M ADTV of \$1mn.	Non-compliance with the UNGC. Sustainability controversy of level 5. 5% revenue exposure to tobacco, military contracting, small arms, gambling, adult entertainment or alcohol. Any direct or indirect involvement in controversial weapons. 10% revenue exposure to thermal coal. 20% revenues from production of conventional oil and gas, or 50% from generation or supporting products/services. 20% revenue from unconventional oil & gas (shale oil, Arctic oil & gas). Classified as an "Energy" stock by Fartsef.	L&G Battery Value Chain ETF, Global X Battery Tech & Lithium ETF
Solactive K Battery North America Supply Chain	SOIKBAT	Battery production, battery equipment, ESS, battery recycling	Korea	Equity	24/05/2024	15	Uses natural language processing to assign a score to companies listed on the KOSPI or KOSDAQ based on their current or expected exposure to: a) lithium ion and solid-state batteries, b) lithium-based energy storage solutions, c) lithium battery technology, such as battery packs, management systems and charging infrastructure, or d) lithium battery recycling. The top 40 firms are then ranked by their share of revenue derived from North America, with the 15 highest being selected. Minimum 1M and 6M ADTV of KRW50bn. Minimum share class market cap of KRW50bn.	Dual share classes	Kinwoom K Battery North America Supply Chain ETF
Chi New Energy Battery	980027	Battery production, battery and ESS related equipment	China	Equity	16/02/2015	50	Companies listed in China involved in new energy battery industry, including battery manufacturing, ESS inverters, ESS integration, battery temperature control, and fire protection systems. Bottom 10% of companies by 6M ADTV are removed, and then the top 50 companies by 6M average daily market cap are included in the index.		4 funds in our battery universe
CSI Battery Thematic	CS831719	Full value chain	China	Equity	07/04/2021	30	Securities involved in the "power battery industry chain". Top 30 securities by average market cap over the past year are included.	Companies in the bottom 20% of CSI All Share Index by 1Y ADTV	12 funds in our battery universe
Chi NEV Battery	980032	Full value chain	China	Equity	17/02/2015	30	Companies listed in China involved in new energy vehicle batteries (cathode materials, anode materials, electrolytes, diaphragms etc), new energy vehicle battery management systems, charging piles, and similar industries. Bottom 10% of companies by 6M ADTV are removed, and then the top 30 companies by 6M average daily market cap are included in the index.		5 funds in our battery universe
EQM Lithium & Battery Technology	BAFTIIX	Full value chain	Global	Equity	31/05/2017	50	Companies that derive at least 50% of revenue from the development and production of lithium battery technology and/or battery storage solutions. Companies that derive at least 50% revenue of profit from mining, processing, operations, contracts and/or projects utilized in lithium battery chemistries (lithium, cobalt, nickel, manganese, vanadium, graphite, copper). Companies that derive at least 90% of revenue from development and production of electric vehicles. Minimum market cap of \$250mn. Minimum ADTV of \$1mn.		Amplify Lithium & Battery Technology ETF
STOXX Global Lithium and Battery Producers	STXLBV	Full value chain	Global	Equity	29/08/2023	64	Companies with at least 25% revenue from lithium ore mining, consumer batteries manufacturing or EV battery manufacturing, as defined by RBICS. Companies with revenues of at least \$1mn in those sectors, that fall within the top half for revenues in the starting universe. Companies with >50% revenue exposure to the mixed heavy-duty and high-end batteries makers L6 RBICS sector, who also either have the top 30% of number of high quality patents for lithium batteries, or have a patent specialization (share of total patents for lithium batteries) > 25%. Minimum free float market cap of \$100mn. Minimum 3M ADTV of \$1mn.	Non-compliance with Sustainability Global Standards Screening (GSS), which assesses companies compliance with the UN Global Compact's (UNGC) 10 principles. Sustainability controversy rating of 5.	iShares Lithium & Battery Producers ETF
WisdomTree Battery Solutions	WTBSI	Full value chain	Global	Equity	26/02/2020	111	Companies involved in a) raw materials mining or chemical extraction used for battery and energy storage solutions (BESS), b) processing of materials, or production of components for BESS, c) developers of infrastructure which enables BESS, or d) use of new storage technologies or applications. Companies deemed to be in the top 80% of overall exposure, or top 33% exposure to each category, using their own "intensity rating", are included. Minimum market cap of \$250mn. Minimum median daily dollar volume of \$1mn.	Companies in the bottom 10% of the universe for "Composite score", which is the average of a quality factor and momentum factor. Non-compliance with Global Standards Screening. Involvement in controversial weapons. 5% revenue from small arms, thermal coal, oil sands, Arctic oil and gas exploration or shale energy exploration or production. Involvement in tobacco production, or 5% revenue from tobacco distribution.	WisdomTree Battery Solutions UCITS ETF
WisdomTree Battery Metals Commodity	WTBMCIR	Raw materials	Global	Commodity	03/03/2022	7	Commodity futures listed on eligible exchanges that have a minimum ADTV of \$15mn. Metals consist of aluminum, zinc, nickel, copper, lead, cobalt and lithium.		WisdomTree Battery Metals LIC

Source: J.P. Morgan ADTV = average daily trading volume.

