Ceres

Electric Vehicle Batteries

A Guidebook for Responsible Corporate Engagement Throughout the Supply Chain

September 2023

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About This Report

This report was prepared for Ceres by UC Berkeley Law's Center for Law, Energy, & the Environment (CLEE) for use by the Corporate Electric Vehicle Alliance and other major companies looking to support a more sustainable electric vehicle battery supply chain. The Corporate Electric Vehicle Alliance, led by Ceres, is a collaborative group of more than 30 major corporate fleet owners and operators committed to accelerating the U.S. transition to electric vehicles (EVs) through coalition-wide policy and industry advocacy, EV demand aggregation, and best practice/information sharing.

The contents of this report reflect the views of the authors and do not necessarily reflect the official views or policies of Corporate Electric Vehicle Alliance members.

About Ceres

Ceres is a nonprofit organization working with the most influential capital market leaders to solve the world's greatest sustainability challenges. Through our powerful networks and global collaborations of investors, companies, and nonprofits, we drive action and inspire equitable market-based and policy solutions throughout the economy to build a just and sustainable future. For more information, visit ceres.org and follow @CeresNews.

About the Center for Law, Energy & the Environment

The Center for Law, Energy & the Environment (CLEE) channels the expertise and creativity of the Berkeley Law community into pragmatic policy solutions to environmental and energy challenges. CLEE works with government, business, and the nonprofit sector to help solve urgent problems requiring innovative, often interdisciplinary approaches. Drawing on the combined expertise of faculty, staff and students across University of California, Berkeley, CLEE strives to translate empirical findings into smart public policy solutions to better environmental and energy governance systems.

CLEE & Building a Sustainable Electric Vehicle Battery Supply Chain

The global transition from fossil fuel-powered vehicles to battery electric vehicles (EVs) will require the production of hundreds of millions of batteries. This massive deployment frequently raises questions from the general public and critics alike about the sustainability of the battery supply chain, from mining impacts to vehicle carbon emissions.

To address these questions, CLEE conducts outreach to stakeholders and legal research focused on identifying strategies to improve sustainability and governance across the EV battery supply chain. In partnership with organizations like Natural Resource Governance Institute (NRGI) and ClimateWorks, CLEE convenes leaders from across the mining, battery manufacturing, automaker, and governance observer/advocate sectors, to develop policy and industry responses to human rights, governance, environmental, and other risks facing the supply chain. View CLEE's publications on this topic here.

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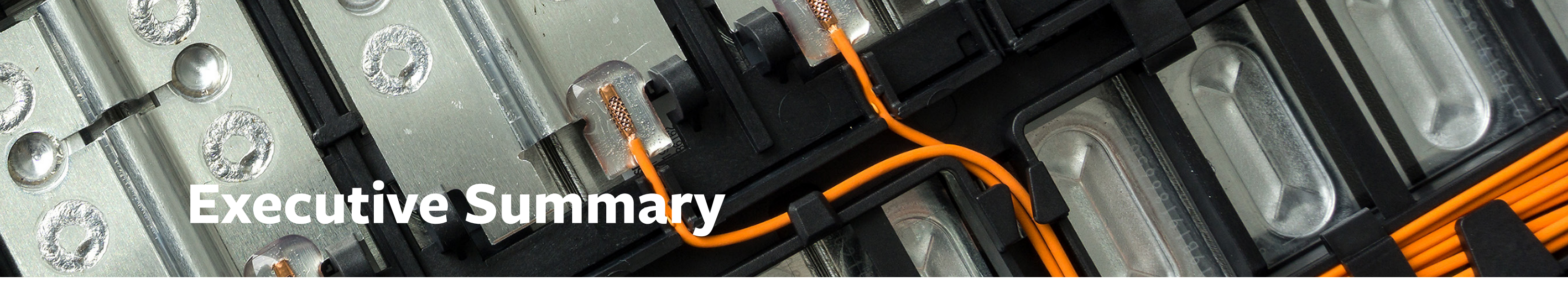

Executive Summary

This report aims to provide major corporate fleets with a guide for responsible engagement with electric vehicle (EV) battery supply chains to enhance resiliency, promote humane practices, and advance sustainability. The focus is on strategies for U.S. on-road fleets, but the information and recommendations included can also benefit other EV supply chain stakeholders. Corporate fleets are significant stakeholders in the EV supply chain whose collective voice and purchasing power can inform policy agendas and industry priorities. This guidebook offers recommendations for three categories where fleets can influence positive outcomes:

1. **Critical minerals[1] mining**
2. **Second life and recycling**
3. **Battery traceability**

EV markets are growing exponentially, putting pressure on EV battery supply chains that already face challenges. The surge in demand for batteries relies on critical mineral extraction and refining processes that have environmental and social impacts (see charts page 12-14), while the global spread of extraction and refining operations are subject to geopolitical vulnerabilities (see graphic 6). The next few years present a unique window to ensure supply chains grow in a sustainable, just, and low-carbon manner. The policy and technology solutions for improving mining practices and developing circular economies for critical minerals are still in the early stages. As a result, EV supply chains are increasingly at the forefront of EV-related policymaking as jurisdictions seek to build resilience through diversification and promote the development of tools for tracing, reusing, and recycling EV batteries. While policymakers and vehicle manufacturers have started to address concerns related to EV battery supply chains, considerable advancement is still needed, and the support of major customers can be instrumental in accelerating progress.

Recognizing the strategic significance of domestic EV battery production, the U.S. has implemented several policies to strengthen supply chains and promote domestic manufacturing. The Infrastructure Investment and Jobs Act of 2021 allocated funding for critical minerals mining, processing, and research activities. In early 2022, the Biden administration invoked the Defense Production Act to encourage domestic battery investment and reduce dependence on imports. The Inflation Reduction Act then expanded and redefined EV purchase credits to require at least 40% of minerals in U.S.-made EV batteries be sourced domestically or from countries with free trade deals with the U.S.[2]

While these steps support the expansion and reshoring of the EV battery industry, the supply chain remains global and considerable growth is still needed. Corporate actors have a significant opportunity to improve the social, environmental, and climate impact of EV battery production both within the U.S. and throughout the world. A summary of recommendations for how large fleets and other major corporations can engage with policymakers, vehicle manufacturers, and other supply chain players can be found in the table (next page).

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1 The Energy Act of 2020 defines a "critical mineral" as a non-fuel mineral or mineral material essential to the economic or national security of the U.S. and which has a supply chain vulnerable to disruption. Critical minerals are also characterized as serving an essential function in the manufacturing of a product, the absence of which would have significant consequences for the economy or national security.

2 The countries with which the United States currently has a free trade agreement in effect are: Australia, Bahrain, Canada, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Israel, Japan, Jordan, South Korea, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, and Singapore.

Summary of Recommendations

Area	Engagement and Procurement Principles	Actions
Critical Minerals Mining	• Preference for batteries with minerals sourced from **Initiative for Responsible Mining Assurance (IRMA)**-certified mining operators. Next-best preference for IRMA-affiliated and/or other third-party verifications. Lowest preference for batteries that include information on the sourcing of their minerals. • Preference for EVs and batteries that are designed to limit mineral consumption to the minimum needed to efficiently and safely meet their commercial use-case. • Prioritize the lowest impact transport mode, such as rail for long-haul or e-bike for last-mile delivery.	• Join IRMA to: (1) publicly demonstrate commitment to responsible sourcing; and (2) add political momentum and end-user economic clout to IRMA's efforts to engage and audit the mining industry. • Advocate for domestic mining reform that expands mining only as much as necessary while ensuring responsible environmental management and cleanup as well as community and Tribal engagement. • Support well-resourced review agencies and the implementation of royalties to ensure that economic benefits from mining are reinvested into the local environment and community.
Second Life and Recycling	• Preference for EVs and batteries designed with second life and recyclability in mind. • Preference for batteries labeled with all relevant information pertinent to end-of-life processing. • Preference for EVs that are part of extended producer responsibility schemes, or for vehicle manufacturers with second life and recycling partnerships and supply chains. • Preference for vehicle manufacturers with programs to refurbish and redeploy batteries where feasible.	• Fleets can participate in extended producer responsibility schemes and build partnerships with second life and recycling entities. • Advocate for policies that will accelerate the development of second life and recycling markets, to ensure the circularity of critical minerals. • Support policies that will encourage or require extended producer responsibility, updated hazardous waste rules, improved battery labeling, modernized energy storage regulations, and improved recycling recovery rates.
Battery Traceability	• Preference for vehicle manufacturers that are participating in the Global Battery Alliance (GBA) to support the Battery Passport. • Preference for batteries that include (via label, digital passport, or other method) information on their supply chain. • Preference for vehicle manufacturers with greater supply chain transparency and better industry benchmarking (such as a higher **Lead the Charge Scorecard** ranking).	• Support the GBA to further the development of the **GBA Battery Passport** and encourage suppliers and partners to do the same. • Advocate for federal policy to standardize EV battery labeling and traceability through an open-source, interoperable digital product passport with requirements designed to improve environmental and human impacts, carbon footprint, and end-of-life opportunities.

