FACTSHEET

GLOBAL EV BATTERY RECYCLING POLICIES AT A GLANCE

FACTSHEET

GLOBAL EV BATTERY RECYCLING POLICIES AT A GLANCE

Author: Vivek Chattopadhyaya

Editor: Yashita Mishra

Cover design: Ajit Bajaj

Layout: Surender Singh

Production: Rakesh Shrivastava and Gundhar Das

The Centre for Science and Environment is grateful to the Swedish International Development Cooperation Agency (Sida) for their institutional support

Maps in this report are indicative and not to scale.

Citation: Vivek Chattopadhyaya, 2026, *Factsheet: Global EV Battery Recycling Policies at a Glance*, Centre for Science and Environment, New Delhi

Published by

Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi 110062
Phone: 91-11-40616000
E-mail: cse@cseindia.org
Website: www.cseindia.org

Printed at

END-OF-LIFE BATTERY MANAGEMENT CHALLENGES

The sustainability of the electric vehicle transition is intrinsically linked to the responsible management of the batteries that power these vehicles. The increasing volume of end-of-life EV batteries presents considerable environmental and logistical challenges, with industry projections indicating millions of tonnes of battery waste requiring recycling or disposal in the coming decades. The sheer scale of this anticipated battery waste underscores the critical urgency of developing effective recycling solutions and establishing robust regulatory frameworks capable of managing this complex waste stream.

Establishing comprehensive EV battery recycling regulations addresses multiple interconnected environmental, economic, and resource security concerns. From an environmental perspective, proper recycling is crucial for mitigating risks associated with hazardous materials contained in batteries, and preventing potential soil and water contamination that could result from improper disposal. Economically, effective recycling enables the recovery of valuable critical minerals such as lithium, cobalt, and nickel, reducing the need for environmentally damaging primary mining activities while ensuring a sustainable supply of these essential materials for future battery production. This circular approach to battery materials management supports both environmental protection and economic resilience in the growing clean energy sector.

This factsheet presents the key features of the global regulations on EV battery recycling management in a concise, scannable format. The objective is to address the environmental, economic, and logistical challenges posed by the millions of tonnes of battery waste projected to be generated as the world transitions to electric mobility. Achieving this requires mitigating environmental risks; establishing frameworks to prevent soil and water contamination from hazardous materials like lithium, nickel,

and cobalt; ensuring resource security by promoting a circular economy through the recovery of critical minerals, thereby reducing dependence on primary mining and external suppliers; and establishing regulatory standards by providing a comparative analysis of regional approaches to mandatory recycling targets, producer responsibility, and technical safety standards.

Table 1: Summary of regional regulations

Region	Key regulatory approach and policy status
European Union	Features the most comprehensive framework via the 2023 Batteries Regulation. It mandates specific material recovery targets (e.g., 80 per cent lithium recovery by 2031) and the use of Digital Battery Passports by 2027.
China	A global leader with 70 per cent of the world's recycling capacity. It utilises a "Whitelist" of approved recyclers and strict recovery targets (98 per cent for nickel/cobalt, 90 per cent for lithium). However, it faces challenges from a large "grey market" of informal workshops.
United States	Primarily governed by the RCRA at the federal level, which classifies batteries as hazardous or universal waste. While federal mandatory recycling targets are currently absent, California leads with the Responsible Battery Recycling Act of 2022.
Norway	Leveraging its high EV penetration, it focuses on a Battery Strategy to attract private investment and operates Europe's largest dedicated recycling plant, Hydrovolt.
Japan	Relies on a voluntary scheme driven by strong industry-government collaboration and producer responsibility organisations (PROs), like the JBRC.
Africa	No continent-wide binding regulation exists, the African Union promotes circular economy via Agenda 2063 and the Continental Circular Economy Action Plan 2024–2034, encouraging member states on waste management, but regional bodies (e.g., EAC, SADC) have e-waste guidelines. All African nations are parties to the global UN Basel Convention on hazardous waste, several African nations are party to a stricter, regional treaty the Bamako Convention that bans all hazardous waste imports into Africa and prohibits ocean/inland water dumping. In Nation specific regulations are in a nascent stage. However, some African countries have introduced battery recycling regulations, primarily through extended producer responsibility (EPR) frameworks: (i) Nigeria has the most comprehensive regulation with the National Environmental (Battery Control) Regulations, 2024, (ii) South Africa enforces mandatory EPR under the National Environmental Management: Waste Act since 2021, (iii) Kenya includes batteries and accumulators in its 2024 EPR regulations, and (iv) Rwanda mandates EPR for e-waste (including batteries) since 2021. Among others, Senegal and Tunisia have lead-acid-focused rules, while nations such as Ghana, Morocco, Cameroon rely on general e-waste laws. In the African continent, which heavily relies on old vehicle imports, the key concerns include preventing "waste colonialism" (dumping of toxic waste from high-income nations) while developing local jobs and infrastructure.

Sources:

Europe:

Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC (2023) Official Journal L 191/1. Available at: https://eur-lex.europa.eu/eli/reg/2023/1542/oj.

China:

Ministry of Industry and Information Technology et al. (2025) [Interim Measures for the Management of Recycling and Comprehensive Utilization of Retired Power Batteries of New Energy Vehicles], Order No. 73 of 31 December 2025 (effective 1 April 2026). Available at: https://wap.miit.gov.cn/zcfg/jdcjxl/art/2026/art_640a0abfac6549feb6ead9c591b7680d.html

CONTINUED...

...CONTINUED

USA:
U.S. Environmental Protection Agency (2025) Improving recycling and management of renewable energy wastes: Universal waste regulations for solar panels and lithium batteries (RIN 2050-AH32). Latest Unified Agenda entry. Available at: https://www.reginfo.gov/public/do/eAgendaViewRule?RIN=2050-AH32
California Department of Resources Recycling and Recovery (CalRecycle) (2025) Responsible Battery Recycling Act Regulations. Available at: https://calrecycle.ca.gov/laws/rulemaking/rbrar
Norway:
Norwegian Ministry of Trade, Industry and Fisheries (2022) Norway's battery strategy. Available at: https://www.regjeringen.no/contentassets/a894b5594dbf4eccbec0d65f491e4809/norways-battery-strategy_singlepages_web.pdf
Japan:
Ministry of Economy, Trade and Industry (METI) (various dates, overarching framework) Act on the Promotion of Effective Utilization of Resources. Available at: https://www.meti.go.jp/policy/recycle/main/admin_info/law/02/index02.html and https://www.env.go.jp/content/900451446.pdf
Japan Automobile Manufacturers Association (JAMA) (2025) Mobility Innovation toward 2050 (or similar annual reports). Available at: https://www.jama.or.jp/english/reports/docs/MIoJ2025_e.pdf
Africa:
African Union (2025) Continental Circular Economy Action Plan for Africa (2024-2034). Available at: https://au.int/en/documents/20250910/continental-circular-economy-action-plan-africa-2024-2034
Nigeria:
National Environmental (Battery Control) Regulations, 2024, https://www.iea.org/policies/25120-national-environmental-battery-control-regulations-2024
South Africa:
National Environmental Management: Waste Act, 2008: Year 2021 amendments regarding EPR, https://www.gov.za/sites/default/files/gcis_document/202105/44539gon400.pdf
Kenya's Sustainable Waste Management (Extended Producer Responsibility) Regulations, 2024, National Environment Management Authority (NEMA), https://new.kenyalaw.org/akn/ke/act/ln/2024/176/eng@2025-03-24
National E-Waste Management Policy for Rwanda, https://www.eaco.int/admin/docs/reports/RW-04_National_E_waste_Policy_2018_Revision.pdf

Table 2: Key features of battery recycling and related policies across the United States, European Union, and China

Feature	United States	European Union	China
Mandatory Recycling Targets	No (No Federal level target; USEPA voluntary best practices; State-level EPR mandates in more than ten states, phased implementation 2026–2029).	Yes (Collection target of 63 per cent collection by 2027, 73 per cent by 2030, recycling and material recovery specific targets for lithium, cobalt, nickel, etc. rules for verification entered force 2025).	Yes (Mandatory recycling targets under EPR; ambitious recovery rates via "whitelist" system for approved recyclers).
Extended Producer Responsibility	Developing national framework (EPA/DOE guidance expected in 2026); state-level EPR laws enacted/expanded in multiple states).	Yes (Strong emphasis and implementation; producers responsible for collection, recycling, and compliance across lifecycle; due diligence postponed to 2027).	Yes (EPR policies in place 2018, with updates; producers must establish recycling systems, meet targets, and ensure traceability).
Material Recovery Targets	No (Federal; focus on voluntary collection best practices and safety).	Yes (Specific targets for various materials; e.g., cobalt/copper/lead/nickel: 90 per cent by 2027, 95 per cent by 2031; lithium: 50 per cent by 2027, 80 per cent by 2031; verification rules 2025).	Yes (Specific recovery rate requirements, e.g., for lithium, nickel, and cobalt; high mandatory rates for whitelisted recyclers -- lithium ≥90 per cent, nickel/cobalt/manganese ≥98 per cent, copper/aluminum/rare earths ≥98 per cent; pilots show 96.5–99.6 per cent recovery).

CONTINUED...

GLOBAL EV BATTERY RECYCLING POLICIES AT A GLANCE

...CONTINUED

Recycled Content Requirements	No (Federal) mandates; voluntary labelling guidelines in development for 2026.	Yes (Minimum levels mandated for new batteries from Aug 2031: cobalt 16 per cent, lead 85 per cent, lithium 6 per cent, nickel 6 per cent; from 2036: cobalt 26 per cent, lead 85 per cent, lithium 12 per cent, nickel 15 per cent).	No explicit federal mandates for minimum recycled content, but focus on material recovery suggests implicit encouragement.
Battery Passport/ Tracking	No (Federal; no mandatory digital passport or tracking).	Yes (Mandatory for industrial and EV batteries > 2 kWh; from Feb 2027 – includes carbon footprint, materials, traceability, due diligence; QR code access).	Yes (National platform for tracing batteries; "battery passport" system for EV batteries; required for producers/recyclers under EPR and standards).
Enforcement Mechanisms	Through Resource Conservation and Recovery Act (RCRA) hazardous waste regulations; state-level enforcement varies (e.g., penalties, stewardship organization requirements, disposal bans); voluntary federal efforts with no penalties yet.	Legally binding regulations with potential penalties; due diligence, reporting, and conformity assessments required.	"Whitelist" system, but enforcement challenges exist, action plans for improvement; enforcement via standards, action plans, penalties; improving rigor with rules.

Sources:

USA:

U.S. Environmental Protection Agency Resource Conservation and Recovery Act (RCRA) Laws and Regulations, Available at: https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-regulations

U.S. Environmental Protection Agency (2025) Lithium-ion battery recycling frequently asked questions. Available at: https://www.epa.gov/hw/lithium-ion-battery-recycling-frequently-asked-questions

U.S. Environmental Protection Agency (2026a) Battery collection best practices. Available at: https://www.epa.gov/electronics-batteries-management/battery-collection-best-practices

U.S. Environmental Protection Agency (2026b) Extended battery producer responsibility (EPR) framework. Available at: https://www.epa.gov/electronics-batteries-management/extended-battery-producer-responsibility-epr-framework

Product Stewardship Institute (2026) Batteries archives: EPR by product. Available at: https://productstewardship.us/category/epr-by-product/batteries

Waste Dive (2026) 'Where new 2026 recycling and waste laws are taking effect', 5 January. Available at: https://www.wastedive.com/news/new-laws-2026-battery-epr-waste-recycling-organics-landfill-policy/808714

European Union:

European Commission (n.d.) Sustainability rules for batteries and waste batteries – Summary. Available at: https://eur-lex.europa.eu/EN/legal-content/summary/sustainability-rules-for-batteries-and-waste-batteries.html

European Parliament and Council of the European Union (2023) Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC. Official Journal of the European Union, L 191, 28 July. Consolidated version as at 31 July 2025. Available at: https://eur-lex.europa.eu/eli/reg/2023/1542/2025-07-31/eng

European Parliament and Council of the European Union (2025) Regulation (EU) 2025/1561 of the European Parliament and of the Council of 18 July 2025 amending Regulation (EU) 2023/1542 as regards obligations of economic operators concerning battery due diligence policies. Official Journal of the European Union, L series, 30 July. Available at: https://eur-lex.europa.eu/eli/reg/2025/1561/oj/eng

CONTINUED...