Espresso shots

Table 22: Espresso shots: valuation metrics

	Upside to PT (%)	Mkt cap (\$mn)	EPS g FY1 (%)	EPS g FY2 (%)	RoE FY2 (%)	PE FY2	P/B FY2
Aneka Tambang	103	4,009	82.1	22	34	4	1.5
CATL - A	25	269,444	29.4	22	26	16	4
L&F	94	3,603	NM	NM	-10	127	NM
LG Energy Solution	38	59,741	NM	58	7	41	2.5
Samsung SDI	22	34,452	NM	176	2	39	2.2
Sungrow - A	15	56,240	12.5	26	29	20	5.3

Source: J.P. Morgan

Aneka Tambang (ANTM IJ, OW, PT Rp 6000)

Aneka Tambang is a vertically integrated mining company primarily involved in three commodities – nickel (18% of sales in FY 2025), gold and to a lesser extent silver (79% of sales), and bauxite & alumina (3% of sales). ANTM was listed in 1997 with a 35% free float, with its main shareholder remaining the Government of Indonesia throughout the last three decades (65% ownership). ANTM's nickel operation is its main profitability driver. The nickel business consists of production and sale of raw ore, and production of ferronickel (FeNi), using mined raw ore as feedstock. Nickel production is currently centered in Pomalaa (Sulawesi), Pakal (North Maluku) and Gag Island (Papua). ANTM's nickel resource is roughly 12% of Indonesia's total resource and is currently the country's largest producer. ANTAM's gold and silver business consists of gold refining and also a small gold mining operation in West Java. ANTM's gold refining is the only refiner that is LBMA certified in Indonesia and its brand Logam Mulia has the number 1 market share in the country

Investment case

ANTM is Benny Kurniawan's preferred pick among the Indonesian Nickel miners. At the end of April 2026, Benny revised his earnings forecast by 16-17% and increased his Jun-27 PT to IDR6,000/share, driven by higher nickel ore prices and a recovery in gold volumes. Benny's FY26-28E earnings are 45-66% higher than the Street.

With tight supply of high-grade saprolite ore and slower approval of the 2026 RKAB permit, ore prices are expected to remain strong and benefit upstream players like ANTM. Furthermore, Benny anticipates gold sales volumes to rebound to 3-4 tons per month (up from 1 ton per month in 4Q25), positioning ANTM to deliver record profitability in 2026.

Separately, ANTM is insulated from several recent regulatory changes, cementing their advantage over other Indonesian miners:

- The Indonesian government is expected to announce export levies on nickel products. Within the JPM coverage, INCO has the highest export exposure as its nickel matte is exported to both Vale Canada and Sumitomo Metal Mining. By contrast, ANTM's export exposure, which comes from its FeNi business, accounts for less than 4% of revenues.
- ANTM sells high grade saprolite which is unaffected by changes to the nickel ore benchmark price (HPM) formula. Two significant changes were introduced in the new formula: 1) the correction factor was increased by 13% and 2) it incorporates values from other minerals. Based on the USD17,000/t LME price and 35%

moisture content, a 1.6% grade saprolite would previously have a reference price of ~USD30/t (vs USD60-70/wmt price in the spot market). The new HPM will be ~USD53/wmt and all royalties will be the higher of 1) market price or 2) HPM. The change will have no negative bearing on ANTM, as it has been paying royalties based on realized market prices.

Valuation: Benny's Jun-27 PT of Rp6,000 is based on a 9x P/E, using 2027E earnings. His multiple of 9x P/E is lower than the historical average of 12x, as he takes into account a high commodity price regime that will result in investors assessing the name on a dividend yield basis. Multiple assignment implies a 11% dividend yield which is compelling against Indonesia's 10Y bond yield of ~6.5%. ANTM historically paid a 100% payout and should have no significant capex requirements beyond the JV growth projects.

Risks include: (1) inability/delays in securing nickel ore mining permits from the gov't, (2) issues in gold supply, hampering sales volume in the refining & minting business, and (3) regulatory issues pertaining to nickel mining.