Introduction

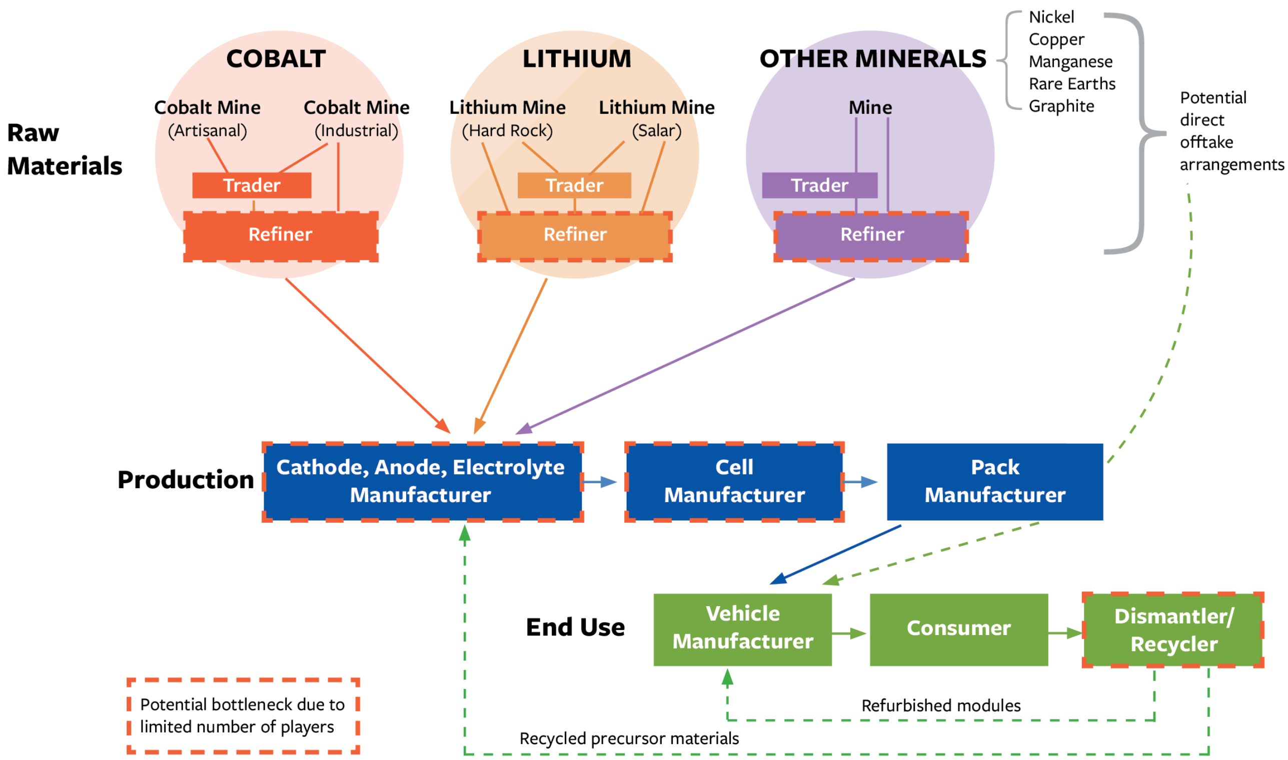
This guidebook summarizes the market status, U.S. context, and key initiatives for improvement for three categories where major fleets can influence positive outcomes: **(1) critical minerals mining; (2) second life and recycling; and (3) battery traceability**. While the focus is primarily for U.S. companies operating on-road vehicle fleets, the information and recommendations can also benefit other types of companies involved in the EV supply chain. The goal is to highlight where corporate advocacy and procurement practices can have the greatest impact in shaping a responsible EV industry.

Corporate fleets are significant and powerful stakeholders in the EV market and supply chain. In an effort to reduce their carbon footprint and capture cost savings, a number of private fleets plan to purchase or already deploy EVs. Large fleets with ambitious electrification plans play a particularly prominent role as major end users in the EV supply chain. However, other major non-fleet companies with ambitious climate goals may also seek to decarbonize the transport inherent in their product supply chains. For these companies and fleets, EVs are key to meeting financial, brand, work culture, and climate targets. As such, they have a strong interest in ensuring that EV battery supply chains are resilient, sustainable, and humane.

Globally, the EV battery supply chain is growing to accommodate the demands of the exponentially expanding EV industry, with a corresponding increase in mining, refining, manufacturing, and battery end-of-life processing in the U.S. and abroad. While the transition to EVs will deliver significant climate and environmental benefits, the increased demand for battery minerals raises concerns about how to scale up in a way that protects human and labor rights, engages frontline communities, minimizes both environmental and climate impacts, and ensures a sustainable mineral supply for the future.

Battery Supply Chain Overview

Figure 1 - Battery supply chain overview



Growing Battery Demand

As the global push towards vehicle electrification accelerates, more critical minerals[3] are required to supply an increasing demand for batteries. The most common battery type in EVs today is the lithium-ion battery (LIB), typically composed of lithium, cobalt, manganese, nickel, and graphite.[4] However, the high price of cobalt and negative impacts of mining have motivated efforts to reduce cobalt dependence and seek low- or no-cobalt alternatives.[5]

The International Energy Agency (IEA) projects that, by 2040, demand could increase more than 40 times over for lithium and 20 to 25 times for other battery minerals. The World Bank estimates that demand for these materials will increase by nearly 500% by 2050. By 2050, EV battery demand is expected to account for 80% to 90% of global cobalt and lithium demand and 45% to 65% of manganese demand. Historically, global critical mineral needs have been met with existing extraction and processing operations.

3 The Energy Act of 2020 defines a "critical mineral" as a non-fuel mineral or mineral material essential to the economic or national security of the U.S. and which has a supply chain vulnerable to disruption. Critical minerals are also characterized as serving an essential function in the manufacturing of a product, the absence of which would have significant consequences for the economy or national security.

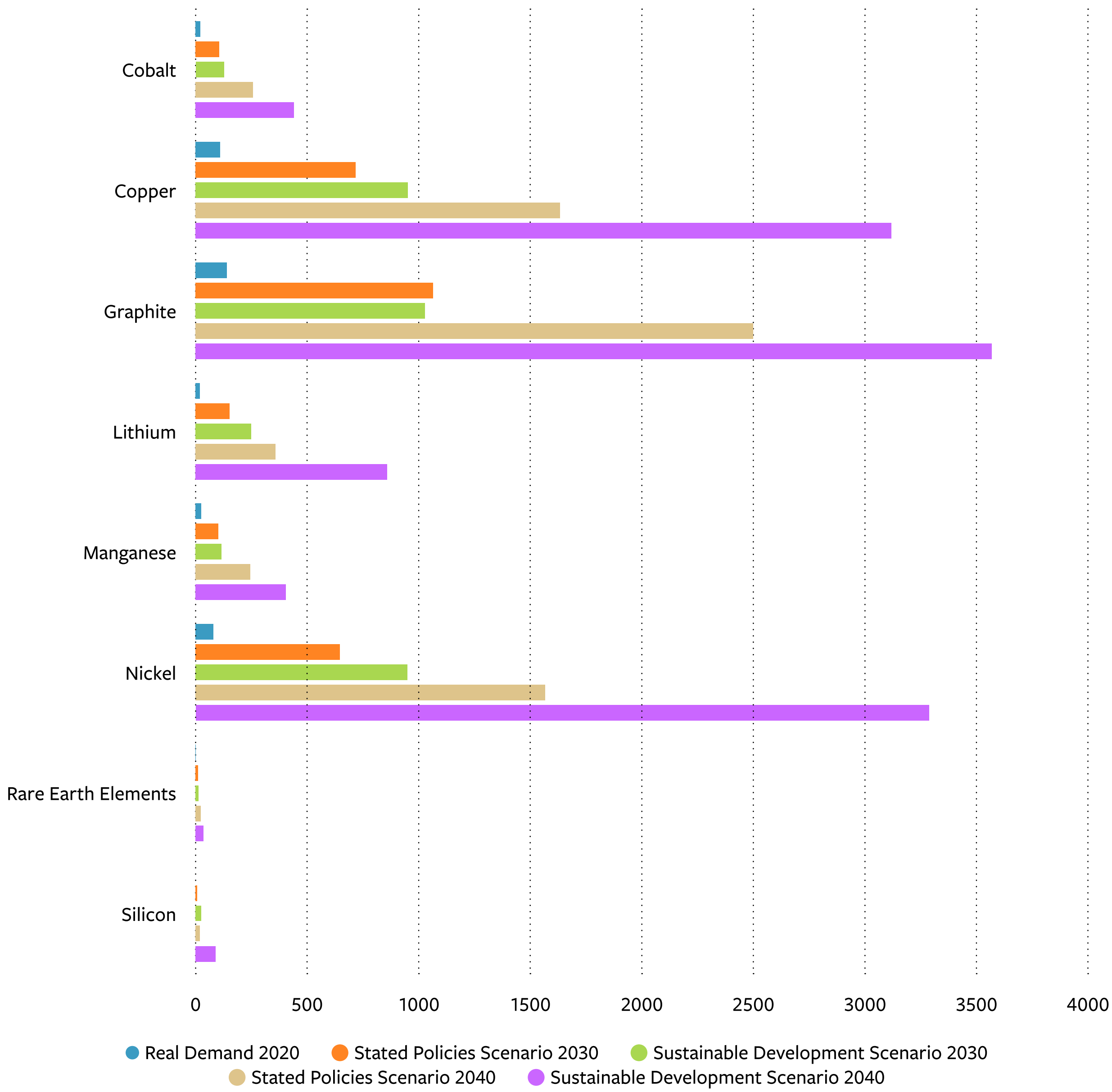
4 Although Lithium Nickel Manganese Cobalt Oxide or NCM batteries currently dominate the market, several alternative battery chemistries are currently in use or development. Lithium-iron-phosphate (LFP) batteries are a leading alternative. These have the benefits of being cheaper and not needing cobalt, but offer lower ranges. In Q1 of 2022, more than half of Tesla's new vehicles sold globally had LFPs and Ford is building an LFP plant in Michigan. Solid state batteries offer significantly higher energy densities and are expected to be the next step-change improvement in battery performance. While some automakers are starting pilots and aiming for mass production in the late 2020s, they still face major technical challenges and high production costs. Moreover, according to some experts, there is currently no effective way to recycle solid-state battery packs. As such, solid state batteries are unlikely to represent a very large share of the market until after 2030.

5 There is growing awareness of human rights, security, and environmental problems related to cobalt, particularly in the Congo. Details on concerns around cobalt mining and potential solutions can be found in some of CLEE's other battery supply chain publications.

However, the rapid surge in demand is straining supply chains, causing prices to rise, and generating concerns around securing enough minerals to satisfy future demand, as well as the social and environmental impacts of increased mining.