...CONTINUED

European Commission (2025) Commission Delegated Regulation (EU) 2025/606 of 4 July 2025 supplementing Regulation (EU) 2023/1542 of the European Parliament and of the Council as regards rules for calculating and verifying rates of recycling efficiency and recovery of materials from waste batteries. Official Journal of the European Union, L series (published 24 July 2025). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202500606

China:

Ministry of Industry and Information Technology (MIIT) et al. (2026) Interim Measures for the Management of Recycling and Comprehensive Utilization of Retired Power Batteries of New Energy Vehicles. Available at: https://wap.miit.gov.cn/zcfg/jdcjxl/art/2026/art_640a0abfac6549feb6ead9c591b7680d.html

State Council of the People's Republic of China (2026) China to strengthen recycling management of used power batteries from NEVs. Available at: https://english.www.gov.cn/news/202601/16/content_WS6969df0cc6d00ca5f9a089c0.html

Ministry of Industry and Information Technology (MIIT) (2024) Specifications for the comprehensive utilisation of waste power batteries of new energy vehicles (2024 edition). Available via IEA policy database and MIIT announcements

THE UNITED STATES

The electric vehicle market in the United States (US) and globally is experiencing unprecedented expansion, driven by increasing environmental awareness, significant advancements in battery technology, and supportive government policies at federal and state levels. This rapidly growing market will inevitably generate substantial volumes of end-of-life batteries requiring proper management in the near future. The United States Environmental Protection Agency (USEPA) plays a central role in establishing the regulatory landscape for battery recycling through comprehensive rules, regulations, and policies pertaining to EV battery management.

The foundational legal and regulatory framework

The Resource Conservation and Recovery Act (RCRA)[1] is the foundational legal framework for managing battery waste in the US, providing comprehensive authority for regulating solid and hazardous waste management. Under RCRA regulations, the end-of-life EV batteries are primarily classified as hazardous waste due to their characteristic properties of ignitability and reactivity. This classification triggers specific management requirements governing their

collection, transportation, and disposal. RCRA incorporates the Universal Waste Regulatory Approach (40 CFR Part 273),[2] which offers a streamlined regulatory approach for managing certain hazardous wastes, including lithium-ion batteries, that are commonly generated by diverse establishments. This rule facilitates collection and recycling by providing less stringent requirements for storage and transportation compared to full hazardous waste regulations.

However, there are nuances in implementation. The USEPA has clarified that most end-of-life lithium-ion batteries qualify as hazardous waste but can be managed under the universal waste standards until they reach permitted hazardous waste recycling or disposal facilities. At that point, they become subject to the full RCRA hazardous waste regulations.[3]

The handling requirements for universal waste handlers (such as collection sites, intermediate processors, and transporters) require that batteries be managed in accordance with specific safety and operational standards. These standards include storing them in leak-resistant, properly labelled containers, adhering to accumulation time limits, and sending them only to permitted facilities or legitimate recyclers.

In May 2023, the USEPA issued a Comprehensive Guidance Memorandum addressing the application of hazardous waste regulations to lithium-ion batteries. This guidance clarified key aspects such as the regulatory status of battery recycling facilities and operational requirements. Crucially, the EPA clarified that battery recycling facilities generally do not require RCRA permits for their actual recycling operations; however, this exemption does not cover the storage of hazardous waste batteries or processed intermediates, like "black mass", prior to recycling, which still requires a RCRA Part B permit. The memo also provided detailed safety recommendations to prevent thermal runaway and fires, including employee safety training, isolation of battery terminals, protocols to prevent physical damage, climate-controlled storage, and segregation of damaged batteries.[4]

Key policy developments and strategic initiatives

Building on this foundation, the USEPA has advanced several key initiatives:

Forthcoming universal waste rule modifications

The EPA is developing a proposed rule, anticipated for signature around June 2025, to create a new, distinct category of universal waste specifically tailored for lithium batteries. This will separate them from the existing general "batteries" category and aims to enhance safety standards while promoting recycling. This rulemaking will also propose adding hazardous waste solar panels to the universal waste regulations.

Extended Producer Responsibility (EPR) framework development

A cornerstone of USEPA's policy is the ongoing development of a national EPR framework, mandated by the Bipartisan Infrastructure Law. This law requires the EPA, with the U.S. Department of Energy, to establish a comprehensive strategy for battery management throughout their lifecycle. The EPR framework aims to address national recycling goals, cost structures for mandatory recycling, reporting requirements, product design improvements, collection system models, and transportation logistics. Its scope is comprehensive, covering all battery chemistries (lithium-based, nickel-metal hydride, and alkaline) and all formats, from small consumer electronics batteries to large format batteries for EVs and grid storage. To support this effort, USEPA has engaged in an extensive stakeholder process, involving battery producers, retailers, recyclers, government agencies, and advocacy groups. In addition, focused consultation sessions were conducted with industry experts throughout early 2025 to gather input on programme scope, producer responsibilities, government roles, goals, infrastructure needs, and product design. An inaugural virtual EPR conversation was held in April 2025 to provide background and an overview of the EPR policy landscape. EPA is expected to publish the voluntary

National Battery EPR Framework to promote consistency across state programmes, enhance critical mineral recovery, and support safety and supply chain goals. In parallel, EPA plans to initiate a rulemaking to modify the RCRA Universal Waste Rule for lithium batteries, creating a distinct category with enhanced fire safety standards.[5]

Battery collection best practices and labelling guidelines initiative

This initiative is mandated by the Bipartisan Infrastructure Law.[6] The USEPA is developing best practices for battery collection[7] and voluntary battery labelling guidelines, with substantial funding allocated and a target completion date of September 30, 2026.[8] The objectives include improving collection rates, promoting consumer education, and reducing safety concerns from improper disposal. Best practices are being developed based on technical and economic feasibility, environmental soundness, safety, and optimisation of recovered material value. Voluntary labelling guidelines aim to enhance collection by identifying locations, increasing accessibility, educating consumers, and reducing safety risks.

In order to conduct implementation research for best practices and labelling guidelines,[9] the USEPA has conducted extensive outreach to assess existing infrastructure and practices. The EPA has also conducted detailed working sessions with industry stakeholders throughout 2024 and 2025. These sessions are organised by battery format (small, mid-format, and large format) to ensure that the guidelines address specific challenges.

Supporting regulatory initiatives

The EPA has also developed a streamlined review process under the New Chemical Program to expedite the review of certain new chemicals used in battery manufacturing and EV production, thereby supporting innovation.

International Context on Black Mass: While the EPA's 2023 memo clarified that black mass (shredded anode/cathode material) is not universal waste and its hazardous status

depends on its characteristics, international developments are noteworthy. For example, the European Union (EU) has moved to classify black mass as hazardous waste as of early 2025 to improve shipment control and boost EU recycling. China has also implemented new technical standards for recycled black mass (e.g., GB/T 45203-2024, effective July 2025). These international actions can influence industry practices.

What more is needed

Current USEPA initiatives, including the EPR framework development and guidelines for battery collection and labelling, represent important steps; however, there is a growing view that the USEPA's approach needs to set mandatory recycling targets and requires more robust enforcement mechanisms. Comparative analysis with more comprehensive regulations in the EU and China reveals areas where the US framework could be strengthened. Enhancing USEPA regulations can foster a more sustainable EV battery recycling ecosystem.

Union of Concerned Scientists (UCS) has further recommended that the USEPA require material recovery rates and environmental impact reporting, and disallow incineration-based techniques that do not recover lithium. These measures would help ensure producer responsibility for end-of-life battery management, maximise resource recovery, and minimise environmental harm.[10]

Earthjustice has recommended the establishment of a federal law mandating EV battery recycling, including producer responsibility requirements. It also calls for stringent air and water emissions standards for recycling and manufacturing facilities, as well as mandated targets for battery mineral recovery. Such measures are considered necessary to achieve large-scale impact, shift the burden of responsibility to producers, protect communities from pollution, and ensure resource recovery.[11]

Automotive Innovation has recommended implementing a core exchange with complete vehicle backstop policy that assigns responsibility throughout the vehicle lifecycle;

supporting the development of industry standards for battery identification; and establishing a clear framework for battery end-of-life management to facilitate efficient recycling.

Energy Policy at Columbia University has demanded to set strict critical material recycling targets for EV and battery manufacturers; control exports of end-of-life EVs containing domestically sourced materials; implement EPR policies for US-based EV makers; and promoting domestic recycling to secure feedstock for recyclers and hold manufacturers accountable.

Ascend Elements Survey has recommended enhancing consumer education on safe battery disposal and recycling practices, noting significant misconceptions and a lack of awareness among consumers.

California takes the lead in electric vehicle battery recycling

California has emerged as a national leader in EV battery recycling regulation, combining aggressive EV adoption targets with robust end-of-life management requirements. California Air Resources Board (CARB), under the California Environmental Protection Agency, has established the most ambitious zero-emission vehicle (ZEV) mandates in the U.S., driving the need for corresponding battery recycling infrastructure.

Its Advanced Clean Cars (ACC) Program and ZEV requirements mandate that, beginning January 1, 2024, 50 per cent of vehicle purchases must be ZEVs, increasing to 100 per cent by January 1, 2027, for government fleets. CARB estimates the ACC program will result in 10 per cent of all vehicle sales being ZEVs by 2025, creating substantial volumes of batteries needing end-of-life management. This necessitates parallel development of battery recycling infrastructure.

Responsible Battery Recycling Act of 2022 (California EPR)

This groundbreaking legislation establishes one of the most comprehensive battery EPR programmes in the US. It requires producers to establish or fund stewardship programmes for

collecting and recycling most batteries sold in California, beginning no later than April 1, 2027. All producers of covered batteries sold in the state must participate in a CalRecycle-approved stewardship plan by April 1, 2027, creating lifecycle legal obligations for manufacturers.

Senate Bill 615: Vehicle Traction Battery Requirements

This bill addresses EV traction battery management. By January 1, 2025, it requires battery suppliers to develop a core exchange programme for replacing batteries, modules, or cells, and to submit annual reports. The bill recognises the unique challenges associated with large-format vehicle batteries. It builds on existing legislation, including the mandate for the Secretary for Environmental Protection to convene the Lithium-Ion Car Battery Recycling Advisory Group. This group submits policy recommendations to ensure that as close to 100 per cent as possible of lithium-ion vehicle batteries are reused or recycled.

CalRecycle Implementation and Fee Structure

California's Department of Resources Recycling and Recovery (CalRecycle) is the primary implementation agency, with authority over fee structures and operational requirements. CalRecycle is required to establish the consumer fee amount for covered battery-embedded products no later than October 1, 2025, with retailers starting fee collection on January 1, 2026. This ensures sustainable financing for recycling infrastructure.

CARB—A Model for National Policy

California's approach encompasses an integrated approach to battery lifecycle management. It recognises interconnected nature of battery lifecycle management. Retired battery systems can be refurbished and reused as replacement batteries, used in other applications based on their condition, or recycled/disposed of if no longer usable, maximising resource recovery.