Sustainability

Aneka Tambang has an MSCI rating of B, placing it in the lower tier of global peers. MSCI notes that the company is on par with peers regarding potential toxic emissions risk management but lags peers in corporate governance and business ethics practices. MSCI also flags the company's recurring related-party transactions with its controlling shareholder and an apparent lack of mandatory ethics training for all staff. Sustainalytics views Aneka Tambang as having a high ESG risk, ranking it 46th out of 171 companies in the Diversified Metals Mining subindustry (27th percentile).

Environmental: ANTM aligns with the reduction targets of MIND ID (Indonesia's state-owned mining holding company, of which it is a part) and has reported an 8.03% reduction in Scope 1+2 emissions relative to business-as-usual (BAU) for 2025, compared to MIND ID's target of 2.70%. In its ESG Roadmap, the company also includes 2029-2030 environmental targets of reducing Scope 1+2 emissions by 15.8% and increasing the renewable energy mix by 10%, both compared to a BAU in 2023 baseline, and achieving a >75% success rate for all rehabilitated land that has undergone a minimum 5-year program. The company also commits to aligning its decarbonization efforts with Indonesia's national target of net zero emissions by 2060 or sooner. ANTM's thermal coal exposure is limited and is primarily through its direct subsidiary PT Indonesia Coal Resources. ANTM has not provided a separate revenue breakdown after FY22, in which coal represented 0% of revenue from sales, down from ~0.03% of sales in FY21.

Social: Women represent 0% of the supervisory board (zero of seven), 17% of the management board (one of six) and 11% of permanent employees. ANTM reports that there is a 1:1 ratio of wages and benefits for male and female employees in the same position levels. The company reported unchanged zero fatalities and minor accidents in 2025, as well as zero major accidents, down from two in 2024. The Total Recordable Incident Rate fell from 0.07 in 2024 to 0.03 in 2025. In its ESG Roadmap, the company also targets a Social Return on Investment (SROI) index score of >2 for all social development programs and a Total Recordable Incident Frequency Rate above the International Council on Mining and Metals (ICMM) average score, both for 2029-2030.

Governance: The board has a two-tier structure, with a six-member management board and a seven-member supervisory board (57% independent of management). The nomination, audit, risk and pay committees are fully independent of management and the roles of CEO and Chairman have been separated.

Battery exposure

ANTM is exposed to the battery value chain primarily through its role as an upstream nickel ore supplier and its participation in an integrated battery ecosystem consortium alongside the Indonesia Battery Corporation, Zhejiang Huayou Cobalt and EVE Energy. The parties signed a Framework Agreement in January 2026 to develop an integrated battery ecosystem in Indonesia that spans nickel processing, refining and battery production with a potential target capacity of up to 20 GWh and an investment value of US\$5-6 billion ([link](#)). The project is currently in the feasibility study stage. ANTM is also [participating](#) in a partnership with the CBL Consortium (CATL, Brunp, Lygend) in a joint venture to build and operate a High Pressure Acid Leach (HPAL) plant in Buli, East Halmahera to produce MHP (a common battery supply chain intermediate), which is also in the early stages. ANTM's nickel ore open pit mines and ferronickel processing operations accounted for a combined 17.5% of the company's revenue in 2025.

L&F (066970 KS, OW, PT W 290,000)

Established in 2000, and listed on KOSDAQ in 2003, L&F is a cathode material manufacturer for various battery applications, such as power tools, electric vehicles, and energy storage systems.

Investment Case

L&F remains Korean autos analyst Sonny Lee's top pick within the battery materials sector, offering a differentiated growth profile among Korean cathode peers, underpinned by its dominant position in ultra-high-nickel cathodes for cylindrical EV batteries and its early-mover advantage in LFP, targeting both ESS and EV markets. With differentiated end market exposure and an early lead in LFP, L&F is well positioned for superior earnings momentum compared to peers, in Sonny's view.

He sees upside to the company's 2026 shipment guidance of +20% y/y (JPMe >30% y/y), driven by rising 4680 cylindrical battery volumes and the Phase 1 LFP capacity ramp from 3Q. Financial leverage remains a watch item, though management has outlined a credible mitigation path via external funding sources and improving operating cash flow, while ruling out an imminent need for a rights offering. Furthermore, the company has taken a relatively conservative approach to capacity expansion, particularly overseas, which has helped mitigate the risk of large-scale impairment losses.

Valuation: Sonny's Dec-26 PT of W290,000 is based on an up-cycle EV/EBITDA multiple of 50x, reflecting the company's five-year trading history.