Importantly, a number of factors could help reduce critical mineral demand, including: the evolution of low-mineral battery technologies; progress in battery recycling and critical minerals recovery; and/or mitigating vehicle demand with improved land use and increased transit and mobility options. Prioritizing policy interventions that reduce car dependency, ensure battery right-sizing and technology improvements, and promote battery recycling could significantly ease supply chain pressures in comparison to the more lithium-intensive scenarios. A key element of ensuring a sustainable EV transition will be reducing reliance on on-road transport.

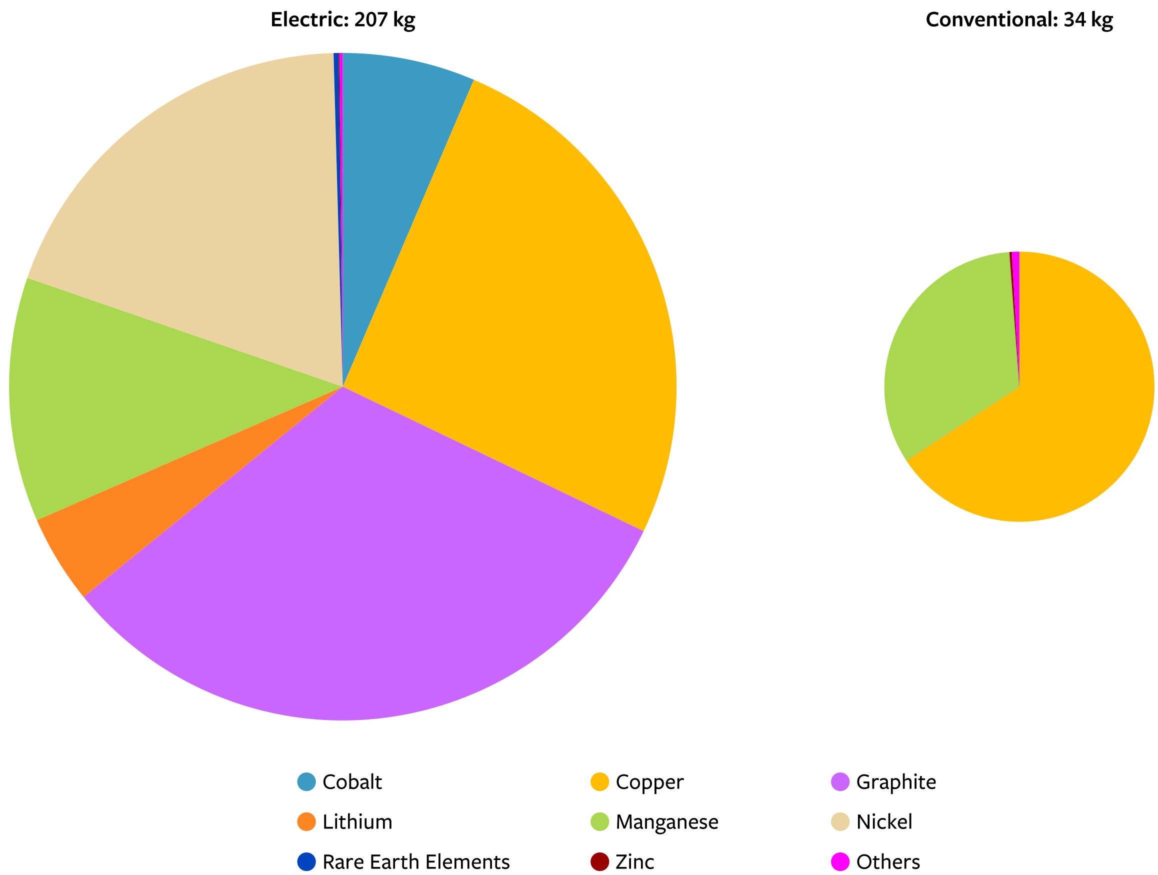
Figure 2 · Mineral Demand Projections, in kilotons



EV Battery Benefits

Due to their mineral intensive batteries, EVs are much more reliant on critical mineral mining than internal combustion engine (ICE) vehicles. Despite this, EVs offer significant benefits compared to ICE vehicles.

Figure 3 · Minerals Used in Electric Cars Compared to Conventional Cars



Benefit #1: EVs have a significantly smaller carbon footprint than gas-powered vehicles.
On average, EVs' total life-cycle greenhouse gas (GHG emissions) are about half those of ICE vehicles, with the potential for a further 25% reduction when charged with low-carbon electricity. The carbon footprint of the mineral supply chain means that EV production is higher-emission than ICE vehicle production. However, EVs make up for these production emissions within the first one or two years of zero-emission driving. Thus, EVs have a substantially lower life-cycle climate impact than ICE vehicles all around the world, even when charged from more carbon-intensive electricity grids.

Benefit #2: Replacing ICE vehicles with EVs generates social and environmental benefits.
Transitioning to EVs improves local air quality and public health, often offers a better driver experience, and delivers significant fuel and maintenance cost savings. There is great potential for supply chain improvements to mitigate the environmental impacts of mineral extraction and improve labor conditions. Furthermore, the opportunities to advance battery traceability and build robust second life markets and recycling technologies would promote a more circular battery economy. Compared to ICE vehicles, fossil fuel extraction and refinement impose severe environmental, human, and geopolitical costs, and offer none of the opportunities for recycling or circularity. Besides being the primary driver of climate change, fossil fuels are also a major cause of local air pollution and trigger considerable public health burdens.

Mining Critical Minerals

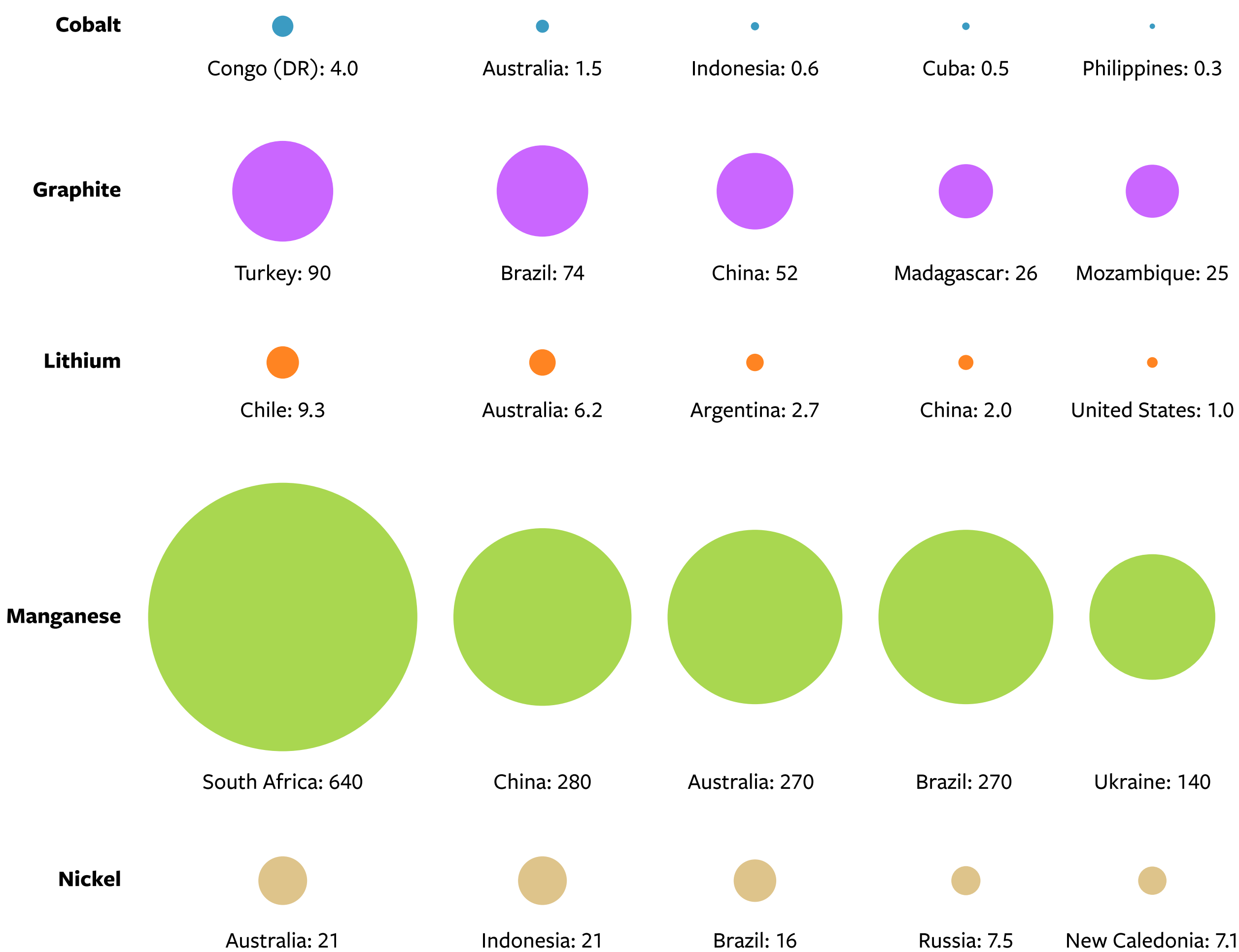
Market Status

Current Mining Capacity, Mineral Reserves, and Growth Timeline

Current mining capacity for critical minerals is largely centralized in a few countries: lithium mining is mostly in Australia and South America, nickel in Indonesia, cobalt in the Democratic Republic of the Congo, and graphite in China. However, the growth in demand means supply chains also rely heavily on countries with lower production volumes, including Chile, Argentina, and the U.S. (Nevada especially, but also North Carolina) for lithium, as well as Brazil and Russia for nickel. Mineral reserves are similarly concentrated, although their dispersion offers more opportunity to diversify supply chains. Like most countries, the U.S. does not currently have sufficient reserves of critical minerals to be entirely self-reliant — but it does have large deposits of many of these minerals.