The enforcement and compliance framework under California's regulations includes comprehensive enforcement

by CalRecycle, coordinated with CARB's vehicle emission requirements. This integrates battery recycling with ZEV compliance, creating synergistic regulatory pressure. Mandatory reporting and stewardship plan approvals enable oversight and data collection. Hence, overall, California's comprehensive approach serves as a model for national policy, demonstrating how state innovation can address federal gaps. Its integration of electrification targets with end-of-life management provides a template for other jurisdictions. The emphasis on producer responsibility, mandatory participation, and sustainable financing offers proven approaches for federal EPR development.

The USEPA framework has several strengths, including a legal foundation via RCRA, a streamlined approach with universal waste regulations, active stakeholder engagement, mandated national EPR development, and a strong emphasis on safety. Despite these strengths, significant gaps limit its effectiveness. A key limitation is the absence of mandatory recycling targets or performance standards, for which more robust enforcement mechanisms are needed. Comparative analysis with the EU and China reveals opportunities to strengthen the US framework by adopting proven policy mechanisms and performance standards.

The strategic path forward is to enhance USEPA regulations by addressing these gaps to foster a more sustainable EV battery recycling ecosystem. Such improvements would support EV adoption while ensuring responsible end-of-life management, protecting resources, recovering valuable materials, and contributing to a circular economy. This comprehensive stewardship is essential for maintaining the environmental benefits of EV adoption while managing waste streams responsibly.

CHINA

China has emerged as a global leader in both the manufacturing and recycling of EVs and their batteries. This dominant position in the EV sector has naturally positioned the nation at the forefront of addressing the end-of-life

management of these critical components. Approximately 70 per cent of the world's battery recycling capacity is located in China, underscoring its significance in this burgeoning industry.[12]

This leadership role is driven by several key factors, including the imperative for resource security, the necessity of environmental protection, and the anticipated surge in the volume of end-of-life EV batteries in the coming years. Projections indicate that over four million tonnes of used car batteries will be scrapped annually by 2028, highlighting the scale of the challenge and the opportunity. Effective recycling policies are crucial to alleviate the potential strain on critical metal resources and mitigate environmental pollution associated with improper disposal.

Regulatory framework in China

China's current framework for EV battery recycling exhibits notable strengths, including proactive regulatory development and a rapidly expanding recycling capacity. The government has established a "white list" of approved recyclers and implemented regulations that assign responsibility to original equipment manufacturers (OEMs) for setting up collection facilities. The nation's lithium-ion battery recycling capacity is substantial and is projected to exceed one million tonnes, reflecting significant investment and infrastructure development in this area.[13, 14]

However, the system also faces critical challenges and policy gaps. Illegal workshops continue to operate, often dominating the sector due to weaknesses in collection networks. Furthermore, China's regulatory infrastructure, while evolving, remains less developed in certain aspects when compared to regions like the EU.

Effective EV battery recycling also makes economic sense. Recycling can reduce carbon emissions and lessen the nation's dependence on imported metals. Studies estimate that the gross income per EV recycled in China is approximately US $473.9, indicating the economic potential of this industry.[15]

GLOBAL EV BATTERY RECYCLING POLICIES AT A GLANCE

Explosive EV growth and challenges in managing end-of-life batteries

The rapid scaling of EV production, supported by strong governmental initiatives, has resulted in a large number of batteries entering the market. This has compelled the government to address the downstream implications of battery disposal and recycling early on to secure resources and mitigate environmental risks associated with such a large volume. Simultaneously, a tension exists between the advanced technological capabilities in EV manufacturing and the comparatively nascent stage of standardised and fully enforced recycling regulations.

As the first wave of EVs reaches the end of their operational lifespan, China is bracing for a substantial increase in the volume of end-of-life EV batteries in the coming years. The China Electronics Energy Saving Technology Association estimates that China's retired-battery volume will reach 820,000 tonnes in 2025 and exceed 4 million tonnes by 2028. Compliant recycling remains below 50 per cent, and illegal workshops persist. The industry also faces challenges related to an aging workforce and waste collection.[16] Industry experts anticipate a smaller peak in battery retirements between 2025 and 2027, followed by a larger peak between 2030 and 2032, reflecting the surge in EV sales that began around 2022. By 2040, the number of end-of-life batteries could reach 1,500 to 3,300 thousand tonnes, underscoring the long-term scale of this challenge. More recent global projections (e.g., 20.5 million tonnes worldwide by 2040) suggest China's share could be much higher given its 50–60 per cent dominance in global EV stock.[17, 18, 19, 20, 21]

The rapid expansion of the EV market, coupled with the finite lifespan of EV batteries and established warranty periods, creates a predictable and escalating demand for battery recycling infrastructure and effective policies. The projected timelines for battery retirement allow for anticipatory policy adjustments and investment in recycling technologies.

The implementation of an eight-year or 120,000-kilometer warranty policy in 2016 is a significant factor contributing

to the current and near-future wave of battery retirements.[22] This predictable timeframe allows policymakers and recycling companies to anticipate and prepare for the increasing volumes of batteries reaching their end-of-life. Furthermore, the rapid increase in EV sales since 2022 suggests that another, even larger peak in battery retirements is expected around 2030–2032.[23] This lag between EV sales and battery retirement necessitates continuous policy adaptation and infrastructure development to handle the future surge in recycling demand.

While technological solutions for recycling are emerging, as highlighted by claims from major companies and growth in the number of recycling enterprises, the regulatory framework and its effective implementation require further maturation to ensure widespread adoption of best practices and curb unregulated activities.

China's success in EV technology development has, in some respects, outpaced the establishment of a comprehensive and strictly enforced battery recycling system. This disparity creates a potential vulnerability where technological advancements in recycling might not be fully realised due to regulatory gaps or ineffective enforcement, potentially hindering the transition to a truly sustainable closed-loop system.

Regulatory framework for EV battery recycling: Policy developments in past-decade

China has been actively developing its policy and regulatory framework for EV battery recycling over the past decade, demonstrating an increasing focus and level of specificity in its approach. The government recognised the importance of managing battery recycling and reuse as early as 2012 when the State Council proposed drafting relevant regulations.[24] By the end of 2025, over 22 national standards related to power battery recycling had been issued,[25] indicating a sustained effort in this domain. The evolution of these policies reflects a growing understanding of the complexities and the strategic importance of establishing a robust system for managing end-of-life EV batteries.

Earlier the policy was based on broad guidelines which became increasingly specific and stringent requirements, reflecting a maturing understanding of the challenges and opportunities in this sector. The progression from interim measures to detailed specifications and action plans indicates a commitment to building a comprehensive regulatory framework. The initial policies laid the groundwork by assigning responsibility and outlining basic principles. As the volume of retired batteries grew and the industry developed, the regulations became more detailed, addressing specific aspects like recovery rates, R&D investment, and safety standards. This iterative approach allows the policy to adapt to the evolving needs and challenges of the industry. Furthermore, the interconnectedness of safety standards (like GB38031-2025) with recycling regulations highlights a holistic approach to battery lifecycle management. Ensuring batteries are safe throughout their use phase and at their end-of-life is crucial for both public safety and the integrity of the recycling process. While the primary goal of safety standards is to prevent accidents during EV operation, these standards can also influence the design and durability of batteries, which in turn can affect their suitability for repurposing and the efficiency of recycling processes. For instance, batteries designed with robust thermal management systems might be better candidates for second-life applications.[26, 27]

The GB38031-2025: Safety requirements for power batteries of electric vehicles

This is a key national regulation and form the core of this framework. Set to take effect on July 1, 2026, it represents a significant step in ensuring the safety of EV batteries.[28] While primarily focused on operational safety, this standard indirectly impacts recycling by ensuring the integrity of batteries entering the recycling stream. The regulation mandates that batteries must prevent fire and explosion even after internal thermal runaway occurs—a stricter requirement than previous standards. It also introduces additional requirements, including bottom-impact testing and fast-charging cycle safety testing.

GLOBAL EV BATTERY RECYCLING POLICIES AT A GLANCE

The 2024 Battery Recycling Regulations titled "Specifications for the Comprehensive Utilisation of Waste EV Batteries"
These regulations represent an update and enhancement of the 2019 edition. They introduce updated and higher requirements, particularly concerning research and development (R&D) investment and stricter recovery rate targets for various materials. A key update includes the stipulation that enterprises involved in the comprehensive utilisation of retired power batteries should invest no less than 3 per cent of their revenue from this activity into annual expenses for R&D and process improvement. For cascade utilisation enterprises, priority is given to those with multiple relevant patents, and they must ensure that the annual cascade utilisation volume is not less than 60 per cent of their actual recycling volume.

The regulations also set minimum recovery rates for various materials, including electrode powder, lithium (90 per cent), nickel, cobalt, and manganese (98 per cent). Furthermore, they specify comprehensive energy consumption limits for lithium carbonate production and include updated requirements for land use, traceability, safety, and infrastructure for recycling enterprises.[29]

The interim measures for the management of traction battery recycling for New Energy Vehicles, 2018
These measures clarified the management scope of traction battery recycling and assigned the primary responsibility for this to automobile production enterprises. This regulation established a fundamental principle of Extended Producer Responsibility (EPR) within China's policy framework. In February 2025, the State Council passed an Action Plan to further promote EV battery recycling, calling for more stringent recycling regulations and an acceleration in the establishment and revision of relevant standards, including those related to green design and product carbon footprint accounting.

The 2026 Interim Measures—issued January 16, 2026, effective April 1, 2026, by MIIT and five other ministries—further detail producer responsibilities, mandate digital

IDs and a national traceability platform for full-lifecycle supervision, require batteries to remain with vehicles upon scrapping (non-swap models), and prohibit improper channels to curb informal recycling. These cross-ministerial efforts highlight the multi-agency, evolving approach to battery recycling supervision.[30, 31]

Extended Producer Responsibility (EPR)

A cornerstone of China's policy is the principle of Extended Producer Responsibility (EPR), which places the primary responsibility for the entire lifecycle of EV batteries—from production to end-of-life management—on the EV manufacturers. This signifies that EV makers are accountable for the take-back, recycling, and final disposal of the batteries used in their vehicles.

The EPR framework transfers the responsibility for waste management from the general public and municipalities to the producers themselves. To fulfil these obligations, EV manufacturers are required to establish networks of recycling service centres, often based on their existing sales networks, to facilitate the collection of used EV batteries from consumers. Once collected, these batteries are then transferred to specialised recycling businesses with whom the manufacturers have established partnerships to ensure proper handling and processing.[32, 33]

The "Whitelist" System: State-approved or certified battery recycling companies

China has established a "whitelist" system, comprising a list of state-approved or certified battery recycling companies that meet specific criteria set by the government. This system aims to regulate the industry by identifying and endorsing compliant recyclers. The Ministry of Industry and Information Technology (MIIT) has introduced revised guidelines outlining the extensive criteria that companies must meet to be included on this whitelist.

These criteria cover various aspects, including facility specifications, business structures, and technology standards. Notably, the guidelines include stringent recovery rate

requirements for a range of valuable materials. For instance, the lithium recovery rate is set at 90 per cent, while the recovery rates for nickel, cobalt, and manganese remain at 98 per cent. Furthermore, new recovery targets of 98 per cent have been introduced for copper, aluminium, and rare earth metals. Environmental standards are also a key component of the criteria, specifying limits for energy consumption and emissions, such as the energy consumption for producing one tonne of lithium carbonate. Additionally, whitelisted companies must adhere to minimum utilisation rates and reinvest a minimum of 3 per cent of their earnings into research and development. Importantly, only companies included on this "whitelist" are eligible to receive subsidies from the government, further incentivising compliance with the established standards. By the end of 2023, the MIIT had published five batches of compliant companies, totalling 156 whitelisted recyclers, in contrast with ~188,300 total registered recycling firms.[34, 35]

Traceability and information management

A critical element of China's policy is the requirement for establishing a comprehensive system for tracking the entire lifecycle of EV batteries, from their production and sale to their eventual recycling and utilisation. This traceability system mandates that battery makers, sales units, and carmakers must work together to track discarded batteries.