Risks include: (1) slower EV/ESS sales growth; (2) delays in the LFP business ramp-up; and (3) intensifying competition in the 95% nickel cathode segment.

Sustainability

L&F has an MSCI rating of BBB, after being upgraded from BB in March 2026 as a result of improvements in corporate governance practices, placing it in the middle tier of global peers. MSCI highlights the company's peer-leading management practices for clean technology opportunities, toxic emissions and waste and notes that it is on par with industry peers in labor management. Sustainalytics views L&F as having a high ESG risk, ranking it 86th out of 154 companies in the Specialty Chemicals subindustry (56th percentile).

Environmental: L&F targets carbon neutrality by 2050 (not SBTi validated), and RE100 (corporate [pledge](#) to source 100% of global electricity from renewable sources) by 2035. The company notes that 100% of its Scope 2 emissions, which account for ~98% of total emissions, stem from electricity use and that it is "actively reviewing" renewable energy solutions such as REC purchases and PPA agreements to reach 100% renewable energy conversion by 2035. In 2024, L&F reported an unchanged waste recycling rate of 100%. The company was the first cathode material manufacturer to achieve the highest "Platinum" grade for Zero Waste to Landfill certification (third-party validation to verify that waste is diverted from landfills) and has maintained this for three of its five plants.

Social: Women represent one out of eight (12.5%) of L&F's board of directors and 9.4% of the total workforce. In 2024, the company continued to report zero fatal accidents and experienced a slight increase in accident rates (0.18 for employees and 0.02 for contractors and suppliers, up from 0.11 and 0 in 2023, respectively). The

company's "supply chain sustainability assessment system" includes an annual supplier ESG evaluation with 100 questions, a minerals risk assessment and an annual "TQRDCM" (technology, quality, responsiveness, delivery, cost and management) assessment.

Governance: Five out of eight board members (62.5%) are independent of management. The audit committee is fully independent of management and the nomination committee (two out of three members) and the pay committee (three out of four members) have independent majorities. The company also has a fully independent ESG committee that reviews and deliberates on ESG-related activities and met four times in 2024 (consistent with 2023). The roles of Chairman and CEO are combined in the same person.

Battery exposure

L&F is directly exposed to the battery value chain as a cathode material manufacturer, with 100% of revenue attributed to the production of cathode active materials, anode materials, electrolytes and separators for power tools, EVs, E-bikes, cables drones and ESS. L&F is a maker of NCMA (nickel, cobalt, manganese and aluminum) cathode, and was the first to mass produce cathode with 90% nickel. The company aims to accelerate the development of high-nickel cathodes and scale up commercial production.

Sungrow (300274 CH, OW, PT Rmb 212)

Sungrow is the world's largest solar inverter producer (by production volume), with a market share of ~30% as of FY24. It also produces energy storage solutions, EV chargers, and wind and hydrogen energy equipment. In 2025, solar PV accounted for 58% of the firm's revenue, and 42% came from energy storage solutions. APAC Utilities analyst Alan Hon has identified Sungrow as a top beneficiary of the growth in AI data center related power infrastructure ([link](#)).

Investment Thesis

Alan highlights that Sungrow is the largest solar inverter producer (by production volume), with a market share of ~30% as of FY24, and notes that Sungrow has gained market share in recent years because of its cost advantage. In Alan's view, Sungrow has superior product quality and more established brand awareness relative to other domestic producers. He rates Sungrow OW as he expects it to ride on strong ESS demand, on the back of rising order potential from both utilities and data centers.

Valuation: Alan's Dec-26 PT of Rmb212 equates to a 12-month forward target P/E of 23.0x. He uses SOTP valuations for its different segments. His target multiple is -0.1 stdev vs. the historical average.

Risks to the rating and price target: Downside risks to Alan's rating and price target include: 1) lower-than-expected solar/ESS installation growth; 2) worse-than-expected pricing and GPM profile; and 3) worse-than-expected competition from domestic players. Upside risks include: 1) higher-than-expected solar/ESS installation growth; 2) better-than-expected pricing and GPM profile; and 3) better-than-expected competition from domestic players.

Sustainability

Sungrow's MSCI ESG rating is unchanged at AAA, which puts the company in the top decile of global peers. MSCI highlights that Sungrow leads industry peers in toxic emissions and waste, cleantech innovation and labor management, and leads global peers in business ethics. Sustainalytics gives Sungrow an ESG risk score of 22.2 (medium risk), placing it in the 14th percentile of global peers (40th out of 293 companies) in the Electrical Equipment subindustry.