The IEA estimates that if all announced and anticipated supply of critical minerals come online as scheduled, sufficient supply should exist to meet increased demand through 2025. This dynamic will likely hold true through 2030, but with a relatively thin margin that will likely require significant effort to expand supply and reduce demand. That goal will require bringing dozens of planned mining projects to market and constructing new mineral processing and precursor plants, cathode and anode plants, gigafactories, and EV production plants. Reducing demand will require policies supporting behavior change and land use planning that promotes modal shifts to public transit and e-bicycles.

Figure 4 · Mineral Reserves of the Top Countries Producing Cobalt, Graphite, Lithium, Manganese, and Nickel (2022), in millions of metric tons



Expanding the supply chain will take time and planning. Each component has a different lead time, with the development of new refining facilities and the establishment of new mines taking the longest. Once an extractable resource is identified, it can take from four to over 20 years to commence commercial production, and another 10 years to reach full production capacity. In the U.S., these delays are not necessarily due to permitting hurdles or agency review processes, but rather because initial mining proposals may have inadequately considered community or environmental harms. Local groups can challenge harmful proposals in court, which lengthens the average new mine lead time. As detailed further in the recommendations section, well-designed and well-communicated application processes paired with well-staffed review agencies can help ensure faster lead times for robust, low-harm proposals.

Environmental and Social Concerns

The tables below offer a high-level summary of the environmental and social impacts from mining battery minerals. As previously noted, these concerns should be understood within the context of pre-existing impacts from oil and gas extraction. For each of these concerns, there is a similar impact in the oil and gas industry that, in some cases, may be more widespread and more entrenched. Taking these concerns seriously early in the growth of the EV battery supply chain, and committing to responsible engagement to drive improvement, will be crucial to ensuring that the battery supply chain fully delivers on its potential benefits.

The solutions summarized below are drawn from the Initiative for Responsible Mining Assurance (IRMA) Standard; learn more about IRMA in the Key Initiatives section. See the next section on Second Life and Recycling for recommendations on how demand for new mining can be reduced by recycling batteries and reusing minerals to create a circular EV battery supply chain. Notably, recycling as a solution for mining concerns is not an option for the one-way extraction and combustion of ICE vehicles.

Environmental Risks

Climate Change

Concerns	• EVs offer major reductions in carbon emissions compared to ICE vehicles. However, mining and refining of battery minerals can be energy and emissions intensive.
Solutions	• Mine operators should set and report on progress towards GHG reduction targets. • Emissions can be reduced through fuel and energy efficiency, renewable power for remote and grid connected operations, and zero emission vehicles for transporting ore and staff.

Ecosystem Disruption

Concerns	• Mining can lead to the destruction of natural habitats and ecosystems, resulting in biodiversity loss, species extinction, and soil erosion.
Solutions	• Mine operators should proactively assess and manage impacts on biodiversity and ecosystem services to avoid and minimize impacts early in the project life cycle. • Operators should restore and offset or compensate for unavoidable/residual impacts through the remainder of the mine's life.

Water Management

Concerns	• Mining can be water intensive, depleting resources in regions already facing water stress, and can leach hazardous waste, heavy metals, and chemicals into water supplies.
Solutions	• Mine operators should protect water resources by using water efficiently, minimizing groundwater drawdown, and maintaining environmental flows in streams, springs, and other surface waters. • Operators should prevent contamination by treating used water and discharging it in ways that minimize harm to surrounding water users and environmental resources. • Operators should clean impacted water to make it usable and/or provide an alternative water source.

Waste Management

Concerns

- Mining and mineral processing can generate hazardous wastes (heavy metals, radioactive material, acid/alkaline drainage), contaminating soil and water.
- Tailings are often stored in heaps or large ponds which can collapse, with disastrous health, economic, and environmental consequences.

Solutions

- Existing and emerging materials, technologies, and waste management practices can prevent or greatly reduce the can prevent or greatly reduce the potential for contamination and catastrophic failures of waste facilities.
- Mine operators should use testing to determine whether wastes have the potential to generate acid and/or leach metals and other contaminants, and take mitigation measures.
- Stronger accountability mechanisms can ensure good practice: waste facility decisions approved at the highest levels of the company; more rigorous assessments of potential contamination sources and waste facility risks; and independent review of waste facility siting, design, construction, operation, and closures.

Social Risks

Governance

Concerns

- Battery mineral mining and refining activities are concentrated in a few countries. This concentration of resources can exacerbate geopolitical tensions and disputes over control.
- Demand for minerals can exacerbate corruption. Managing corruption can be a challenge for jurisdictions where governing and judicial institutions lack resources and accountability.

Solutions

- Governance issues could in part be addressed by increasing transparency of mining-related payments to provide communities and the general public with information they need to understand and assess the fairness of mining-related financial arrangements.
- The **Extractive Industries Transparency Initiative** (EITI) is a global coalition of governments, companies, and civil society working to improve openness and accountable management of revenues from natural resources.

Health and Safety

Concerns

- Mine workers for all types of minerals often face poor working conditions and workplace hazards (e.g. accidents, exposure to toxic chemicals).
- Workers at artisanal and small-scale mine sites often work in unstable underground mines without access to safety equipment.
- Nearby communities are also subject to health and safety impacts, including respiratory health risks from industrial trucks and dust and exposure to hazardous substances like heavy metals, acid, mercury, and cyanide.

Solutions

- Mining operations should identify and avoid or mitigate occupational health and safety hazards, maintain working environments that protect workers' health and working capacity, and promote workplace safety and health.
- Best practices include: safety and health inspections; accident reporting and investigations; hazard assessment and management; and workers' rights to participate in workplace health and safety decisions, be adequately trained in their tasks, be informed of occupational hazards, and to remove themselves from dangerous workplace situations.
- Operators should responsibly and proactively manage the release or use of hazardous substances and airborne contaminants.

Social Risks *(continued)*

Human Rights and Indigenous Sovereignty

Concerns

- The mining industry has been associated with labor rights violations, including unsafe working conditions, exploitation, child labor, and forced labor.
- Some indigenous communities near mining operations (such as in **the U.S., Argentina, and Chile)** have raised concerns around lack of adequate consultations, unequal benefit sharing, and lack of remedy for the disruption to their livelihoods and the environment.
- Artisanal cobalt mining in impoverished areas has involved **child labor in dangerous working conditions**.
- Of the five biggest lithium mining companies in the world, **only one has a publicly available human rights policy** and all have seen allegations of human rights abuse. News related to these **allegations** is collated by the Business and Human Rights Resource Centre.

Solutions

- Mine operators should adopt human rights policies with corresponding processes for identifying, preventing, mitigating, and remedying infringements of human rights.
- There should be methods for communities and individuals to raise and resolve mine related complaints and grievances.
- Operations should obtain the Free, Prior and Informed Consent (FPIC) of indigenous peoples and provide adequate compensation and benefits.

Benefit Sharing

Concerns

- There can be significant community resistance to new mines in the U.S., in part because communities want to avoid the environmental and social harms summarized above.
- This is despite the fact that mining is often the highest profit industry in rural areas and mining jobs can be among the best available options for rural economies. In places like the U.S., mining can offer living wage work with benefits to workers without college degrees.
- Yet current policy and industry paradigms do not enable adequate sharing of profits and benefits with workers and communities or for the prevention and remediation of environmental harm.

Solutions

- Mine operators need to produce tangible and equitable benefits for workers and communities.
- Operators should engage in meaningful stakeholder engagement that is proactive, inclusive, accountable, and transparent. Communities should be able to easily participate in mining decisions that affect their health, well-being, safety, livelihoods, futures, and environment.

U.S. Context

The 151-year-old General Mining Act of 1872 makes mining the "highest and best use" of U.S. federal land, despite cultural significance, recreation value, or value for wildlife or clean water. The act was originally intended to motivate exploration and land ownership to encourage western settlement. It has been criticized for its encroachment of Tribal lands and has contributed to a legacy of over 500,000 abandoned mines across the Western U.S., many of which continue to pollute local waters and habitats and cause ongoing health problems for local and Indigenous communities. Remarkably, the act does not require companies to pay royalties for the metals taken from public lands (unlike the 8-12.5% royalties required for coal, oil, and gas extraction), which could be reinvested in remediation and local communities. Even today, mining companies can acquire legal ownership of public lands and valuable resources for a nominal cost with no responsibility for local impacts.

In response to these issues, the increased demand for critical minerals, as well as the growing awareness of the geopolitical vulnerability and strategic importance of EV battery supply chains, the U.S. has taken steps to update mining governance and EV battery industry support. These actions include:

- The 2021 Infrastructure Investment and Jobs Act (IIJA) invests $3 billion in battery material processing and $1 billion for rare earth and critical minerals resiliency.
- The Clean Energy Minerals Reform Act, first introduced in 2022 and reintroduced in 2023, aims to amend the 1872 General Mining Act to eliminate the ability to claim ownership to federal lands, institute a federal minerals royalty for local taxpayers, and establish a Hardrock Minerals Reclamation Fund for the cleanup of abandoned mines.
- Following the IIJA, the Department of Interior launched the Interagency Working Group on Mining Reform in February 2022 to review existing mining laws, regulations, and permitting processes to identify improvements for robust environmental standards and community and Tribal engagement.
- In March 2022, President Biden invoked the Defense Production Act to reduce reliance on imports by strengthening domestic mining and processing capacity for battery materials.
- The Inflation Reduction Act of 2022 incentivizes domestic EV supply chains with a $7,500 EV tax credit that only applies when final assembly occurs in North America. EV companies must source at least 50% of battery components by value from the U.S. or allied countries beginning in 2024, increasing to 80% after 2026. By 2029, 100% of battery manufacturing must be in North America, although the exact interpretation of how this requirement will apply to production in allied countries is still a matter of debate.

The mining industry supports policies that will promote increased mining activities and has lobbied for streamlining permitting processes. Stakeholders interviewed by CLEE emphasized the political power of the hard rock mining industry as a roadblock to reform. While policymakers were considering potential mining reforms in 2021, the National Mining Association's federal lobbying spending doubled as compared to the previous two years.