To facilitate this, a "comprehensive management platform for national monitoring of new energy vehicles and traceability of power storage batteries" has been established. This platform collects information on the entire process of power storage battery production, sales, use, scrapping, recycling, and utilisation.

New energy vehicle manufacturers are obligated to upload traceability information related to production, sales, maintenance, replacement, and recycling, including vehicle and battery coding information. Similarly, scrap car recycling and dismantling enterprises are required to upload traceability information pertaining to recycling and dismantling links, including scrap car information, scrap

battery coding information, and the destination of the scrap batteries. The Interim Measures (effective April 1, 2026) mandate a digital ID (unique identifier) for full-lifecycle supervision and real-time monitoring via the national platform. This reinforces reporting obligations, prohibits improper transfers, and requires batteries to remain with vehicles upon scrapping (non-swap models) to ensure controlled flows to licensed recyclers.[36]

Targets and standards for material recovery

China's EV battery recycling policy includes specific targets and standards for the recovery of valuable materials from end-of-life batteries. As mentioned earlier, the lithium recovery rate is set at a minimum of 90 per cent. The recovery rates for nickel, cobalt, and manganese are mandated to be at least 98 per cent. Furthermore, new recovery targets of 98 per cent have been established for copper, aluminium, and rare earth metals, expanding the scope of material recovery requirements. The regulations also specify a minimum recovery rate of 98 per cent for electrode powder after crushing and separation, with impurity limits for aluminium and copper content. Additionally, a lithium recovery rate of no less than 90 per cent is required during the smelting process.[37]

Leading companies within the industry have reported high recovery rates for key battery materials; however, the overall effectiveness of recycling efforts across the entire industry depends on the widespread adoption of such advanced technologies and adherence to best practices. The gap between the reported potential and the actual recycling rate suggests that there is still room for improvement in disseminating and implementing these technologies across all recycling operators. The technological capability to achieve high recovery rates exists within the Chinese recycling industry. However, ensuring that these advanced technologies are adopted by a larger number of recyclers, including smaller and medium-sized enterprises, is essential for maximising resource recovery and minimising waste on a national scale. This might require government support,

technology transfer initiatives, and stricter enforcement of standards.

Emphasis on battery repurposing and cascade utilisation

Recognising the potential for extending the lifespan and maximising the value of EV batteries, China's policy also emphasises battery repurposing and cascade utilisation. The State Council has proposed establishing a management system for tiered reuse and recycling, acknowledging that many retired EV batteries still retain a significant amount of capacity suitable for less demanding applications, such as energy storage.

The 2024 Battery Recycling Regulations[38] prioritise cascade utilisation enterprises, requiring them to have an annual repurposing volume that is not less than 60 per cent of the total weight of recovered batteries. To ensure the quality and safety of repurposed batteries, new certification rules have been introduced for recycled batteries used in fixed energy storage applications, such as uninterruptible power supply (UPS) and emergency power supply (EPS) systems.[39]

The "whitelist" vs grey list

The "whitelist" system, while intended to ensure quality and environmental standards, might inadvertently create an oligopolistic market structure, potentially hindering competition and innovation from smaller but potentially capable recyclers who may struggle to meet the stringent criteria or navigate the application process. The dominance of illegal workshops despite the whitelist suggests that the system alone is insufficient to address the complexities of the collection network and economic incentives. As per reports, the grey market deals with 75 per cent of retired batteries; whitelisted capacity utilisation is less than 18 per cent; such low-cost and high-profit small workshops are disrupting legitimate firms and traceability.[40]

The high barriers to entry for the whitelist, coupled with the lack of compulsory protection or crackdowns on illegal businesses, could limit the number of certified recyclers and their ability to handle the increasing volume of batteries. This

might leave room for informal operators to thrive by offering more attractive prices or simpler collection processes, even if their environmental practices are substandard. The detailed recovery rate targets for a broad spectrum of materials demonstrate a comprehensive approach to resource utilisation and a recognition of the increasing value of materials beyond lithium, nickel, and cobalt.

This indicates a forward-thinking policy aimed at maximising the recovery of all valuable components from end-of-life batteries. By setting specific targets for materials like copper, aluminium, and rare earth metals, the government encourages recyclers to adopt more sophisticated and thorough recycling processes. This not only conserves these valuable resources but also reduces the amount of waste generated and the potential for environmental contamination. The strong emphasis on traceability throughout the battery lifecycle is a crucial element for ensuring accountability and preventing the leakage of hazardous materials into the environment.

This system allows for monitoring the flow of batteries and verifying that they are handled by authorised entities and processed according to regulations. A robust traceability system enables regulators to track batteries from their manufacture and use in vehicles to their eventual recycling or repurposing. This transparency is essential for enforcing EPR, ensuring that manufacturers and recyclers are fulfilling their responsibilities, and identifying any points in the lifecycle where batteries may be mishandled or illegally disposed of.

Implementation mechanism of regulations

The implementation of China's EV battery recycling regulations involves various mechanisms for collection, transportation, and recycling, along with efforts to certify and standardise recycled products. However, there is a need to bridge the gap between the ambitious regulatory framework and its effective on-the-ground implementation. This requires a multi-faceted approach that includes not only strengthening enforcement but also addressing the

economic and logistical factors that currently favour the informal recycling sector. Enhancing transparency and standardisation across the industry, particularly in areas like battery health assessment and carbon accounting, is crucial for building trust, promoting best practices, and accurately measuring progress towards sustainability goals. Fostering greater collaboration and information sharing among all stakeholders, from battery manufacturers to consumers and recyclers, is essential for creating a more integrated and efficient battery lifecycle management system.

Collection and transportation

Formal collection channels have been established by EV manufacturers, who are mandated to set up recycling service centres based on their sales networks. Carmakers often enter into agreements with battery suppliers or specialised recycling companies to handle the recycling process on their behalf. However, a significant portion of end-of-life batteries is collected through the informal market, often driven by individuals and small workshops. These illegal workshops still dominate in some areas due to weak formal collection networks. A large grey market exists where individuals actively seek out recyclable batteries, sometimes offering higher prices than formal channels. National standards do exist for dismantling of battery cells and transportation of battery components. These rules stipulate that batteries must be transported to recycling facilities in trucks equipped with smoke alarms and must be shipped in flame-retardant and heat-resistant containers. Despite these regulations, enforcement can be challenging, and the guidelines are often disregarded by operators in the informal market due to the added costs associated with compliance.

Recycling technologies and processes

Hydrometallurgical recycling has emerged as the prevalent technology for EV battery recycling in China, largely due to its high recovery efficiencies for critical materials like lithium, cobalt, and nickel (ranging from 90–99 per cent). This process involves chemical leaching, where aqueous

solutions are used to dissolve metals from battery materials. Pyrometallurgical recycling, which involves melting battery modules at high temperatures, is another method used but is less effective at recovering lithium and may not be suitable for all types of EV batteries. An emerging technique known as direct recycling, or cathode-to-cathode recycling, aims to recover the battery's cathode material intact for direct reuse, potentially offering a lower energy and lower emission route compared to traditional methods. Regardless of the specific technology used, the recycling process typically begins with a pre-processing stage involving mechanical dismantling of battery packs and shredding of cells to produce a concentrated "black mass" rich in battery metals.

The reliance on hydrometallurgical processes as the primary recycling technology, while effective in recovering key metals, also has its environmental footprint due to the use of chemicals and energy. The emergence of direct recycling techniques offers a potentially more sustainable alternative, but its scalability and commercial viability are still under development in China. While hydrometallurgy plays a crucial role in current recycling efforts, its environmental impact necessitates the exploration and promotion of newer technologies like direct recycling. Supporting research and development in this area and creating a favourable regulatory environment for their adoption could lead to a more environmentally benign battery recycling industry in the future.[41, 42, 43]

Leading manufacturers like CATL claim to have already developed technologies that meet the new safety and recycling standards. Chinese companies are also experiencing a rising demand for recycling machines, indicating an industry-wide effort to scale up recycling capabilities. However, the industry also faces challenges. Many recyclers report overcapacity, as the supply of legally collected batteries lags behind their processing capabilities. Additionally, formal recycling business is not always profitable across the industry, particularly for less valuable battery chemistries, and these companies face competition from the informal market.

Certification and standardisation: China Green Product (CGP)

The implementation of certification standards for recycled batteries in energy storage applications represents a positive step towards ensuring the quality and safety of second-life batteries. This can build confidence in their use and promote the repurposing of EV batteries, contributing to a more circular economy. However, the limited scope of these rules (currently only for fixed energy storage) suggests that further standardisation efforts might be needed for other potential second-life applications. By establishing clear standards and a certification process for repurposed batteries, the government can facilitate their wider adoption in secondary applications. This not only extends the useful life of the batteries but also creates new economic opportunities and reduces the demand for new battery production, leading to environmental benefits. Expanding the scope of these certification efforts to cover other potential reuse cases could further enhance the circularity of EV batteries.

Efforts are underway to certify and standardise recycled products from EV batteries. The National Certification and Accreditation Administration (CNCA) has established certification rules for the recycling of batteries used in new energy vehicles. These rules also apply to second-usage of batteries. Recycled NEV power batteries are utilised in fixed energy storage battery recycling products, such as uninterruptible power supply (UPS) and emergency power supply (EPS) systems. The certification process involves several steps, including application submission, factory inspection, product type testing, evaluation, and ongoing monitoring. The certification is based on existing standards like GB 40165-2021 and YD/T 3768.1-2020. Certified products are allowed to use the China Green Product (CGP) mark, indicating compliance with the established standards.[44]

Battery traceability system

The establishment of traceability systems represents another significant achievement. A traceability system is mandated for carmakers, battery manufacturers, and sales units to track batteries throughout their lifecycle. Additionally, a national

monitoring platform for new energy vehicles and battery traceability has been established to oversee the entire process, from production to disposal and recycling. Over the past decade, multiple national standards related to power battery recycling have been issued, demonstrating a sustained focus on this critical area.

Challenges faced by China's EV battery recycling policy

Leakages in the recycling framework implementation

The significant gap between the number of licensed recycling companies and the much larger number of companies holding business licenses for battery recycling underscores the challenge of bringing the entire recycling industry under regulatory oversight. The fact that fewer than four in 1,000 used EV batteries are processed by certified recyclers indicates a substantial leakage to the informal sector, potentially due to factors like higher prices offered by informal channels or lack of consumer awareness about proper disposal. While the government has established a licensing system, the vast number of unlicensed operators suggests that the current regulatory framework and enforcement mechanisms are not fully effective in capturing the entire market. This could be due to various reasons, including insufficient enforcement resources, the economic incentives for operating outside the regulated system, or a lack of convenient and accessible formal collection channels for consumers.

Develop clear provisions for historical and "orphan" batteries

Despite the progress made, China's EV battery recycling policy and its implementation still face several lacunae and challenges that need to be addressed to create a truly sustainable and effective system. One notable gap is the lack of clear provisions for managing historical and "orphan" batteries—those from older EVs or from manufacturers that are no longer in operation. Without specific guidelines, these

batteries may not be properly accounted for or recycled, potentially leading to environmental risks. One way to deal with the issue is to establish a specific framework or fund to manage batteries from older EVs or defunct manufacturers, potentially involving government-backed collection and recycling schemes.