Environmental: The firm has put in place targets to achieve scope 1+2 operational carbon neutrality by 2028, scope 1,2 and 3 carbon neutrality by 2038, and net zero across scopes 1, 2, and 3 by 2048 (not SBTi validated). Between 2024 and 2025, the company's Scope 1, Scope 2 (location-based) and Scope 3 emissions increased by 51.8% , 14.5% and 8.8%, respectively, and its Scope 2 (market-based) emissions decreased by 10%. It also reported that 79% of its electricity usage was from renewable sources in 2025, and is targeting 100% by 2028. Sungrow previously targeted a 40% reduction in product water intensity by 2025, compared to 2020, but only realized a 29% reduction in 2025, citing an expansion of the statistical scope and the commissioning of new production facilities. It also targeted a 70% recycling rate of non-hazardous waste by 2025, exceeded this in 2024 by reaching 90% and is now targeting 95% for 2030.

Social: One out of eight board members (12.5%) and 16.85% of managers are female, compared with 19% of employees. The firm is targeting 20% female managers by 2030 but missed its 2025 target of 22% female employees (citing production expansion that led to increased workforce, particularly male employees). In 2025, Sungrow reported a

lost-time injury frequency rate (LTIFR) of 0.25, achieving its 2028 target to reduce the LTIFR to 0.5. The company also reported zero fatalities and had a 100% occupational health and safety training rate in 2025. For 2028, Sungrow targets due diligence on 100% of suppliers, ESG audits on 80% of suppliers and a 98% ESG audit coverage rate for new suppliers, and the company achieved 100%, 36.06% and 84.09%, respectively, in 2025.

Governance: According to MSCI, Sungrow lacks an independent majority on its board, which includes four company executives. It has a fully independent audit committee and majority-independent nomination and pay committees. The roles of Chairman and CEO are combined in the same person. The company has a Sustainability and Strategy Committee composed of directors of the board that oversees the sustainability strategy and approves and reviews sustainability policies, targets and KPIs. The company has linked the compensation of all senior executives to ESG performance and 10% of the annual variable compensation for all senior executives to the company's sustainability objectives.

Battery exposure

42% of Sungrow's revenue in 2025 was derived from energy storage solutions (ESS), and it is the second largest ESS manufacturer globally ([link](#)). It sells ESS systems to residential, commercial and industrial (C&I) and utility-scale clients, with global shipments of 43GWh in 2025. The company expects to see installation demand growth of >40% in 2026, and a doubling of installations in China, versus 2025. Domestically, price competition has led to Sungrow's market share falling from ~10% in 2024 to ~5% in 2025, though Alan believes that the company should benefit from demand clustering towards higher-quality products in 2026. He also sees Sungrow as a likely top choice for US data centers due to well-ranked inverter and ESS bankability, and strong PCS/grid knowledge.

LG Energy Solution (373220 KS, OW, PT W 530,000)

LGES manufactures and sells automobile batteries, consumer batteries, energy storage solutions and markets its products worldwide. The company is one of the largest EV battery suppliers in the world, with a Top 5 global market share.

Investment case

Asia Energy & Chemicals analyst Parsley Ong is OW on LGES due to its improving product mix and strong US ESS volumes. US ESS orders contribute significantly higher NP to shareholders than US EV battery orders due to lower AMPC sharing. The company has accumulated >140 Gwh of LFP ESS orders since mid-2024, which Parsley estimates translates into W4tn of NP to shareholders (cumulative). She expects LGES's ESS revenue mix to rise from 8% in 2024 to >30% by 2027.

Parsley upgraded LGES in July 2025 as the US Big Beautiful Bill (OBBBA) would allow LGES to gain market share in US ESS, offsetting weakness in EV batteries.

Our Korean fundamental analysts favor battery makers (LGES OW; SDI OW) over lithium producers (POSCO was initiated at N in March 2026) and cathode suppliers (L&F at OW; PFM/EBM at UW), based on relative bargaining power and execution capability.

Valuation: Parsley applies a 15x 2-year forward EV/EBITDA to derive her Dec-26 PT of W530K. The 15x EV/EBITDA multiple is on par with the Korea EV battery supply chain.

Risks include: (1) weaker-than-expected US ESS demand due to the phase-out of solar ITC; (2) loss of US subsidies (section 45X AMPC) due to sharing arrangements; and (3) cost inflation due to US tariffs on Korea/Indonesia.

Sustainability

LG Energy Solution was downgraded by MSCI ESG from A to BBB in March 2026, placing it in the middle tier of global peers, as a result of MSCI's new ESG Ratings model and flagged allegations of unlawful practices amid a raid and the subsequent detention of workers at a U.S. battery factory. MSCI notes that the company now trails industry peers regarding product quality assurance and highlights that it continues to lead peers in monetizing opportunities in cleantech. Sustainalytics assigns the company an ESG risk score of 22.4 (medium risk), placing it in the 15th percentile of global peers (42nd out of 293 companies) in the Electrical Equipment subindustry.