On the other hand, conservationists and some indigenous and Tribal communities have called for more cautious development. Both share concerns about the ecological impacts of mining, especially habitat destruction and pollution. Half of known U.S. critical mineral deposits lie in key trout and salmon habitat, and one in 10 are in protected public lands. Among battery minerals, 97% of nickel, 79% of lithium, and 68% of cobalt reserves and resources in the U.S. are located within 35 miles of Native American reservations. Beyond ecological concerns, some members of Tribal communities have opposed mining projects in lands that hold cultural and spiritual significance. However, Tribal opposition is not uniform: some point to the potential for jobs in impoverished areas and hope to enforce mine operators' commitment to stable, well-paying work and other local benefits.

Key Initiatives for Improving Mining

The following are select examples of initiatives that were referenced as best practice in our research, the literature, and stakeholder interviews.

Initiative for Responsible Mining Assurance (IRMA)

IRMA is an independent third-party standard-setting organization that promotes responsible international mining practices. IRMA believes that many of mining's negative social and environmental impacts can be avoided if mines operate according to leading practices. They have recently finalized an initial standard and set of guidance materials for responsible mining. See the above section on Environmental and Social Concerns for tables summarizing some of IRMA's solutions and opportunities for improvement. IRMA offers a digital tool for mining suppliers to self-assess and about a dozen mining operations have been certified through third-party audits, with IRMA expecting the rate of audits to increase. IRMA is in the process of developing additional standards for minerals processing and refining.

Unlike other standards, IRMA goes beyond solely addressing human rights concerns and incorporates environmental impacts into their framework. IRMA aims to set the bar for a comprehensive and inclusive approach to responsible mining through multi-stakeholder engagement. Its standard-setting and auditing processes are fully transparent and incorporate input from public, civil, and private sectors. Stakeholders interviewed by CLEE often pointed to IRMA as best in class for inclusivity, transparency, and comprehensiveness.

EU Critical Raw Materials Act

The EU has introduced a regulatory framework to coordinate and improve critical raw material supply chains, including those used in EV batteries. The package is currently being considered by the EU parliament and aims to make the region more competitive and self-reliant by:

- **Increasing domestic production of strategic raw materials.** The act identifies a list of 34 critical metals and minerals, including those used in EV batteries, and sets 2030 goals for domestic extraction (10%), processing (40%), and recycling (15%). It also requires that no more than 65% of the EU's annual consumption of a raw material (for any processing stage) can come from any one country outside the EU. Member states would be required to adopt and implement national measures aimed at enhancing the collection and recycling of critical raw materials.
- **Supporting supply chain development and resiliency.** The act has an application process to be named a Strategic Project resulting in shorter permitting timelines. It also provides for the monitoring of certain supply chains which may include audits or stress tests of the larger relevant companies. The act seeks to increase investment in innovation, research, and skills, both within the EU and through efforts to assist partner countries.

Recommendations

Establish Engagement and Procurement Principles

Below are mining-specific suggestions for a set of principles, which can be used for responsible EV battery supply chain engagement by large fleets and major companies. These principles could be incorporated into procurement policies to guide vehicle purchasing and partnerships with vehicle manufacturers or contracts with logistics providers or other suppliers. They can also be shared publicly, with policymakers or other EV battery supply chain stakeholders, to communicate preferred outcomes for public or private policies, processes, and partnerships related to critical mineral mining.

- **Verified responsible battery mineral sourcing.** Indicate a preference for batteries with minerals from IRMA-certified suppliers. Since IRMA is still in the early stages of auditing mines, a next best preference would be for mining operators to be IRMA members and to have used IRMA's self-assessment tool. A third-best preference would be for an alternative third-party verification that includes ethical standards for human and environmental impacts. If none of these options are available, a final preference would be for the batteries to have EV end-user accessible information on the sourcing of their minerals. (See the Battery Traceability section for more details on tracking sourcing information.)

- **Design and right-size batteries to minimize minerals.** Indicate a preference for EV and battery designs that limit mineral consumption to the minimum needed to efficiently and safely meet their commercial use-case. This approach will be essential to minimizing the overall environmental footprint associated with critical minerals extraction and processing.

- **Seek opportunities for freight and last-mile modal shift.** For companies working with logistics providers, indicate a preference for using lowest impact transport modes wherever feasible. This could include rail for long-haul or e-bike for last-mile delivery.

ACTION: Join IRMA

Within the past few years, a number of vehicle manufacturers became members of IRMA, a development which, according to stakeholders interviewed by CLEE, increased the engagement of the mining industry.[6] However, stakeholders also noted that vehicle manufacturers' efforts to request IRMA certification from mining operators have been ignored. This indicates that the unqualified demand for critical minerals gives mining operators an economic mandate to pursue increased production over and/or without attempting to mitigate human and environmental impacts. By joining IRMA as "purchasing" or end-use company members, fleets and companies can amplify both their own voice and IRMA's market signaling power to qualify the demand for critical minerals with insistence for humane and sustainable practices. If IRMA's purchasing company membership includes the significant EV demand of large fleets and major companies, IRMA and vehicle manufacturers will be better positioned to negotiate more responsible behavior from mining operators. This engagement could increase the number of IRMA-certified, self-assessed, and affiliated mining operations. Becoming a member of IRMA also publicly demonstrates a commitment to responsible sourcing which can enhance a company's ability to effectively advocate with policymakers and other stakeholders and contribute to broader political momentum for positive change.

6 IRMA automaker members include BMW Group, Ford, GM, Volkswagen, Mercedes-Benz, Tesla, and Rivian.

ACTION: Advocate for Ambitious Domestic Policy

U.S. mining laws are outdated and need to be updated if growth in domestic critical mineral mining is to be sustainable and just. Large fleets and major companies based in the U.S. can engage in advocacy to support reform. This could include direct engagement with policymakers, such as requesting meetings, sending or signing on to advocacy letters, submitting comments, providing testimony, and outreach through emails or calls. This could also include engaging in more public-facing activities to broadcast support for reform, such as panels, events, letters to editors, op-eds, and blogs. The audience for this engagement can be quite broad or more targeted depending on the window of opportunity, but could include state and federal legislators, regulators, and executive offices responsible for public lands management, Tribal engagement, industrial policy, and labor rights. Whether reform comes through executive action, regulatory updates or legislative changes, a few key priorities should be considered:

- **Prioritize alternatives to mining.** Recognizing the harmful environmental, social, and cultural impacts of mining, the increasing demand for critical minerals should not be met by new mining alone. Alternative strategies for meeting demand include promoting recycling and second life applications, designing technologies that use less materials more efficiently, and creating robust transportation alternatives to help slow the demand for new vehicles.
- **Require reasonable royalties and support the Clean Energy Minerals Reform Act of 2023.** The act eliminates the ability to claim ownership to federal land and institutes a federal minerals royalty for local taxpayers. By implementing royalties, the U.S. government can capture a fair share of economic benefits from mining and put those toward mitigating environmental and social impacts, as well as public goods and services that benefit local communities.
- **Fund the cleanup of abandoned mines.** The $3 billion abandoned hardrock mine remediation program, authorized under the IIJA, currently lacks funding. Congress can allocate interim funding through the budget and establish a dedicated long-term funding mechanism such as setting royalties for hardrock minerals extracted from federal public lands.
- **Implement Free, Prior and Informed Consent (FPIC).** FPIC is a crucial right for Indigenous peoples, empowering them to give or withhold consent to projects affecting their territories and ensuring social justice, human rights, and sustainable development for Tribes and Tribal lands in the U.S. When submitting applications, mining operators should be required to demonstrate evidence of effective FPIC processes and high-quality agreements with Tribal communities.
- **Improved mine planning and permitting processes.** When seeking to streamline the mine permitting process, it is crucial to strike a balance between efficiency and maintaining rigorous environmental and social safeguards. Instead of simply aiming to expedite approvals, a more effective approach involves advancing stakeholder-based planning to identify "no regrets" mines that have low conflict potential and streamline permitting for these sites first. This can be supported through three improvements to the current process:
  - **Increased resources** for agencies to effectively serve applicants and concerned citizens, ensuring competent staff in sufficient numbers to meet increasing demand for review.
  - **Clear communication** between government agencies and industry applicants regarding expectations for proposals that employ best practices and minimize harm.
  - **Transparency in the decision-making process**, including clarity on who is deciding if the permit is granted, based on what criteria, and who had input on the decision. This can help address concerns about political influence and motivations, which in turn fosters trust and reduces the need for protracted legal battles.

Second Life and Recycling

Market Status

Battery recycling and second life markets are still in the beginning stages, with significant opportunities for innovation and technological advancement. Growth of these markets will hinge on the availability of end-of-life batteries increasing with cumulative retirements of EVs, as well as on supportive policy and industry coordination to overcome technology and logistical barriers.

Battery End-of-Life Forecasts

The total number of EVs ready for retirement is currently low, but is expected to increase considerably in the coming decades. While EV battery technology is evolving, batteries are typically considered to be at end of life when they are below 70-80% of their initial capacity.

	2030	2040	2050
LD/MD/HD batteries at end of life	1.2 million	14 million	50 million
Reusing 50% offers storage capacity of	96 GWh	3,000 GWh	12,000 GWh
Recycling could reduce demand for new lithium, cobalt, nickel, and manganese mining by	3%	11%	28%

Second Life Opportunities

Some light-duty EV batteries with minimal degradation could be refurbished and reused directly as a replacement for the same model vehicle. Nissan and Tesla have offered rebuilt battery packs for purchase or replacement. For batteries where refurbishment for continued EV use is not an option, a number of second life applications are possible. Although the market for reuse is still immature, there are deployments and pilot projects around the world, from small-scale residential batteries to large-scale electric grid storage.

Recycling

EV battery recycling is scaling up while seeing rapid technological development. Many battery recyclers are sourcing much of their current feedstock from battery manufacturing scrap but will transition to end of life batteries as manufacturing quality control improves, scrap quantity declines, and more EVs reach their end of life. There are three main recycling pathways that can be mixed and matched, offering a wide variety of approaches with ample opportunity for innovation. A recent ICCT analysis offers details on each of the pathways, their opportunities and challenges, and their potential to reduce mineral demand (see table below).