Formal vs informal: Cost competitiveness

A significant challenge lies in weaknesses in enforcement and the continued prevalence of unregulated activities. Illegal workshops still dominate the recycling landscape in many areas due to weak formal collection networks and the cost advantages they may have gained by bypassing environmental regulations. The fact that fewer than four in every 1,000 used EV batteries are processed by certified recyclers highlights the scale of this issue. Government guidelines for transportation and dismantling are often flouted because compliance adds to the cost of recycled materials.

Therefore, this persistent issue of a large informal recycling sector, despite government regulations and the "whitelist" system, suggests a fundamental disconnect between the regulatory framework and the practical realities of battery collection and economic incentives for both consumers and smaller recycling operators. This highlights the need for a more nuanced approach that addresses the underlying drivers of the informal market, such as price advantages and convenience. The continued dominance of illegal workshops indicates that the formal system, even with its stricter standards and potential subsidies, is not effectively competing with the informal sector. This could be due to factors like the higher prices offered by informal operators (as they may avoid environmental compliance costs), more convenient collection methods, or a lack of awareness among consumers about the risks associated with informal recycling. Addressing this requires a multi-pronged strategy that includes stronger enforcement, incentives for consumers to use formal channels, and measures to reduce the cost burden on compliant recyclers.

The economic viability of formal recycling needs a regulatory response. The business may not always be profitable across the industry, especially for batteries with lower economic value, potentially disincentivising their proper recycling. Many lithium batteries currently being recovered may not have significant economic value, making recycling less attractive for enterprises. Additionally, in order to incentivise consumers to participate in formal system, China needs to implement strategies such as deposit schemes or convenient collection points to encourage greater consumer participation in formal recycling channels.

Standardisation of technical methodologies to assess battery health and remaining useful life

Supporting research and development to establish standardised methodologies for assessing battery health and remaining useful life, as well as for recycling reporting requirements is essential. Collaboration between government, industry, and research institutions is crucial in this effort.

Key areas such as establishing standardised methodologies for estimating the remaining useful life of EV batteries and setting up uniform recycling reporting requirements remain unstandardised. This lack of standardisation can hinder the efficient repurposing of batteries and the accurate assessment of recycling performance.

The absence of standardised technical standards for crucial aspects like battery health assessment and recycling reporting hinders the development of a transparent and efficient recycling ecosystem. Without these standards, it is difficult to accurately determine the suitability of batteries for repurposing, track the performance of recycling processes, and compare data across different operators, ultimately impeding progress towards a more optimised system. Lack of standardisation creates uncertainty and inefficiencies in the recycling process. For example, without a reliable method to assess the remaining useful life of a battery, potentially valuable batteries might be prematurely recycled, or conversely, unsafe batteries might be put back into use.

Similarly, the absence of standardised reporting makes it challenging to monitor the overall recycling rate, track the flow of materials, and identify areas for improvement in the industry's performance.

Furthermore, there is a lack of a standardised framework for carbon footprint accounting across the entire EV lifecycle, including the battery recycling phase. This absence makes it difficult to accurately evaluate the environmental impact of EV batteries from cradle to grave and to track the effectiveness of recycling efforts in reducing carbon emissions.

Addressing conflicts of interest

Ensuring effective collaboration among the various stakeholders involved in the battery lifecycle—EV manufacturers, battery producers, recycling companies, and consumers—also presents challenges. Conflicts of interest and a lack of seamless coordination can hinder the efficiency of the recycling process. Existing policies also lack specific targets for battery collection and without such targets, it may be difficult to gauge the overall effectiveness of collection efforts and to drive improvements in collection rates.

Lack of coordinated action among agencies

The scope of authority among various central and local government agencies involved in regulating waste battery treatment is not always clearly defined, potentially leading to inefficiencies and a lack of coordinated action. Additionally, policies may not adequately address the complexities of ensuring cooperation among different players in the ecosystem. Finally, the policy framework does not explicitly specify the mechanisms for financing waste battery treatment, which is crucial for the long-term sustainability of the system.

Develop clear financing mechanisms for long-term sustainability

On one hand, there is a huge dependence on market forces to implement the recycling programme; on the other, there

is lack of explicit financing mechanisms for waste battery treatment. This poses a significant risk to the long-term sustainability of the recycling industry. Relying solely on market forces and the responsibilities of producers might not be sufficient to ensure adequate investment in the necessary infrastructure and technologies, especially for recycling less economically valuable battery types. The financial burden of collecting, transporting, and recycling EV batteries can be substantial. Without clear and dedicated funding mechanisms, there is a risk that the industry will struggle to scale up its operations to meet the growing demand, or that some types of batteries will not be recycled due to low profitability. Government support—through subsidies, tax incentives, or other financial instruments—might be necessary to ensure the economic viability of the entire recycling value chain. In summary, establishing clear and dedicated financing mechanisms for waste battery treatment, potentially through government investment, industry contributions, or consumer fees, is essential to ensure the long-term sustainability of the recycling system.

Beating the challenges: Rise of formal recyclers and recovery rates

To streamline recycling efforts across various sectors, including batteries, the state-owned China Resources Recycling Group was formed. There has been a significant growth in recycling capacity and infrastructure within the country. By the end of 2025, over 156 companies had qualified to recycle power batteries, indicating a substantial increase in the number of certified operators. The number of battery recycling-related enterprises in China has also grown rapidly, with over 180,000 such businesses, and a remarkable 60 per cent of them established within the last three years, highlighting the dynamism of this sector. The estimated lithium-ion battery recycling capacity in China has seen substantial growth. Recycling capacity, including pre-treatment and refining, has grown massively by 2025. China's pre-treatment capacity reached ~3.6 million tonnes (78 per cent global), while black mass refining reached ~2.5

million tonnes (89 per cent global), according to Benchmark Mineral Intelligence. Whitelisted firms' nominal capacity was ~3.793 million tonnes/year (2023 data), with projections to 10+ million tonnes by 2028. Actual utilisation remains low (~16–20 per cent for whitelisted), due to grey-market dominance (~75 per cent of volume) and feedstock shortages.

Comparison of China with US and EU

China's EV battery recycling policy framework can be compared with those of other leading regions, such as the EU and the US, to identify differences in approaches and potential best practices. The EU has established detailed legislation governing producer responsibilities, battery lifecycle tracing, and supply chain due diligence, notably through the EU Battery Regulation. This regulation includes specific recycling targets, such as requiring 45 per cent of all batteries to be recycled by the end of 2023 and 70 per cent by 2030, with more detailed stipulations for different metals. The EU's approach emphasises a comprehensive legal framework with clear obligations for producers and specific targets for recycling and material recovery.

In contrast, the US currently has regulations in place, but the Ministry of Industry and Information Technology (MIIT) in China has noted that US federal legislation in this area is still in process. The US approach tends to emphasise incentives, technological innovation, and voluntary measures to encourage compliance in battery recycling. California, for example, has proposed a "producer take-back" system, which is a form of Extended Producer Responsibility (EPR).

Notable differences in approaches include the EU's detailed and legally binding legislation on producer responsibilities and battery lifecycle tracing, which is more comprehensive than China's current framework in these specific areas. The US, on the other hand, places a greater emphasis on market-based incentives and fostering technological innovation to drive battery recycling efforts.

China could consider adopting certain best practices from these regions to further enhance its own framework. For instance, similar to the EU, China might benefit from setting

specific and legally binding collection targets for end-of-life EV batteries. Drawing from potential US approaches, China could also explore implementing more formalised incentive programmes to encourage consumers to return their batteries for recycling through authorised channels.

Compared to the EU, China's regulatory infrastructure for EV battery recycling is still considered less developed in certain aspects, particularly regarding detailed legislation on producer responsibilities and lifecycle tracing. The EU's more comprehensive legal framework might offer lessons for China in terms of establishing clearer obligations and ensuring greater transparency and accountability throughout the battery lifecycle. The US approach, with its emphasis on incentivising recycling and fostering technological innovation, could provide complementary strategies for China to further improve its recycling efficiency and material recovery rates. In addition to its regulatory approach, China could explore implementing more direct incentives, such as deposit-refund schemes for consumers or tax credits for companies investing in advanced recycling technologies. Learning from the US, emphasis on innovation could also lead to the development and adoption of more environment-friendly and cost-effective recycling methods.

EUROPEAN UNION

Battery recycling objectives

The European Union's policy on EV battery recycling is driven by several overarching objectives that underpin the new Batteries Regulation. These include strengthening the functioning of the internal market by establishing a common set of rules across all member states, and promoting a circular economy by prioritising the reuse, repurposing, and high-level recycling of batteries.[45]

A core aim is to reduce the environmental and social impacts associated with batteries throughout their entire lifecycle. The policy also seeks to minimise the EU's

dependence on imported raw materials by actively promoting the recovery of critical materials from waste batteries within Europe, and to support the EU's broader clean energy transition and its independence from fossil fuel imports.

Battery recycling is considered strategically important for the EU's strategic autonomy and the security of supply of critical raw materials, especially in light of global geopolitical developments. Recycling can significantly contribute to meeting Europe's growing demand for essential battery materials such as lithium, nickel, and cobalt, thereby reducing reliance on environment-damaging mining practices and external suppliers.

To further these policy goals, the European Battery Alliance was launched in 2017 with the aim of fostering the development of an innovative, sustainable, and globally competitive battery value chain within Europe. The implementation of the new Batteries Regulation is being rolled out in a phased manner, commencing in February, 2024, with various new obligations and requirements being introduced gradually over the coming years. This phased approach allows stakeholders across the battery value chain time to adapt to the new regulatory landscape and implement the necessary changes to comply with the evolving requirements.

Legal framework

The European Union has established a comprehensive regulatory landscape for battery recycling, marked by a significant transition from the previous Batteries Directive (2006/66/EC) to the new and more encompassing Batteries Regulation (2023/1542). This new regulation, which entered into force on 17 August, 2023, fully repealed the 2006 directive on 18 August, 2025.[46] A key aspect of the Batteries Regulation is its adoption of a full life-cycle approach to batteries, integrating requirements from the sourcing and manufacturing stages to their use and eventual recycling within a single legislative framework. This aligns directly with the European Green Deal's overarching ambitions for a circular economy.

The Batteries Regulation sets forth several key requirements and targets specifically relevant to the recycling of EV batteries. Notably, it mandates collection targets requiring the collection of all waste starting, lighting, and ignition (SLI) batteries, waste industrial batteries, and waste electric vehicle batteries, with producers being obligated to accept and take back all such waste batteries from end-users without charge. Regarding treatment requirements, the regulation stipulates that collected waste batteries cannot be disposed of in landfills or used for energy recovery. Instead, they must be treated in permitted facilities that comply with minimum requirements outlined in the regulation and utilise best available techniques.

Key policy developments and strategic initiatives

Recycling efficiency and recovery targets

The regulation also establishes stringent recycling efficiency and recovery targets. Recyclers are required to ensure that their processes achieve specific benchmarks for both the overall efficiency of recycling and the recovery of key materials. For lithium-based batteries, a recycling rate of at least 70 per cent by average weight must be achieved by 31 December, 2030. Furthermore, by 31 December, 2027, targets for the recovery of specific materials include 50 per cent for lithium and 90 per cent for cobalt, copper, lead, and nickel. These material recovery targets increase further by 31 December, 2031 to 80 per cent for lithium and 95 per cent for cobalt, copper, lead, and nickel.[47]

To promote the use of recycled materials, the regulation sets minimum levels of recycled content for new EV batteries, with these levels increasing over time. Initially, these are set at 16 per cent for cobalt, 85 per cent for lead, 6 per cent for lithium, and 6 per cent for nickel. These targets will then increase from 18 August, 2036 to 26 per cent for cobalt, 85 per cent for lead, 12 per cent for lithium, and 15 per cent for nickel.[48]

Battery Passport Initiative

A significant aspect of the new regulation is the Battery Passport Initiative. Starting from 18 February, 2027, every EV battery placed on the EU market must be equipped with a digital battery passport. This passport will contain comprehensive information relevant to the battery's lifecycle, including its material composition and possibilities for treatment and recycling.[49]

The regulation also includes requirements for labelling batteries with QR codes that provide access to the digital passport and information on any hazardous substances they contain.