Environmental: LG Energy Solution has published a "Carbon Negative Strategy" that includes a Scope 1-3 carbon neutrality target for 2050 with a base year of 2021 (not SBTi validated). Key milestones in this strategy include the achievement of RE100 at all business sites and carbon neutrality for all Scope 1+2 emissions within the company's own sites by 2040. The company also targets a 53% reduction in GHG emissions for 2030 and a 70% reduction for 2040, both from a 2021 baseline. Additionally, LG Energy Solution targets Zero Waste to Landfill (ZWTL) certification (third-party validation to verify that waste is diverted from landfills) for all global production sites by 2026 with a 95% recycling rate, along with a 100% recycling rate by 2028. The company has also utilized the Life Cycle Assessment (LCA) technique since 2019 to evaluate the impact of its products and has obtained 25 Environmental Product Declaration (EPD) certifications (which label product environmental impact information

that is quantified through LCA results).

Social: Two out of seven (28.6%) directors on the LG Energy Solution board are women, compared to 25.10% of women in the workforce. The company has developed a Self-Assessment Questionnaire for suppliers that is based on internationally recognized standards such as the OECD Due Diligence Questionnaire and the EU Battery Regulation and runs a quarterly supplier quality assessment program. The company targets an employee Lost Time Injury Frequency Rate (LTIFR) of 0.13 for 2029 and has reduced this figure from 0.25 in 2023 to 0.22 in 2024.

Governance: Four out of seven (57.1%) directors on the LG Energy Solution board are independent. The company's audit committee is fully independent of management and the nomination committee has an independent majority (two out of three directors are independent of management). The roles of CEO and chairman are separate, though MSCI notes that the company is controlled by LG Corp, the CEO of which serves as its chairman.

Battery exposure

LG Energy Solution is one of the largest EV suppliers globally and supplies batteries for consumer electronics and ESS applications, with 100% of revenue aligned with the battery theme. The company is a global leader in cylindrical batteries, boasting order wins with OEMs like Mercedes, BMW and Tesla. It is also a leader in high nickel pouch batteries and solid electrode, and best amongst the ex-Chinese battery companies for LFP, according to covering analyst Parsley Ong. The company sells battery-related products across a wide range of sectors, covering EVs and light EVs, ESS, IT devices and power tools. LG Energy Solution also invests in R&D to "support the expansion of used battery evaluations and EV inspection services" as well as next-generation batteries, recycling and reuse technologies. The company [reports](#) that R&D investment increased 5% between 2023 and 2024 and represented ~4.2% of total sales, with the number of R&D personnel increasing to 4,527.

CATL (300750 CH, OW, PT Rmb 520)

Contemporary Amperex Technology Co., Limited (CATL) is a market leader in advanced lithium-ion batteries. In 2025, ESS battery accounted for 14.7% of revenues, and EV batteries for most of the rest. The great majority of their ESS business (~95% of ESS revenues) is geared to utility scale, with the remainder addressing mostly commercial and industrial customers.

Investment thesis

CATL is Rebecca Wen's top pick in the battery supply chain. Rebecca likes CATL's technology and leadership position in the global EV and ESS battery markets. Despite continued pricing pressure in the supply chain, CATL has demonstrated the ability to deliver resilient profits thanks to its technology leadership.

CATL is systematically building a vertically integrated artificial intelligence data center (AIDC) ESS ecosystem. In the space of just five weeks (April 8–May 13), CATL has executed three complementary moves towards this goal: a 49% stake in Zhongheng Electric's parent for DC-side HVDC and IDC power architecture expertise, the world's largest sodium-ion battery order (60GWh) with Hyperstrong targeting AIDC deployment from 4Q26 (April 27, [note](#)), and a ~38.1% strategic stake in VNET Group, a leading provider of internet data center (IDC) services in China, with a strong focus on supporting the secular growth of the (AIDC) industry, to secure a captive, nationwide ESS deployment channel across 889MW of operational IDC capacity.

At the product level, CATL's purpose-built platform-based sodium-ion ESS solution (debut in April-2026) — offering 97% system efficiency, 15,000+ cycle life, and a -40°C to +70°C operating range — is structurally superior to LFP for AIDC use cases where instantaneous 40MW+ load swings and 99.999% uptime requirements demand sub-second ESS response, with the sodium-ion/LFP cost gap narrowing rapidly toward parity.

