CONFERENCE PROCEEDING

# Battery circularity in India: Policy, regulations, and implementation strategies

## A SUMMARY OF EXPERT PERSPECTIVES ON THE CURRENT REGULATORY STATUS AND ENABLING ACTIONS TOWARD A SUSTAINABLE AND CIRCULAR BATTERY ECOSYSTEM

July 2, 2024 | New Delhi | Compiled by: Parveen Kumar, Mitradev Sahoo, Abhishek Meshram, and Lalit Mudholkar

## BACKGROUND

Globally, lithium-ion battery (LIB) variants are the leading choices for electric vehicles (EVs) and renewable energy (RE) applications. However, these variants require critical minerals and have vulnerable supply chains. Based on current global policies, the demand for certain critical minerals is expected to double by 2030 (IEA 2023) and increase significantly by 2040. It is crucial to integrate circularity into the LIB supply chain to ensure the availability of critical minerals, reduce the dependence on primary mining, and minimize the environmental impact of the supply chain.

To establish a safe, sustainable, and circular battery ecosystem, major global economies, such as the European Union (EU), China, and South Korea, have introduced various policies and regulations. In India, the adoption of LIBs in EVs and RE sector in general is at a very nascent stage and faces various supply-chain-related challenges (see Figure 1). In 2022, India introduced the Battery Waste Management Rules (BWMR), enabling batteries' End of Life (EoL) management and circularity through refurbishment and recycling. The provisions introduced in the BWMR, such as the use of recycled material in new batteries, collection targets, and extended producer responsibility (EPR), are expected to contribute to the development of a circular economy for retired LIBs in India. However, major challenges hinder the development of a safe and sustainable circular economy for batteries. These include the lack of circularity-friendly battery design, implementation issues in the EPR provisions, lack of efficient reverse logistics for retired batteries, challenges in battery data collection and management, absence of standards for battery reuse and recycling, lack of public awareness, and a market gap for recycled battery material (Kumar et al. 2023).

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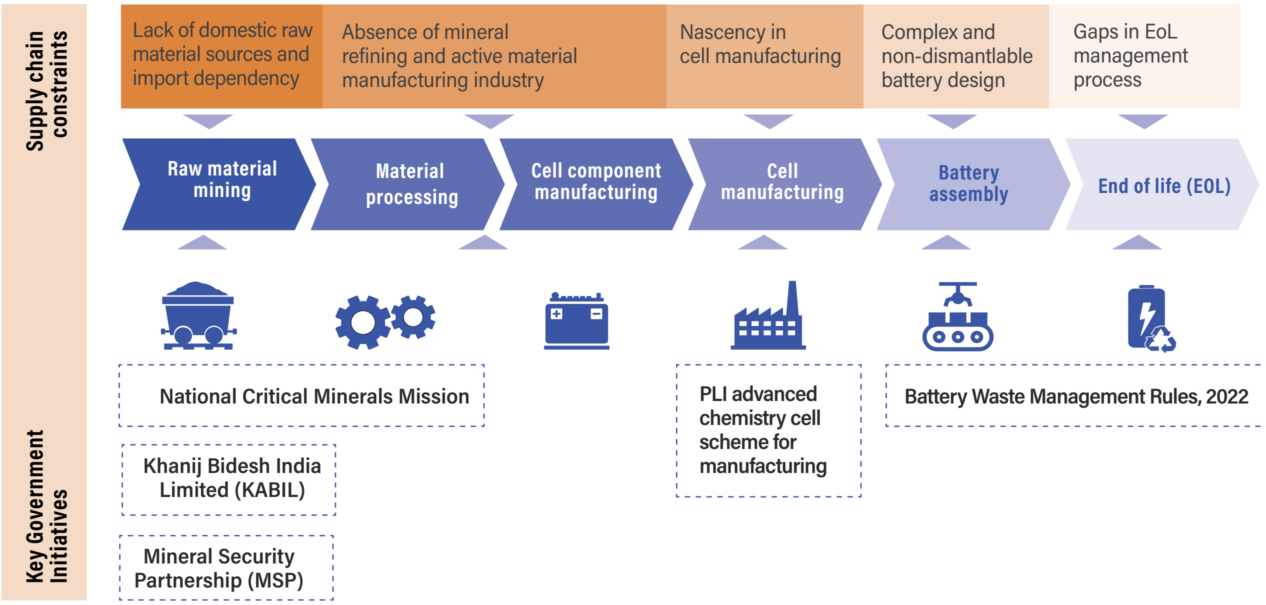
*These conference proceedings reflect the presentations and discussions of participants and do not necessarily represent the views of WRI India or other participating institutions*

On July 2, 2024, WRI India organized a roundtable to discuss the existing gaps, implementation challenges, and the necessary support measures required for enabling battery circularity in India. This document captures the key insights and India-specific actions suggested by the subject-matter experts and industry stakeholders who participated in the roundtable.