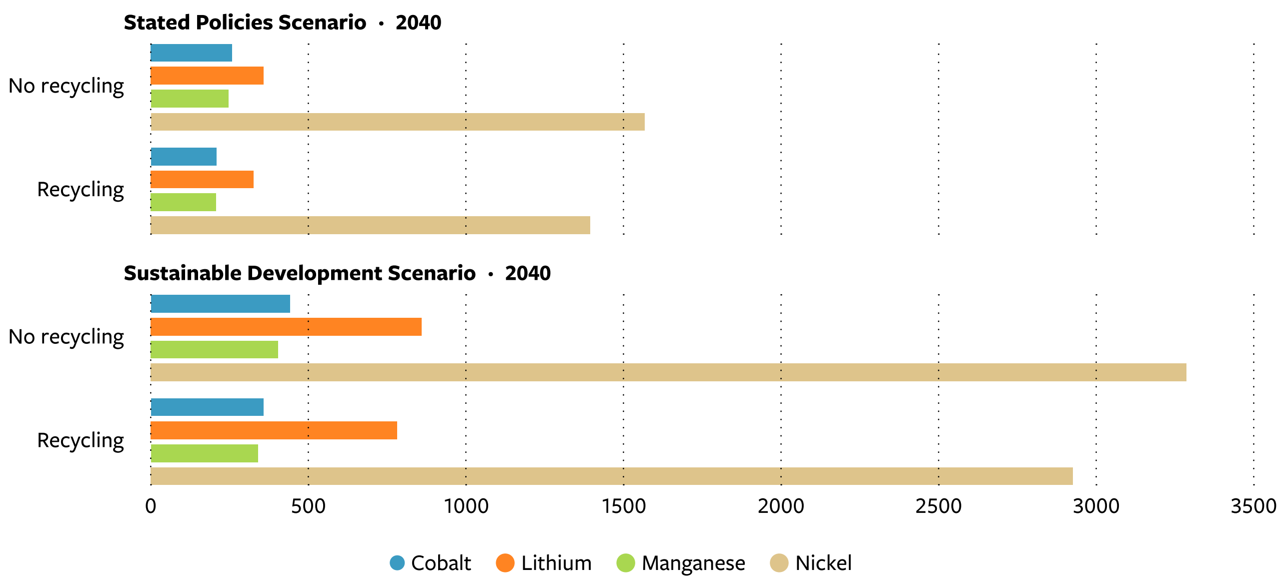
Recycling pathway	Opportunities	Challenges
Pyrometallurgical	• Recover: cobalt, copper, nickel • Mature tech, industrial scale • Can accept mixed chemistries	• Minimum recovery of: aluminum, lithium • No recovery of: graphite, electrolyte, plastics • Higher GHGs, toxics, pollution, water impact • High capital costs • Large, centralized plants, longer transport
Hydrometallurgical	• Recover: aluminum, cobalt, copper, lithium, manganese, and nickel • Mature tech, industrial scale • High purity recovery	• Minimum recovery of: graphite, electrolyte, plastics • Air pollution, water impact • High operating costs • Plants specific to battery chemistries
Direct	• Recover: cathode & anode powder, aluminum, copper, electrolyte, plastics • Cathode structure retained for reuse in new cell • Most/all battery chemistries, including LFP	• Unproven, pilot stage • Plants specific to battery chemistries

Several analyses with more ambitious projections suggest that recycling combined with other policy measures could significantly reduce the demand for new mining. These include the following conclusions:

- By 2040, recycling could reduce new mining demand by 25% for lithium, 35% for cobalt and nickel, and 55% for copper.
- By 2050, improved recycling, circular economy measures, and technology improvements could reduce demand for critical minerals by 58%.
- By 2050, lithium demand could be reduced by up to 92%, and limiting the size of EV batteries alone can cut lithium demand by as much as 42%.

While recycling is not projected to supply a significant amount of battery-grade minerals until after 2040 (see Figure 5), adopting supportive policies and investing in recycling infrastructure now is imperative to creating an ecosystem where end-of-life batteries can act as a feedstock for future generations of EV batteries and where unnecessary waste is avoided.

Figure 5 · Annual Mineral Demand with Recycling, in tons



Challenges

The EV battery second life and recycling markets remain relatively small due to the currently limited supply of end-of-life batteries and the technological and economic challenges related to preparing a battery for a second application. These challenges include:

- **Current lack of life-cycle tracking and responsibility.** Without mechanisms to trace and/or designate responsibility for end-of-life batteries, there is no way to ensure they are collected, resulting in a higher chance that batteries end up in landfills or stranded in developing economies, where they become contamination hazards and a waste of critical mineral resources.

- **Logistics of hazardous waste.** There are a number of restrictions governing the transportation of hazardous wastes due to risks associated with the leakage of toxic substances and high flammability. While safety is important, the current framework of rules makes aggregating and transporting used batteries complex, costly, and time consuming. The longer the distance to a reuse center, the more expensive the process becomes.

- **Battery design and labeling.** At present, EV batteries are a black box, making reuse, repurposing, or recycling problematic. For second life applications, battery packs must be tested to determine the remaining state of health. For recycling, determining the chemistry and components of a battery can be critical for material recovery. For both recycling and second life, batteries must go through various states of disassembly. All of these processes are currently mostly manual and are thus time consuming, potentially dangerous, and costly. Modules and cells are not designed to be disassembled and there is a large variety in terms of battery design. Rather than incorporating reuse principles into design, the industry as a whole is trending towards customization and structurally integrated battery design.

- **Critical mineral recovery rates.** End-of-life EV batteries will likely be the primary source of recycled cobalt, nickel, and lithium. In current EV battery recycling, recovery rates are relatively high for cobalt and nickel and relatively low for lithium. Notably, lithium is very rarely recovered from other end-markets and is unlikely to be in the future. The development of a commercially viable EV battery recycling industry and improved critical mineral recovery will be essential to ensuring mineral circularity that can help meet future demand.

- **Costs and benefits.** The economics of both second life and recycling are highly dependent on the above challenges and a variety of other contextual factors (e.g. liability, cost of labor, battery chemistries, etc.). Encouraging end-of-life markets will require regulatory reform and rethinking of business models to help overcome these barriers and reduce costs. Mechanisms like extended producer responsibility and capturing potential new revenue streams from storage applications will be key.

U.S. Context

Although the U.S. is one of the three largest EV markets, it has been the least active in promoting battery recycling. Federal action has been limited largely to research and development funding and incentives, including:

- **Infrastructure Investment and Jobs Act of 2021:** $60 million for research on battery recycling, and $50 million for local governments and $15 million to retailers to fund battery recycling programs.

- **Inflation Reduction Act of 2022:** New EV incentives include criteria for battery material origin that would encourage the use of recycled materials, although these can also be satisfied by using virgin minerals from a select list of markets.

- The Department of Energy's battery recycling research and development ReCell Center aims to reduce costs and increase the purity of recovered materials.

On the state level, California is the furthest along in developing comprehensive policies; see details in the next section. New Jersey is forming a battery recycling taskforce to investigate, among other things, whether to implement extended producer responsibility (EPR) for EV batteries.

Key Initiatives for Improving Second Life and Recycling

The following are select examples of initiatives that were referenced as best practice in our research, the literature, and stakeholder interviews.

EU Battery Regulations

In parallel to the Critical Raw Materials Act, the EU has recently adopted a comprehensive regulatory framework for batteries that aims to make EVs more sustainable and set a precedent for European battery policy. The provisions related to battery end-of-life include:

- **Extended producer responsibility and reporting.** Vehicle manufacturers are required to ensure retired batteries are collected to be reused, repurposed, or recycled, and must also report on how many retired batteries are transitioned to recycling. The provision encourages second life applications and considers battery recycling responsibility to be transferred to repurposing entities.
- **Recycling recovery rates.** From 2027, recycling processes must ensure that material recovery rates reach 90% for cobalt, nickel, and copper, and 50% for lithium, increasing to 95% and 80% respectively from 2031. In addition to the element-specific recovery rates, 65% of all material (by weight) in a battery needs to be recovered by 2025, which increases to 70% by 2030.
- **Recycled content standards.** New batteries need to include recycled material. From 2031, at least 16% of the cobalt, 6% of the lithium, and 6% of the nickel must be recycled material, and that increases to 26%, 12%, and 15% respectively in 2035. There was some disagreement about the benefit of these requirements, as some stakeholders felt it would be better to let the recovered material go where it's most efficient, whether that is an EV battery or some other end use.
- **Battery passport and improved labeling.** The regulation requires EV batteries to include information on: (1) battery removal, disassembly, dismantling; (2) waste collection, second life preparation, and recycling; and (3) performance and durability (e.g. state of health). Starting in 2026, all EV batteries must have a digital battery passport which is expected to include the above standards and requirements.