Finally, while the market has broadly written off CATL's US ESS opportunity post-OBBBA, Rebecca views this as overly pessimistic — ESS batteries represent less than 5% of total AIDC capex, meaning that a 30-40% ITC subsidy translates into less than 2% of overall project cost, a rounding error for hyperscalers whose primary constraints are product quality, safety, stability and time-to-market, not subsidy optimization. This demand dynamic, combined with CATL's purpose-built sodium-ion AIDC ESS product and unmatched scale and technology leadership, suggests that there is upside potential to CATL's US market opportunity that is not currently reflected in the price.

Valuation: Rebecca sets her Dec-26 PT at Rmb520, based on a 25x 2026E PER. This is slightly below CATL-A's historical trading average of 30x PER given the lower growth profile vs. the industry's early stage.

Risks include lower-than-expected sales volume or margins, and US-China geopolitical risks.

Sustainability

CATL maintains its MSCI AA rating, which places it in the top 17% of its global peers. MSCI ESG highlights the company's leadership in capitalizing on cleantech opportunities, managing toxic emissions risks and upholding strong business ethics practices. Sustainalytics assigns the company a 20.2 ESG risk score (medium risk).

placing it in the 8th percentile of global peers (23rd out of 293 companies) in the Electrical Equipment subindustry.

Environmental: CATL has set a target for carbon neutrality across its entire value chain for 2035 (not SBTi validated) and achieved its target of carbon neutrality for its own operations in 2025 (through a combination of internal emissions reductions and carbon credits to offset residual emissions). The company has also set the following targets for 2030, all of which it describes as in progress: keep average annual water consumption per factory below 760,000 cubic meters and, versus 2021 at its battery bases, reduce per-GWh COD discharge from industrial wastewater by 15%, NOx emissions by 25% and hazardous waste generation by 30%.

Social: One out of nine (11.1%) of CATL's board members are women, compared with 22% of women in the company's total workforce. In 2025, the company reported zero work-related fatalities, major safety accidents and environmental pollution events and the employee LTIR decreased to 0.102 from 0.124 in 2024. CATL has various levers in place to manage sustainability at the supply chain level, including baking ESG requirements into cooperation agreements, procurement framework contracts and supplier performance evaluation criteria, conducting annual due diligence audits for critical minerals and establishing a value chain sustainable transparency audit tool for core suppliers.

Governance: MSCI flags that CATL's board lacks an independent majority, with three out of nine directors (33.3%) independent of management. The company's audit committee is fully independent of management, and the nomination and pay committees have independent majorities (two of three directors independent of management). The board has established a Corporate Sustainability Management Committee to oversee climate matters, "promote the alignment of senior executive remuneration packages with climate-related performance indicators" and report on climate risks to the board annually. The roles of Chairman and CEO are combined in the same person.

Battery Exposure

CATL is a major producer of batteries for EVs, which accounted for 74.7% of 2025 revenue, and energy storage solutions, which accounted for 14.7% of 2025 revenue. The company also produces battery materials such as lithium-ion salts, precursors and cathode materials and directly sources raw materials through its mining operations and battery recycling through its subsidiary Brunp, which together accounted for 6.6% of 2025 revenue. CATL is also a market leader in battery innovation, with a [reported](#) six R&D centers globally, 23,000 R&D personnel, ~US\$3.2 billion in R&D investment in 2025 (up 19.02% YoY) and over US\$13.2 billion in cumulative R&D investment. The company also [reports](#) that in 2025, it maintained "the world's largest power battery market share at 39.2% for the ninth consecutive year" and led global ESS battery shipments for a fifth consecutive year.

Samsung SDI (006400 KS, OW, PT W 770,000)

Samsung SDI specializes in developing lithium-ion battery technology. The Company also produces display materials and rechargeable batteries for cellular phones and energy storage systems. The business is divided into two segments: Energy Solutions manufactures and sales secondary batteries (93% of group revenues), and Electronic Materials manufactures and sales semi-conductors and display materials (7% of revenues).

Investment thesis

Korean Autos analyst Sonny Lee upgraded Samsung SDI it to OW with a Dec-26 PT of W650,000 at the end of March 2026. He also placed SDI on Positive Catalyst Watch. Even though SDI shares are +159% YTD (vs. KOSPI +54%), Sonny thinks it is still not too late to accumulate, given: (1) structural US ESS demand growth alongside a shift in demand from Chinese to Korean suppliers; (2) incremental policy support in Korea; and (3) EV downside protection, supported by comparatively steadier demand visibility from Hyundai/Kia.