Extended Producer Responsibility (EPR)

The Batteries Regulation also reinforces the principle of Extended Producer Responsibility (EPR), making producers responsible for managing their batteries throughout their entire lifecycle, including the financial costs associated with the collection, treatment, and recycling of all collected batteries.

Furthermore, it introduces due diligence obligations for companies, requiring them to implement policies to identify, prevent, and address social and environmental risks linked to the sourcing of raw materials such as lithium, cobalt, nickel, and natural graphite used in their batteries.

Starting from February 2025, manufacturers need to provide a carbon footprint declaration for EV batteries, with the potential for maximum life cycle carbon footprint thresholds to be introduced at a later stage. Finally, to facilitate recycling and reuse, the regulation mandates that portable batteries incorporated into appliances must be easily removable and replaceable by the end-user by 18 February, 2027.[50, 51]

Scaling recycling to meet the requirement: Challenges

Infrastructure

While the EU's Batteries Regulation represents a significant step forward in establishing a comprehensive framework

for EV battery recycling, several potential shortcomings, challenges, and areas requiring further development can be identified. One of the primary hurdles is the high cost and energy-intensive nature of current EV battery recycling processes, coupled with concerns that the existing recycling infrastructure within the EU may not be adequately scaled to handle the anticipated surge in end-of-life batteries in the coming years.[52]

Technology barriers

Technological barriers also persist, as efficient and cost-effective recycling technologies, particularly those capable of recovering high percentages of lithium and other critical materials, are still under development and require further innovation and scaling.

The increasing complexity and diversity of battery chemistries and the evolution of battery pack designs, such as cell-to-pack architectures, can pose significant challenges for achieving efficient and standardised recycling processes, often necessitating specialised techniques for disassembly and material recovery.[53]

Recycling targets

While the regulation sets ambitious recycling targets, some experts have raised concerns about the practical achievability of certain targets, particularly those related to recycled content, considering the current limitations of recycling technologies and the relatively long lifespan of EV batteries, which may delay the availability of sufficient volumes of end-of-life batteries for recycling.

There are also potential unintended consequences associated with overly ambitious recycled content standards, which could inadvertently incentivise premature recycling or even lead to wasteful manufacturing practices if the supply of end-of-life batteries is insufficient to meet the mandated levels.

Operationalising battery passport

Despite the introduction of battery passport, ensuring effective collection, management, and seamless sharing

of comprehensive battery lifecycle data across all relevant stakeholders throughout the value chain may still present considerable logistical and technological challenges. While the regulation encourages the repurposing of EV batteries for second-life applications, the economic viability of such endeavours and the establishment of clear and supportive regulatory pathways for these applications may require further clarification and the implementation of targeted incentives.[54]

Ensuring consistent and effective implementation and enforcement of the Batteries Regulation across all 27 EU member states, each with its own existing regulatory frameworks and enforcement mechanisms, could prove to be a complex undertaking, potentially leading to disparities in recycling practices and compliance levels across the Union.[55]

International competition

European battery recyclers may also face increasing competition from companies operating in other regions of the world that have more established recycling infrastructure, access to different cost structures, or operate under less stringent regulatory landscapes. The recent delay in the publication of crucial guidelines for the due diligence requirements outlined in the regulation has also created a degree of regulatory uncertainty for businesses that are preparing to comply with these new obligations.[56]

Excessive regulations: Green trade barrier

Finally, concerns have been voiced that the stringent and comprehensive requirements of the EU's Batteries Regulation could potentially act as "green trade barriers," increasing the costs and complexities for companies from outside the EU, particularly battery manufacturers in countries like China, to access the European market. These potential shortcomings highlight the need for ongoing monitoring, adaptation, and further policy support to ensure the EU's ambitious goals for a sustainable and circular EV battery economy are fully realised.[57]

NORWAY

Legal framework

The primary legal framework governing battery recycling in Norway is the Pollution Control Act of 13 March, 1981 No. 6 Concerning Protection Against Pollution and Concerning Waste.[58] This legislation has overarching aims to prevent pollution from occurring, to limit any pollution that does occur, and to avoid issues caused by poorly handled waste management practices.

To achieve these aims, the Act enables the implementation of limits on the amount of specific pollutants and the establishment of thresholds for when certain pollutants, including substances, noise, vibration, and light, are considered problematic.

Moreover, it mandates the use of specific equipment to control pollution. A key provision of the Pollution Control Act is the requirement for any activity that may cause pollution, including the operation of battery recycling facilities, to obtain a permit from the relevant pollution control authority. These permits are granted with specific conditions for operation, which typically include restrictions on pollutants known to be potentially concerning, requirements for measures to protect against pollution and to clean up if it occurs, and stipulations for how waste should be recovered.

In addition to the Pollution Control Act, the Waste Regulation (Regulation No. 930)[59] governs the management of waste in Norway, and it includes a dedicated chapter addressing discarded batteries. The aim of this regulation is to reduce waste production, promote recycling and recovery, and ensure environmentally sound waste management practices across all types of waste, including municipal and industrial waste. Due to Norway's membership in the European Free Trade Association (EFTA) and the European Economic Area (EEA), its legislation closely follows and, in some aspects, exceeds the requirements set forth in the European Union's earlier Batteries Directive (91/157/EC).[60]

Regulations concerning the collection and transport of EV batteries are also crucial aspects of the Norwegian framework. End-of-life EV lithium-ion batteries are classified as category 9 hazardous materials due to their unstable thermal and electrical properties, which present a risk of thermal runaway if mishandled. Consequently, the transport of these batteries requires the use of specific transport crates that are approved for the particular battery type, design, and power capacity. Furthermore, the transport vehicle itself must meet certain criteria to safely transport end-of-life EV lithium-ion batteries.

Shipping documents must clearly state the nature of the cargo, specifically mentioning "Lithium-ion batteries," and packages are required to bear the lithium battery warning mark, which is a distinctive inverse triangle featuring battery and flame symbols. It is important to note that lithium-ion batteries are consistently classified as dangerous during transport, regardless of whether they are pre- or post-use, and the air transport of some types of these batteries is prohibited. Before any end-of-life battery can be packaged for transport, it must be determined that it has been classified as transport-safe.[61, 62]

The Norwegian regulatory framework for EV battery recycling is thus established on existing pollution control and waste management legislation, specifically adapted to address the unique hazards and requirements associated with lithium-ion batteries. Its close alignment with EU directives indicates a commitment to adhering to international standards in this critical area.

Key elements

Norway has adopted a proactive stance as an early and significant adopter of electric vehicles, setting ambitious national targets for the sale of zero-emission vehicles. The country aims for all new passenger cars, light commercial vehicles (LCVs), and city buses sold to be zero-emission by 2025. This ambition extends to larger vehicles, with targets set for 2030 that include the largest LCVs, 50 per cent of new trucks, and 75 per cent of new coaches being zero-emission.

This early and substantial adoption of EVs positions Norway as one of the first markets where significant volumes of used EV batteries will become available for collection, reuse, and recycling in the near future.[63, 64]

To capitalise on this position and foster a sustainable battery industry, Norway has developed a comprehensive Battery Strategy. This strategy outlines ten key actions for sustainable industrialisation, with the overarching goal of attracting private capital to the battery sector.

A central aim of this strategy is to showcase the advantages of choosing Norway as a host country for new investments in the battery industry to both domestic and international commercial actors and investors. The ten actions emphasise leadership in sustainability across the entire battery value chain, promoting Norway as an attractive destination for green investments, and actively pursuing industrial partnerships with key countries.

Battery recycling landscape

Several key actors and initiatives are shaping Norway's battery recycling landscape. Batteriretur is a prominent company specialising in the collection and handling of batteries from the transport sector, boasting an extensive network of over 20,000 drop-off points across Norway. Hydrovolt, a joint venture between the Norwegian aluminium company Hydro and the Swedish battery manufacturer Northvolt, operates what is currently Europe's largest dedicated EV battery recycling plant located in Fredrikstad. This facility has a substantial processing capacity and aims for a high material recovery rate, including valuable materials like lithium, manganese, and cobalt. Furthermore, FREYR, a company constructing a gigafactory in North Norway, has integrated recycling as a crucial component of its overall production strategy, emphasising the importance of responsible sourcing and the creation of a circular battery economy.

Norway's policy strongly emphasises the development of a circular battery economy, driven by the high rate of EV adoption and supportive government policies. Generous

tax incentives and other governmental measures have significantly contributed to the large number of EV batteries in the country. Notably, one of the industrial objectives of the government is to further develop a complete battery value chain that encompasses all stages, from raw material extraction and component manufacturing to the use, collection, and recycling of batteries. This comprehensive approach underscores Norway's commitment to establishing a sustainable and circular system for managing EV batteries.

Challenges

Norway has an early advantage due to its high EV penetration; the sheer volume of batteries anticipated in the future may still place a significant strain on the existing recycling infrastructure and capacity. The rapid pace of evolution in battery technology, coupled with the increasing variety of cell chemistries utilised in EVs, presents ongoing challenges for achieving consistently efficient and cost-effective recycling processes. This necessitates a continuous adaptation of both recycling technologies and the regulations that govern them.

Although the European Union's new Batteries Regulation aims to address the issue of limited access to historical data on battery usage and health through the introduction of battery passports, this regulation is still in its early stages of implementation, and the legacy of batteries currently reaching their end-of-life in Norway may lack this crucial information. The absence of comprehensive historical data can hinder the effective assessment of batteries for potential reuse or repurposing applications. Furthermore, a lack of standardisation in battery pack designs across different EV manufacturers continues to make the processes of dismantling and recycling complex and costly, potentially impacting the overall economic viability of recycling operations.