California

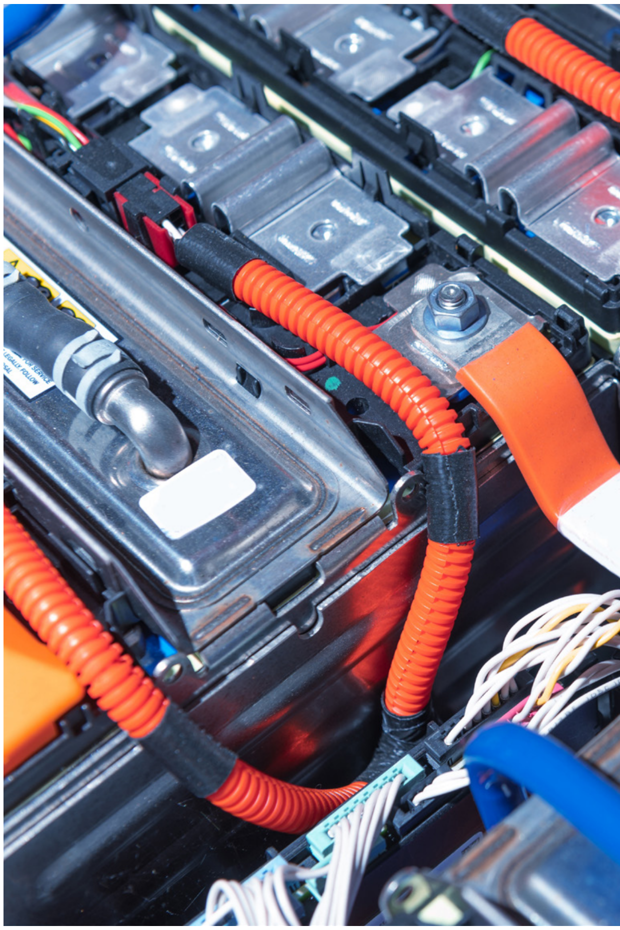
California is leading the country in EV deployment and has recognized the need to address battery disposal and circularity. The state organized the Lithium-ion Car Battery Recycling Advisory Group in 2019 (in response to Assembly Bill (AB) 2832 (Dahle, 2018)) to advise the state legislature on EV battery recycling and reuse policies. The group published its policy recommendations in May 2022. California has already moved forward on some of the group's recommendations, with the recently adopted Advanced Clean Cars II regulations including requirements for manufacturers to disclose all information on batteries via labeling and an online data repository accessible through digital identifiers. The state legislature is currently considering Senate Bill (SB) 615 (Allen and Min), which would regulate the first extended producer responsibility for EV batteries in the U.S. by creating a manufacturer-funded collection, reuse, and recycling system for end-of-life batteries.

Recommendations

Establish Engagement and Procurement Principles

Below are EV battery second life and recycling specific suggestions for a set of principles for responsible supply chain engagement by large fleets and major companies. See the Mining Critical Minerals Recommendations section for more context on the value of principles.

- **Design EVs and batteries for second life and recyclability.** Indicate a preference for EVs and batteries that are designed to make second life applications and recycling swift, safe, and efficient. Planning for easy dismantling and processing needs to be incorporated in the early development phases. This is especially important as most of the EV industry is trending in the opposite direction, with highly customized structurally integrated constructions and significant variety in battery chemistries and durability.
- **Label batteries for end of life processing.** Indicate a preference for batteries that are labeled with all relevant information pertinent to refurbishing, dismantling, and recycling, including chemistry, components, and state of health. (See the Battery Traceability section for more details on labeling.)
- **Build end-of-life partnerships and strategies.** Indicate a preference for EVs and vehicle manufacturers that are part of extended producer responsibility schemes and/or are part of second life and recycling partnerships and supply chains.
- **Refurbish and redeploy batteries where feasible.** Indicate a preference for EVs and vehicle manufacturers with EV battery refurbishment initiatives that extend a battery's useful life.



ACTION: End-of-Life Partnerships

The development of circular business models requires collaboration across supply chain actors, from design to manufacture to end of life. Vehicle manufacturers play a pivotal role in the middle of these economic relationships. They are especially well positioned to work with upstream battery manufacturers as well as to ensure that battery reuse principles are incorporated in EV design. However, fleets can also play a role when it is time to dispose of an EV battery by identifying local second life processors or recyclers to take them on. Building mature and commercially competitive second life and recycling industries will require that both vehicle manufacturers and fleets actively seek partnerships with downstream secondary markets.

ACTION: Advocate for Ambitious Domestic Policy

Second life and recycling markets in the U.S. are still nascent and policies are needed to support growth and innovation if EV battery supply chains are to achieve sustainable levels of circularity. Large fleets and major companies based in the U.S. can engage in advocacy to support the advancement of end-of-life industries. Similar to the advocacy recommendations in the Mining Critical Minerals section, this could include direct engagement with policymakers[7] with a potential policymaker audience of state and federal legislators, regulators, and executive offices responsible for electric utilities, hazardous waste, industrial policy, energy, transportation, and innovation. Whether policy outcomes are achieved through executive action, regulatory updates, or legislative changes, a few key priorities should be considered:

- **Support research and development investments** in order to advance recycling technologies, as well as test and refine second life applications.
- **Encourage or require extended producer responsibility** to ensure that batteries and their minerals are properly processed and deployed in secondary markets or efficiently recycled. Supporting California's SB 615 (Allen and Min) could help institute the first required scheme in the U.S.
- **Update hazardous waste rules** to increase the efficiency of transporting batteries without compromising safety.
- **Encourage or require improved labeling** with details on dismantling, state of health, and chemistry in order to enable efficient disassembly, assessment, repurposing, and materials recovery. (See the Battery Traceability section for more details on labeling.)
- **Modernize energy regulations for storage** to support second life deployments. Importantly, storage applications should be able to capture revenue streams for services they provide to electricity grids. Other helpful policy approaches include developing deployment roadmaps, setting targets, providing incentives, and including storage benefits in utility planning.
- **Encourage or require recycling processes to improve material recovery rates and minimize environmental impacts.** It is technologically possible to recover various critical minerals at rates above 90%. Development and adoption of advanced recycling technologies will be essential to reducing the need for mining. Battery recycling is a chemical and energy intensive process whose environmental impact can and should be mitigated with good management.

7 Such as requesting meetings, sending or signing on to advocacy letters, submitting comments, providing testimony, and outreach through emails or calls. This could also include engaging in more public-facing activities to broadcast support for reform, such as panels, events, letters to editors, op-eds, and blogs.

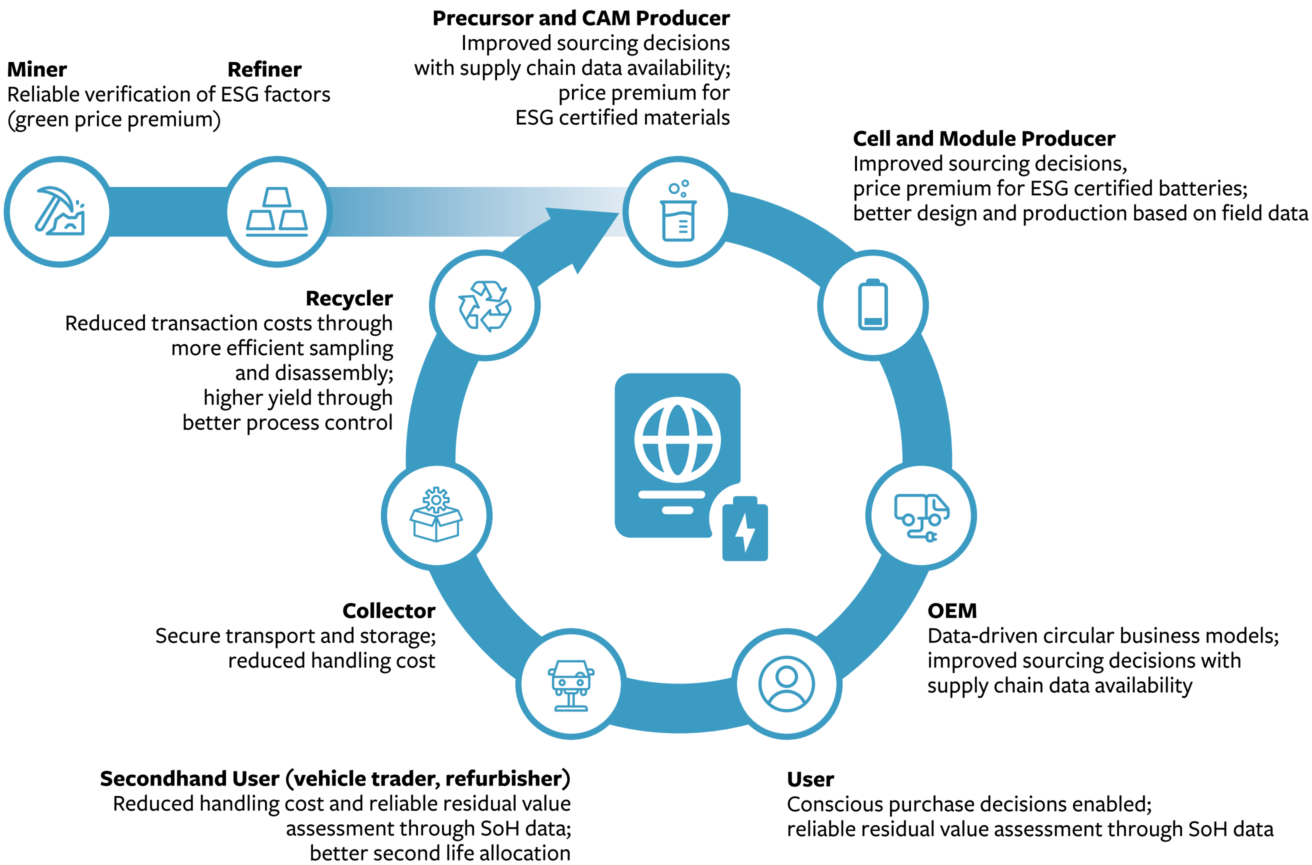
Battery Traceability

Market Status

Supply chain traceability is common practice in agriculture and pharmaceuticals, where public health rules require a level of certainty in order to track and retract a bad product. Vehicle manufacturers already use a basic level of traceability for product quality control. Traceability is composed of a few key data collection and tracking processes:

- Capturing logistics-related point-to-point occurrences throughout the supply chain, which includes tracking the progress of a component from origin to destination, the date and time of each movement, and the mode of transportation used (e.g., vessel, airplane, etc.).
- Verification that supply chain actors are meeting performance (or climate, labor, justice, and environmental sustainability) standards.

Figure 6 - Visualizing life-cycle traceability for the EV battery supply chain



Transparency and traceability for the EV battery supply chain and life-cycle impacts could drive sustainable practices by providing stakeholders with decision-relevant information about battery sourcing, usage, and disposal. At present, the development of traceability systems for EV batteries is still in the beginning stages. This is largely because battery supply chain stakeholders are numerous, diverse, and global — making the collection and exchange of these data an enormous and complex task.