Sonny anticipates a continued shift in sourcing from Chinese to Korean batteries, as US regulations remain in effect. Based on US battery import data, we observe that imports from China have decreased further since July 2025, when the OBBBA was signed. Meanwhile, imports from Korea have increased sequentially, and SDI's US-bound exports rose 21% y/y during 2M26.

Korea's third-round ESS bidding could be meaningfully larger. The Korean government introduced public ESS bidding, and SDI won 3.8GWh of volume across the last two rounds. With the third round of bidding scheduled for June, Sonny believes the government is likely to increase the tender size, given the fuel price surge caused by the Middle East conflict. He sees SDI as well positioned to win the largest share, supported by the largest domestic capacity (10GWh) and ability to supply onshore volumes reliably.

Sonny sees Europe EV risk moderating, with downside offset by Hyundai/Kia mass-market models. High oil prices and a relatively moderate rise in Europe's electricity prices should help sustain EV growth momentum. While SDI is likely to lose vendor share at some European OEMs amid aggressive Chinese pricing, Sonny views SDI's inclusion in Hyundai/Kia new mass-market EV models as a meaningful offset that should protect sales volume in Europe.

Valuation: Sonny's Dec-26 PT of W770,000 is based on SOTP and includes: 1) a core business enterprise value of ~W55tn (applying an up-cycle multiple of 20x); and; 2) an AMPC value of ~W7tn (the present value of the remaining five years of AMPC at a 20x multiple and a 12% discount rate).

Risks include: 1) slower EV/ESS sales growth; 2) higher-than-expected margin pressure on small batteries; and 3) slower material market share gains at captive customers' semiconductor and display businesses.

Sustainability

Samsung SDI maintains its MSCI AA rating, which places it in the top 18% of its global peers. MSCI ESG highlights that the company leads peers in managing toxic emissions and waste and addressing clean technology opportunities, while it lags peers in labor

management practices. Sustainalytics gives the company an ESG risk score of 18.6 (low risk), placing it in the 17th percentile of global peers (27th out of 165 companies) in the Electronic Components subindustry.

Environmental: Samsung SDI has set a net zero commitment for 2050 (not SBTi validated) and aims to reduce Scope 1–2 emissions versus a 2022 baseline by 15% by 2025 and 42% by 2030. It also targets 100% renewable energy power for all worksites by 2050 and a full switch to zero-emission business vehicles powered by Samsung SDI batteries 2030. In 2024, Samsung SDI achieved the highest Zero Waste to Landfill certification (Platinum) for all domestic manufacturing sites and overseas production subsidiaries and met its waste recycling target (95.2% vs. 95%), with goals of 95.5% in 2025 and 96.5% in 2030. On water, the company achieved its reuse rate target (42% vs. 39%) but narrowly missed its water reuse volume target (6.24m vs. 6.26m tons). Targets are 46% and 6.84m tons in 2025 and 58% and 13.34m tons in 2030.

Social: Women comprise 28.6% of Samsung SDI's board (two out of seven), compared to 8.5% of female executives, 15.1% female managers and 24.2% women in the workforce. The company reported that as of 2024, the "average wage level of female employees was 81% of that of male employees." Samsung SDI screens suppliers based on ESG factors and conducts an ESG audit process that includes a self-assessment as well as on-site assessments by external parties. The company reported zero employee fatalities in 2024, down from one in 2023, an unchanged employee accident rate of 0.016 and a slightly higher employee injury frequency rate of 0.07 (up from zero in 2023).

Governance: Samsung SDI's board is 57.1% independent of management (four out of seven directors). The company's nomination, audit and pay committees are all fully independent and the company has a fully independent Sustainability Management Committee that deliberates and decides on sustainability-related policies and activities and pre-deliberates on shareholder return policies. Samsung SDI ties the performance-based bonus of executive directors to financial indicators as well as non-financial indicators related to environmental and social performance such as safety, labor relations and corruption. The roles of Chairman and CEO are combined in the same person.

Battery Exposure

In 2025, the production of batteries for EVs, energy storage and electrical products accounted for 93.3% of Samsung SDI's revenues. The company designs and supplies battery cells, modules and packs for EVs, plug-in hybrids, stationary ESS, UPS systems and residential solutions. Samsung SDI also operates "The R&D Center," which is responsible for the R&D of materials, electrodes and next-gen batteries, and the Advanced Manufacturing R&D Center, which focuses on the R&D of new process technologies and equipment. Battery R&D activities include safety (e.g., newly formulated electrolytes and active material surface coating technologies), ultra-fast charging and dry-type electrodes. The company [reports](#) that its R&D expenditure increased ~14% between 2023 and 2024.