There appears to be a need for more specific regulations and standards that explicitly govern the second-life use of EV batteries. This would include establishing clear safety and reliability protocols, as well as defining the allocation

of responsibility for batteries that are repurposed for applications beyond their initial use in vehicles. Broader concerns also exist regarding the overall effectiveness of Norway's national waste policy. Research indicates that a significant portion of collected waste in Norway is currently being incinerated rather than recycled, suggesting potential for improvement in material recovery rates across all sectors, including the management of end-of-life EV batteries.[65]

Analyses projecting the future availability of EV batteries for recycling also highlight uncertainties in modelling, particularly concerning the assumptions made about the battery sizes in different vehicle models as the market evolves towards 2030. These uncertainties could lead to potential underestimations of the actual recycling capacity required to handle the increasing volumes of retired EV batteries. While Norway, through its EEA agreement, is subject to European Union regulations, the specific mechanisms for the implementation and enforcement of these regulations within Norway's national context may encounter their own unique set of challenges that need to be proactively addressed. Despite the early emergence of significant battery recycling players in Norway, ensuring the long-term scalability and economic sustainability of these operations in the face of rapidly increasing volumes and technological changes remains a critical consideration.[66]

Norway, having been an early and highly successful adopter of electric vehicles, is facing a more immediate and potentially larger influx of end-of-life EV batteries in the near term compared to the European Union as a whole. This early market penetration provides Norway with an earlier "window of opportunity" to develop and refine its systems for battery recycling and reuse. Additionally, Norway benefits from abundant and relatively inexpensive renewable energy sources, which could offer a competitive advantage for the energy-intensive processes involved in battery recycling compared to some EU member states that rely more heavily on fossil fuels for their energy mix.[67]

JAPAN

Japan's approach to battery recycling is significantly driven by its existing waste management regulations and a strong environmental consciousness among both the public and the industry. The country is actively focusing on creating a circular economy for batteries, emphasising collaboration between battery manufacturers, recycling companies, and research institutions to achieve this goal.[68, 69]

The Japanese government is also making substantial investments in battery technology and recycling procedures, with the aim of developing cost-competitive methods for recycling lithium-ion batteries. A key target is to achieve high recovery rates of valuable materials, specifically 70 per cent for lithium and 95 per cent for both nickel and cobalt from used batteries.[70]

Unlike some other regions, Japan does not have strict mandatory rules for a comprehensive battery recycling process. Instead, it relies more on voluntary collection and recycling schemes, with producer responsibility organisations (PROs) like the Japan Battery Recycling Center (JBRC) playing a crucial role. JBRC is responsible for the collection of all non-industrial battery technologies, including lithium-ion batteries (excluding lead-acid batteries), based on the principle of producer responsibility.[71]

However, Japan faces several challenges in establishing a robust EV battery recycling system. These include the high costs associated with ecologically sound recycling compared to extracting virgin materials in countries with less stringent environmental regulations. Additionally, Japan has a limited availability of domestic used EV batteries for recycling due to a significant portion of used EVs being exported to other countries. The increasing demand for batteries in new electric vehicles and consumer electronics is also likely to outpace the growth in the number of recyclable batteries.

Recognising the global nature of the challenge, Japan is engaging in international cooperation on EV battery recycling. Notably, there is collaboration between Japan and

the European Union, including the establishment of a data-sharing system to facilitate the recycling of EV batteries and reduce dependence on major suppliers of rare metals. Furthermore, the Japanese government plans to mandate the disclosure of carbon dioxide emissions during the production of EV batteries. This data will be used to determine the eligibility of manufacturers for subsidies, indicating a move towards integrating environmental considerations into economic incentives.[72]

Key takeaway is that Japan relies more on voluntary schemes and producer responsibility, coupled with government investment in technology. Key challenges include cost and the availability of feedstock. International collaboration is also a part of their strategy.

AFRICA

The regulatory landscape for EV battery recycling across Africa is currently in a nascent stage, with most countries yet to establish comprehensive frameworks.

Despite this, there is a growing awareness of the significant economic and environmental opportunities presented by battery recycling in the region. Recycling allows for the recovery of valuable metals such as lithium, cobalt, and nickel, which are crucial for new battery production, thereby supporting a circular economy and reducing the environmental impact associated with mining virgin materials.

However, the development of a robust battery recycling sector in Africa faces substantial challenges. These include insufficient infrastructure for collection, transportation, and processing of batteries, limited regulations and public awareness regarding proper battery disposal, and high recycling costs, particularly for lithium-ion batteries. The lack of specific regulations in many African countries contributes to improper disposal practices and potential environmental risks.[73]

GLOBAL EV BATTERY RECYCLING POLICIES AT A GLANCE

A significant concern in the context of EV battery recycling in Africa is the potential for waste colonialism.[74] There are fears that high-income countries, facing increasing volumes of spent EV batteries, might seek to dump or export this toxic waste to African nations that may be ill-equipped to handle it safely. This raises ethical and environmental justice issues, placing the burden of managing hazardous battery waste on regions with limited resources and regulatory oversight.

Despite these challenges, several African countries are beginning to take steps towards developing battery recycling capabilities. Countries like Kenya and South Africa have launched pilot projects aimed at testing battery collection and recycling systems. These initiatives often involve collaborations between governments, private companies, and non-governmental organisations to develop sustainable models that can be replicated in other regions.

Notably, Nigeria has recently enacted new legislation focused on the lifecycle management of batteries, including provisions for improved battery recycling, indicating a growing regulatory awareness in some parts of the continent.[75]

Public-private partnerships and international collaborations are expected to play a key role in mobilising resources, sharing knowledge, and developing the necessary recycling infrastructure in Africa. The development of a battery recycling industry in Africa also holds the potential to create thousands of jobs, reduce the dependence on imports of valuable metals, and stimulate technological innovation as local companies develop solutions tailored to the continent's specific realities.

In summary, Africa's EV battery recycling sector is in its early stages, facing significant infrastructural and regulatory challenges. However, there is a growing awareness of the opportunities, with emerging initiatives and international interest.[76] Preventing waste colonialism is a key consideration.

REFERENCES

1. USEPA. *Resource Conservation and Recovery Act.* Available at https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act, as accessed on 18 March, 2026
2. USEPA. *Title 40 of the Code of Federal Regulations (CFR) PART 273—STANDARDS FOR UNIVERSAL WASTE MANAGEMENT.* Available at https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-273#part-273, as accessed on 18 March, 2026
3. USEPA, 2023. *Lithium battery recycling regulatory status and frequently asked questions* (Memorandum from Carolyn Hoskinson, Director, Office of Resource Conservation and Recovery, dated May 24, 2023). Available at: https://rcrapublic.epa.gov/files/14957.pdf and U.S. EPA (2025) Lithium-ion battery recycling frequently asked questions. Available at: https://www.epa.gov/hw/lithium-ion-battery-recycling-frequently-asked-questions, as accessed on 18 March, 2026
4. U.S. Environmental Protection Agency, 2023. *Lithium Battery Recycling Regulatory Status and Frequently Asked Questions* (Memorandum from Carolyn Hoskinson, Director, Office of Resource Conservation and Recovery, dated May 24, 2023; RCRA Online Number 14957). Available at https://rcrapublic.epa.gov/files/14957.pdf, as accessed on 18 March, 2026
5. U.S. Environmental Protection Agency, 2026. (I) *Extended battery producer responsibility (EPR) framework.* Available at: https://www.epa.gov/electronics-batteries-management/extended-battery-producer-responsibility-epr-framework, as accessed on 18 March, 2026. (II) *Battery collection best practices.* Available at: https://www.epa.gov/electronics-batteries-management/battery-collection-best-practices, as accessed on 18 March, 2026. (III) *Voluntary battery labeling guidelines.* Available at: https://www.epa.gov/electronics-batteries-management/voluntary-battery-labeling-guidelines, as accessed on 18 March, 2026. (IV) *Battery collection best practices toolkit.* Available at: https://www.epa.gov/electronics-batteries-management/battery-collection-best-practices-toolkit, as accessed on 18 March, 2026.
6. Development of Best Practices for Collection of Batteries To Be Recycled and Voluntary Battery Labeling Guidelines; Request for Information (RFI); Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act of 2021, Section 70401),
7. U.S. Environmental Protection Agency (2026a) Battery collection best practices. Available at: https://www.epa.gov/electronics-batteries-management/battery-collection-best-practices

8. U.S. Environmental Protection Agency (2022) Development of best practices for collection of batteries to be recycled and voluntary battery labeling guidelines; request for information. Federal Register, 87(111), pp. 35202–35207, 9 June. Available at: https://www.federalregister.gov/documents/2022/06/09/2022-12459/development-of-best-practices-for-collection-of-batteries-to-be-recycled-and-voluntary-battery
9. U.S. Environmental Protection Agency (2025a) White paper summarizing existing battery labeling requirements and standards. EPA 530-R-25-002, January. Available at: https://www.epa.gov/system/files/documents/2025-01/battery-labeling-requirements-and-standards-white-paper.pdf
10. Union of Concerned Scientists (2024) 'All about EV battery recycling': https://www.ucsusa.org/resources/all-about-ev-battery-recycling ; Making the most of electric vehicle batteries: How recycling, innovation, and efficiency can support a sustainable transportation future: https://www.ucsusa.org/sites/default/files/2024-12/making-most-ev-batteries-report_0.pdf
11. Earthjustice (2023) 'Environmental groups urge policymakers to ensure responsible sourcing of EV minerals and secure supply chains', Press release, 12 December. Available at: https://earthjustice.org/press/2023/environmental-groups-urge-policymakers-to-ensure-responsible-sourcing-of-ev-minerals-and-secure-supply-chains
12. ResearchAndMarkets (2025) Global Li-ion battery recycling market report 2025-2045: China leads global Li-ion battery recycling capacity with 70% share. Dublin: ResearchAndMarkets.com. Available at: https://www.businesswire.com/news/home/20250512077618/en/Global-Li-ion-Battery-Recycling-Market-Report-2025-2045-China-Leads-Global-Li-ion-Battery-Recycling-Capacity-with-70-Share---ResearchAndMarkets.com
13. Climate Change News (2026) 'China maximises battery recycling to shore up critical mineral supplies', 9 February. Available at: https://www.climatechangenews.com/2026/02/09/china-maximises-battery-recycling-to-shore-up-critical-mineral-supplies
14 Mysteel (2026) 'China lithium battery recycling market 2025 review and 2026 outlook'. Available at: https://www.mysteel.net/analysis/5113049-china-lithium-battery-recycling-market-2025-review-and-2026-outlook
15. Qiao, Q., Zhao, F., Hao, H. and Liu, Z. (2019) 'Electric vehicle recycling in China: Economic and environmental benefits', Resources, Conservation and Recycling, 140, pp. 45–53. doi: 10.1016/j.resconrec.2018.09.009. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0921344918303288

16. New rules aim to tackle growing retired batteries, https://www.chinadaily.com.cn/a/202511/03/WS690803c2a310f215074b8982.html
17. Dialogue Earth (2025) 'China prepares for wave of EV battery retirements', 27 February. Available at: https://dialogue.earth/en/digest/china-prepares-for-wave-of-ev-battery-retirements
18. China Daily (2025) 'New rules aim to tackle growing retired batteries', 3 November. Available at: https://www.chinadaily.com.cn/a/202511/03/WS690803c2a310f215074b8982.html
19. Qiao, Q. et al. (2021) 'Assessment of end-of-life electric vehicle batteries in China: Future scenarios and economic benefits', Waste Management, 135, pp. 70–78. doi: 10.1016/j.wasman.2021.08.031. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0956053X21004657
20 United Nations Development Programme (2025) Analysis of EV battery end-of-life. Available at: https://www.undp.org/sites/g/files/zskgke326/files/2025-01/analysis-of-ev-battery-end-of-life.pdf
21. International Energy Agency (IEA) (2025) Global EV Outlook 2025. Paris: IEA. Available at: https://www.iea.org/reports/global-ev-outlook-2025
22. China Daily (2025) 'New rules aim to tackle growing retired batteries', 3 November. Available at: https://www.chinadaily.com.cn/a/202511/03/WS690803c2a310f215074b8982.html
23. Dialogue Earth (2025) 'China prepares for wave of EV battery retirements', 27 February. Available at: https://dialogue.earth/en/digest/china-prepares-for-wave-of-ev-battery-retirements
24. State Council of the People's Republic of China (2012) Energy-saving and new energy vehicle industry development plan (2012–2020) (Guofa [2012] No. 22). Available at: https://www.gov.cn/zwgk/2012-07/09/content_2179032.htm
25. China Daily (2025) 'New rules aim to tackle growing retired batteries', 3 November. Available at: https://www.chinadaily.com.cn/a/202511/03/WS690803c2a310f215074b8982.html
26. Interesting Engineering (2025) 'Zero tolerance for EV fire or explosions: China sets mandatory battery rules', 28 December. Available at: https://interestingengineering.com/energy/no-ev-fire-with-mandatory-rules
27 IGARR (2025) 'China: New standard GB 38031-2025 "Safety Requirements for Power Batteries for Electric Vehicles"', 24 April. Available at: https://igarr.com/2025/04/24/china-new-standard-gb-38031-2025-safety-requirements-for-power-batteries-for-electric-vehicles
28 State Administration for Market Regulation (SAMR) / Standardization Administration of China (2025) GB 38031-2025: Electric vehicles traction battery safety requirements. Beijing: Standards Press of China. Available at: https://www.chinesestandard.net/PDF_MS.aspx/GB38031-2025