A number of private firms are offering or developing digital data tracking and on-the-ground verification solutions for companies seeking traceability in their battery supply chains. However, private and customized approaches may not be best suited to addressing the global, complex, and shifting nature of EV battery supply chains. The concept of digital product passports (DPPs), on the other hand, presents a more comprehensive solution. A DPP could enable traceability and better labeling by creating a digital record of a battery's material constituents, state of health, usage history, and life-cycle carbon, environmental, and social impacts. This approach is being prioritized by the Global Battery Alliance through its Battery Passport initiative, as well as through the EU's Battery Regulation (learn more about both of these in the Key Initiatives for Improving Traceability section below).

Challenges

The development of a digital passport for batteries will require the collection and exchange of data across supply chain actors. The enormity and complexity of this task poses a number of challenges, including:

1. **Trust.** Data is intellectual property with business value. Both data providers and receivers need to be confident that collection and exchange systems can ensure the security and authenticity of data. Companies will need to be realistic about (and may need guidance on) what information is commercially sensitive and what is in the public interest.
2. **Comparability.** For information from global supply chains to be brought together into meaningful metrics, data from different nations and sectors will need to be comparable.
3. **Common infrastructure.** Customized approaches create a high risk for lock-in and fractured, incompatible systems. The development of data governance and a common infrastructure that is open source and interoperable will require multi-stakeholder, cross-sector, and trans-boundary collaboration.
4. **Benefit and cost sharing.** Because data is valuable, the collection and sharing of data will have financial costs and can potentially deliver economic benefits. The flow of benefits and costs will need to be structured to ensure stakeholders are incentivized to participate in data sharing. It will also be crucial to help cover data provision costs for and ensure economic benefits flow to local communities and small/medium enterprises throughout the supply chain to ensure they are equitably integrated into any digital passport system.

U.S. Context

As the EV market grows, traceability will be necessary to qualify for IRA incentives. The $7,500 EV tax credit only applies when final assembly of the vehicles occurs in North America. EV companies must source at least 50% of their battery components by value from within the U.S. or allied countries beginning in 2024, with the percentage increasing to 80% after 2026. By 2029, 100% of battery manufacturing must be in North America, although the exact interpretation of how this requirement will apply to production in allied countries is still a matter of debate.

Key Initiatives for Improving Traceability

The following are select examples of initiatives that were referenced as best practice in our research, the literature, and stakeholder interviews.

EU Battery Regulations

The EU's recently adopted comprehensive regulatory framework, first mentioned in the previous Key Initiatives section, includes requirements for mineral sourcing, life-cycle emissions, recycling, and information sharing through a digital passport. Stakeholders noted that there is still scope for a lot of interpretation in how the details of these requirements will be applied. Those provisions related to traceability include:

- **Carbon footprint.** EV batteries must include information on their life-cycle carbon footprint. Based on the information from carbon footprint declarations, the commission will identify maximum carbon footprint thresholds for EV batteries.
- **Supply chain due diligence.** Companies that place EV batteries in the EU market will be required to develop supply chain due diligence policies and incorporate them into supplier contracts. These policies aim to identify and address social and environmental risks associated with battery production.

The regulation highlights specific areas of focus, including human rights, human health, and safety, occupational health and safety, labor rights, community life, water use, soil protection, air pollution, and biodiversity.

- **Battery passport.** Starting in 2026, all EV batteries in the EU market will have a digital battery passport. For information on this aspect of the regulation, see the section below.

Global Battery Alliance (GBA) Battery Passport

The GBA's Battery Passport is intended to enable sustainable, responsible, and circular battery supply chains based on data that is standardized, comparable, and auditable. The GBA's global, multi-stakeholder ecosystem approach facilitates input from a wide variety of battery life-cycle stakeholders to build legitimacy, accountability, and trust in the development of indicators and the establishment of a digital data aggregation and representation platform. GBA members jointly develop rules and mechanisms for performance scoring, data governance, assurance, and verification. Stakeholders noted that this systematic engagement of non-corporate actors is what makes GBA stand out as best practice. Many other initiatives lean heavily toward private-sector consortiums, with outcomes aimed more at basic compliance rather than the holistic sustainability and community benefits of the GBA approach. Following the successful launch of proof-of-concept pilots that focused on GHG emissions and child labor, the GBA aims to expand the passport architecture to encompass dozens of indicators for climate, labor rights, justice, and environmental sustainability. Learn more about supporting this initiative in the Recommendations section below.

Figure 7 · EU Regulations

Regulation categories	Exemplary requirements
Recycled content	Minimum levels of recovered cobalt (16%), lead (85%), lithium (6%), and nickel (6%), increasing over time
Due diligence policies	Implementation of a due diligence policy, including traceability or chain of custody system
Green public procurement	Criteria for sustainable procurement procedures for batteries to be established
Labeling and marking	List of general information on battery labels determined; QR code required
Performance, durability	Minimum performance & durability requirements for batteries will be determined
State-of-health (SoH), expected lifetime	Up-to-date data in the BMS to determine SoH and expected lifetime
Carbon footprint	Carbon footprint reporting required for the first time and for each model per manufacturing plant
Waste battery management	Collection targets as well as minimum recycling efficiencies and levels of recovered Co, Cu, Pb, Li, and Ni
Improved data availability	An electronic record of a battery (battery passport) with key static and dynamic data

The Energy and Mines Digital Trust Initiative

The Energy and Mines Digital Trust Initiative, a pilot project by the British Columbia Ministry of Energy, aims to develop verifiable digital data for specific use cases within the larger value chain with the goal of eventually scaling up to offer broader supply chain traceability. The B.C. Mines Digital Trust uses Verifiable Credentials (VCs) which are enhanced digital versions of physical credentials. VCs use cryptographic proofs to make them tamper-evident, secure, and usable only with the holder's permission. When presented to a verifier, they can confirm the intended holder and original issuer without having to contact that entity. This approach significantly reduces or eliminates the need for government administration and intervention while maintaining data security.

Lead the Charge Scorecard

The Lead the Charge Scorecard reviews the sourcing of all component materials for EVs, as well as their carbon, environmental, and social impacts, in order to establish a benchmark for vehicke manufacturer supply chain performance. While the labeling and traceability market continues to mature, this benchmarking tool can provide some interim insights into vehicle manufacturers' material sourcing. The Scorecard's methodology involves a review of company reporting, policies, and due diligence on a range of factors, including human rights, Indigenous rights, workers' rights, carbon footprint, environmental impacts, supplier engagement, procurement policies and choices, and more.

Recommendations

Establish Engagement and Procurement Principles

Below are EV traceability-specific suggestions for a set of principles, which can be used for responsible supply chain engagement by large fleets and major companies. See the Mining Critical Minerals Recommendations section for more context on the value of principles.

- **Develop and deploy digital battery passports.** Indicate a preference for vehicle manufacturers, carriers, or suppliers who actively participate in the GBA Battery Passport or parallel initiatives and encourage or require their upstream and midstream suppliers to do the same.
- **Benchmark and improve supply chain transparency and battery traceability.** Indicate a preference for vehicle manufacturers, carriers, or suppliers who participate in supply chain transparency initiatives and/or who make information on their supply chains publicly available or available to customers. Additional preference can be given for supply chain information that includes third-party certification or auditing. Similarly, indicate a preference for vehicel manufacturers with higher industry benchmarks, such as a better ranking on the Lead the Charge Scorecard.

ACTION: Support the Global Battery Alliance (GBA)

Developing truly global, interoperable, and equitable transparency and traceability in battery supply chains is an enormously complex challenge. The path to success requires private-sector actors to overcome protective measures that silo data and prevent transparency and instead to volunteer data and make active contributions to the creation of a common infrastructure. Companies and fleets can set the bar for collaboration by engaging with transparency processes in their own right and by calling on vehicle manufacturers and suppliers to do the same. The GBA Battery Passport initiative has an open-door policy and welcomes input from all EV battery stakeholders. Large fleets could become GBA members to support data sharing and to amplify support for GBA and thereby increase GBA's ability to effectively engage other supply chain actors.

ACTION: Advocate for Ambitious Domestic Policy

At present, there is no federal policy in place for a standardized technical solution similar to the Battery Passport. However, stakeholders interviewed by CLEE believed that a framework policy may be introduced in the near future. Companies and fleets could advocate for federal policy to standardize labeling and traceability through a digital product passport with requirements designed to:

- Improve the environmental and human impacts, carbon footprint, and end-of-life opportunities of the EV battery life cycle.
- Enable technical interoperability of systems and comparability of data (across national, regional, and private initiatives).
- Be open-source and technologically agnostic.
- Aim towards the development of truly global solutions that can evolve with transboundary battery supply chains.
- Ensure that both communities and small- and medium-sized enterprises throughout the supply chain are equitably integrated.

Conclusion

Ensuring a sustainable and responsible EV battery supply chain — one that benefits communities, industry, and the environment — will require long-term, coordinated action by stakeholders across the globe. Large fleets and major companies have significant influence and a pivotal role to play in improving the EV battery supply chain. By targeting their purchasing power and engaging with EV supply chain actors, large fleets can incentivize manufacturers and mining operators to prioritize sustainable and responsible practices. Similarly, as major economic actors, large fleets and companies hold significant political influence and have the power to inform policy agendas and priorities. Businesses can leverage their economic clout by actively engaging with state and federal legislators, regulatory agencies, and executive offices to advocate for policy changes that align with their values and goals.

The EV market is at the cusp of substantial growth and battery supply chains are a rising industry priority at the forefront of EV policymaking. Large fleets and major companies have a unique opportunity in the coming years to be part of shaping a supply chain that is resilient, humane, and sustainable. The recommendations in this guidebook provide specific actions for corporate procurement practices, engagement with suppliers, and support for policies and initiatives that aim to make ethical sourcing and environmental stewardship an industry norm. While the guidebook and recommendations are tailored for U.S. companies operating or contracting with on-road vehicle fleets, the information and recommendations can also benefit other companies interested in improving the global EV supply chain.