29. Ministry of Industry and Information Technology (MIIT) (2024) Specifications for the Comprehensive Utilisation of NEV Retired Power Batteries (2024 Edition). Announced 23 December. Available at: https://www.miit.gov.cn
30 State Council of the People's Republic of China (2025) 'Action plan for improving the recycling and utilization system of new energy vehicle power batteries approved', Executive meeting report, February. Available at: https://english.www.gov.cn/news/202502/21/content_WS67b880d-3c6d0868f4e8efdd8.html
31. Ministry of Industry and Information Technology (MIIT) et al. (2026) Interim measures for the management of recycling and comprehensive utilization of retired power batteries of new energy vehicles. Issued January 16, effective April 1. Available at: https://wap.miit.gov.cn/gyhxxhb/jgsj/cyzcyfgs/bmgz/jdcjxl/art/2026/art_392462fdc40c415ea4a4129cac3028c2.html
32. Ministry of Industry and Information Technology (MIIT) et al. (2026) Interim measures for the management of recycling and comprehensive utilization of retired power batteries of new energy vehicles. Issued January 16, effective April 1. Available at: https://english.www.gov.cn/news/202601/16/content_WS6969df0cc6d00ca5f9a089c0.html
33. CarNewsChina (2026) 'China implements strict EV battery recycling rules for 2026', 16 January. Available at: https://carnewschina.com/2026/01/16/china-implements-strict-ev-battery-recycling-rules-for-2026
34 MIT Technology Review (2025) 'China figured out how to sell EVs. Now it has to deal with their aging batteries', 18 December. Available at: https://www.technologyreview.com/2025/12/18/1130148/china-ev-battery-recycle
35. Battery China / SMM Analysis (2025) '[SMM Analysis] Number of Battery Recycling Enterprises Shows Explosive Growth', 30 November. Available at: https://news.metal.com/ru/newscontent/103646870
36. Ministry of Industry and Information Technology (MIIT) et al. (2026) Interim measures for the management of recycling and comprehensive utilization of retired power batteries of new energy vehicles. Issued January 16, effective April 1. Available at: https://english.www.gov.cn/news/202601/16/content_WS6969df0cc6d00ca5f9a089c0.html
37. Ministry of Industry and Information Technology (MIIT) (2024) Specifications for the Comprehensive Utilisation of NEV Retired Power Batteries (2024 Edition). Announced 23 December. Available at: https://www.miit.gov.cn
38 Ministry of Industry and Information Technology (MIIT) (2024) Specifications for the Comprehensive Utilisation of NEV Retired Power Batteries

(2024 Edition). Announced 23 December. Available at: https://www.miit.gov.cn
39. International Energy Agency (IEA) (2025) 'Specifications for the Comprehensive Utilisation of Waste EV Batteries 2024'. Available at: https://www.iea.org/policies/24987-specifications-for-the-comprehensive-utilisation-of-waste-ev-batteries-2024
40. CarNewsChina (2026) 'Unlicensed workshops reportedly dominate China's EV battery recycling, posing environmental and safety risks', 30 January. Available at: https://carnewschina.com/2026/01/30/unlicensed-workshops-reportedly-dominate-chinas-ev-battery-recycling-posing-environmental-and-safety-risks
41. ScienceDirect (2025) 'Lithium-ion battery recycling: a critical review of techno-economical and socio-environmental impacts', Separation and Purification Technology. Available at: https://www.sciencedirect.com/science/article/pii/S1383586625044442
42. Nature Communications (2025) 'Lithium-ion battery recycling relieves the threat to material scarcity amid China's electric vehicle ambitions'. Available at: https://www.nature.com/articles/s41467-025-61481-y
43. MIT Technology Review (2025) 'China figured out how to sell EVs. Now it has to deal with their aging batteries', 18 December. Available at: https://www.technologyreview.com/2025/12/18/1130148/china-ev-battery-recycle
44. National Certification and Accreditation Administration (CNCA) (2023) Announcement No. 19-2023 on compulsory product certification management for recycled power battery products in fixed energy storage applications, September. Available at: https://www.cnca.gov.cn
45. European Parliament and Council of the European Union (2023) Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC. Official Journal of the European Union, L 191, 28 July. Consolidated version as at 31 July 2025. Available at: https://eur-lex.europa.eu/eli/reg/2023/1542/2025-07-31/eng
46. European Commission (2025) Batteries. Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en.
47. European Commission (2025) Batteries. Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en (Accessed: 17 February 2026).
48. International Energy Agency (IEA) (2024) 'EU Sustainable Batteries Regulation'. Available at: https://www.iea.org/policies/16763-eu-sustainable-batteries-regulation
49. European Parliament and Council of the European Union (2023) Regula-

tion (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries.... Official Journal of the European Union, L 191, 28 July. Consolidated version as at 31 July 2025. Available at: https://eur-lex.europa.eu/eli/reg/2023/1542/2025-07-31/eng

5o. European Parliament and Council of the European Union (2023) Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries.... Official Journal of the European Union, L 191, 28 July. Consolidated version as at 31 July 2025. Available at: https://eur-lex.europa.eu/eli/reg/2023/1542/2025-07-31/eng

51. European Parliament and Council of the European Union (2025) Regulation (EU) 2025/1561 of the European Parliament and of the Council of 18 July 2025 amending Regulation (EU) 2023/1542 as regards obligations of economic operators concerning battery due diligence policies. Official Journal of the European Union, L series, 30 July. Available at: https://eur-lex.europa.eu/eli/reg/2025/1561/oj

52. Fraunhofer ISI (2025) 'Recycling capacities for lithium-ion batteries will exceed demand in Europe for the time being – Update 2025'. Available at: https://www.isi.fraunhofer.de/en/blog/themen/batterie-update/batterie-recycling_europa_kapazitaeten_bedarf_update_2025.html (

53. Nature: Materials Sustainability (2025) 'Lithium-ion battery recycling: a critical review...'. Available at: https://www.nature.com/articles/s44296-025-00083-7

54. CEPS (2024) 'Implementing the EU digital battery passport'. Available at: https://circulareconomy.europa.eu/platform/sites/default/files/2024-03/1qp5rxiZ-CEPS-InDepthAnalysis-2024-05_Implementing-the-EU-digital-battery-passport.pdf

55. European Parliament and Council of the European Union (2025) Regulation (EU) 2025/1561... postponing due diligence obligations. Official Journal of the European Union, L series, 30 July. Available at: https://eur-lex.europa.eu/eli/reg/2025/1561/oj

56. ECFR (2025) 'Green competitiveness: Why Europe should rethink targets to outpace China', 31 October. Available at: https://ecfr.eu/article/green-competitiveness-why-europe-should-rethink-targets-to-outpace-china

57. China-CEE Institute (2025) 'EU Green Trade Regulations: Impacts and Responses', 11 December. Available at: https://china-cee.eu/2025/12/11/eu-green-trade-regulations-impacts-and-responses

58 Ministry of Climate and Environment (1981) Pollution Control Act of 13 March 1981 No. 6 Concerning Protection Against Pollution and Concerning Waste. Available at: https://www.regjeringen.no/en/dokumenter/pollution-control-act/id171893

59. Ministry of Climate and Environment (2004) Regulations on the recycling and treatment of waste (Waste Regulations) No. 930. Available at: https://lovdata.no/dokument/SF/forskrift/2004-06-01-930
60. European Commission (2025) Batteries. Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/batteries_en
61. FedEx Norway (2026) 'Shipping lithium batteries | Norway'. Available at: https://www.fedex.com/en-no/shipping/dangerous-goods/how-to-ship/lithium-batteries.html
62. World Cargo Shipping (2025) 'Customs Restrictions When Shipping EVs To Norway'. Available at: https://www.wcshipping.com/blog/customs-restrictions-when-shipping-evs-to-norway
63. Norsk elbilforening (Norwegian EV Association) (2026) 'Norwegian EV policy'. Available at: https://elbil.no/english/norwegian-ev-policy
64. MDPI World Electric Vehicle Journal (2026) 'Reaching the End of the ICEV Domination: 35 Years of Battery Electric Vehicles in Norway'. Available at: https://www.mdpi.com/2032-6653/17/2/89
65. ScienceDaily / NTNU (2024) 'Failed waste policy: We burn more and recycle less than we think', 10 October. Available at: https://www.sciencedaily.com/releases/2024/10/241010124714.htm
66. Transport & Environment (2024) 'From waste to value: the potential for battery recycling in Europe', 12 December. Available at: https://www.transportenvironment.org/articles/from-waste-to-value-the-potential-for-battery-recycling-in-europe
67. Circular Business Review (2025) 'Norway's EV Importers Launch Coordinated Battery Recycling Scheme Amid Rising Volumes', 13 August. Available at: https://www.circularbusinessreview.com/norways-ev-importers-launch-coordinated-battery-recycling-scheme-amid-rising-volumes
68. Eco-Business (2025) 'Japan to join global race to recycle lithium batteries and curb e-waste hazards', 31 October. Available at: https://www.eco-business.com/news/japan-to-join-global-race-to-recycle-lithium-batteries-and-curb-e-waste-hazards
69. Sustainability Directory (2025) 'Japan Mandates Battery Recycling to Secure Critical Minerals and Boost Circularity', 4 November. Available at: https://news.sustainability-directory.com/circularity/japan-mandates-battery-recycling-to-secure-critical-minerals-and-boost-circularity
70. Eco-Business (2025) 'Japan to join global race to recycle lithium batteries and curb e-waste hazards', 31 October. Available at: https://www.eco-business.com/news/japan-to-join-global-race-to-recycle-lithium-batteries-and-curb-e-waste-hazards

71. Eco-Business (2025) 'Japan to join global race to recycle lithium batteries and curb e-waste hazards', 31 October. Available at: https://www.eco-business.com/news/japan-to-join-global-race-to-recycle-lithium-batteries-and-curb-e-waste-hazards
72. Inno Energy / European Battery Alliance (2025) 'European Battery Alliance, RECHARGE, and Japan's BASC join forces to build resilient and competitive battery supply chains', 15 September. Available at: https://www.eba250.com/european-battery-alliance-recharge-and-japans-basc-sign-mou-to-boost-battery-supply-chain-resilience
73. Used Electric Vehicles, Battery End-of-Life & Circularity – Africa Workshop - UNEP, accessed May 9, 2025, https://www.unep.org/events/workshop/used-electric-vehicles-battery-end-life-circularity-africa-workshop
74. GAIA 2024, Electric Vehicle Batteries and Waste Colonialism, https://www.no-burn.org/wp-content/uploads/2024/06/07-Battery-Infosheet-EV-Battery-Risks-of-Waste-Colonialism.pdf
75. National Environmental (Battery Control) Regulations, 2024, https://www.iea.org/policies/25120-national-environmental-battery-control-regulations-2024
76 Exploration of Market Potentials in Battery Recycling and Refurbishment in Africa, https://transformative-mobility.org/wp-content/uploads/2024/07/Battery_Recycling-Opportunities-in-Africa.pdf

GLOBAL EV BATTERY RECYCLING POLICIES AT A GLANCE

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000 Fax: 91-11-29955879
E-mail: cseindia@cseindia.org Website: www.cseindia.org