**FIGURE 1 | LIB supply chain constraints and key government initiatives**

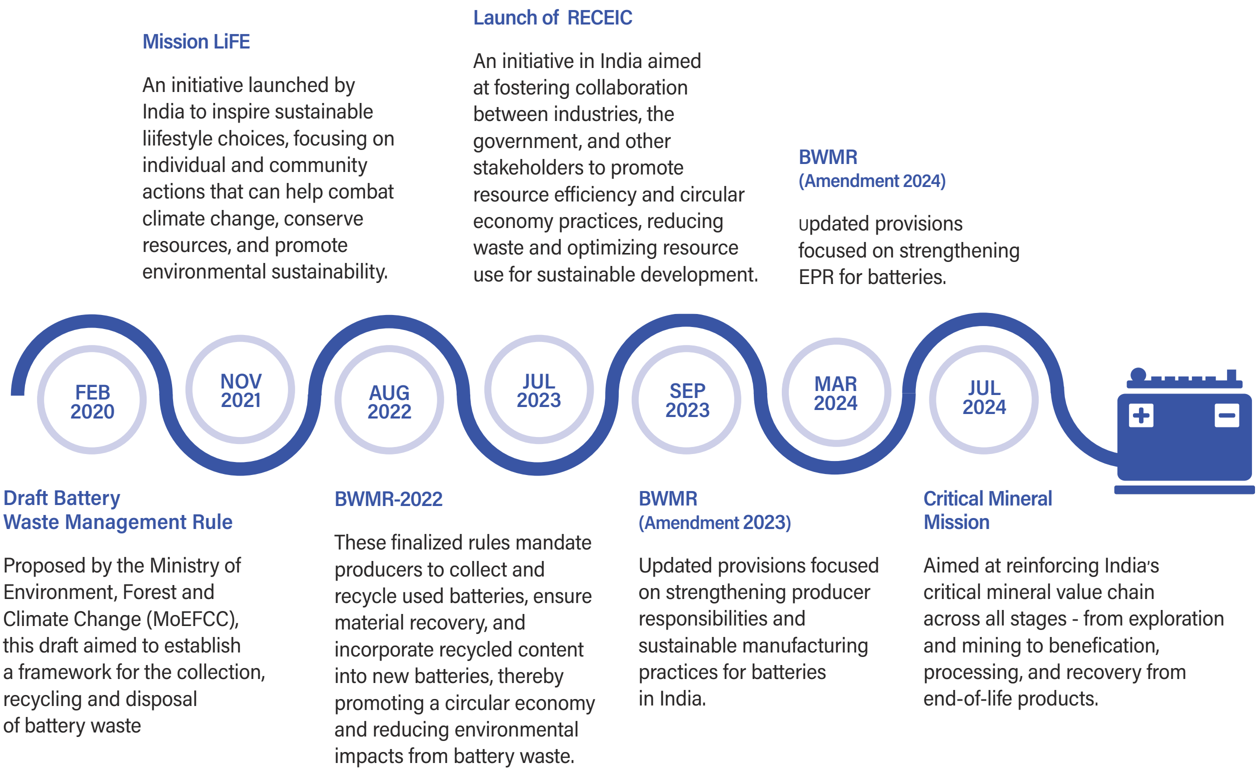



*Note:* LIB = lithium-ion battery PLI = production linked incentive.
*Source:* Compiled by the authors.

## OVERVIEW OF REGULATORY MEASURES TO ENABLE BATTERY CIRCULARITY IN INDIA

The Government of India (GoI) has introduced various initiatives to drive battery circularity in the country (see Figure 2). The BWMR, introduced by the Ministry of Environment, Forest and Climate Change (MoEFCC) in August 2022, focuses on environmentally responsible management of waste batteries. These new regulations replaced the previous Batteries (Management and Handling) Rules (BMHR) of 2001. The BWMR aims to promote EoL circularity by setting requirements for battery refurbishment, repurpose, reuse, and recycling. It classifies battery waste into different categories based on its application and establishes specific collection targets for each category. Producers are responsible for meeting these targets, which can be achieved either by obtaining EPR certificates from recyclers or by collecting batteries for refurbishment and recycling as stipulated by the BWMR. Starting in 2027, producers will be required to use domestically recycled battery materials in new batteries. Additionally, from 2024 onward, recyclers are obligated to meet the minimum recovery targets set by the BWMR. The Central Pollution Control Board (CPCB) is designated as the reporting and monitoring authority to ensure the effective implementation of these rules. An amendment to the BWMR in March 2024 includes mandates for the sustainable production of battery packs, in line with guidelines issued by the CPCB (PIB 2022). Key gaps in the current regulatory system enabling battery circularity in India are the lack of an efficient reverse logistics strategy and a battery data management mechanism. (see Figure 4).

**FIGURE 2 | Government initiatives driving battery circularity in India**




*Note: LiFE = Lifestyle for Environment*
RECEIC = Resource Efficiency Circular Economy Industry Coalition.
BWMR = Battery Waste Management Rules.
EPR = Extended Producer Responsibility.
*Source:* Compiled by the authors.

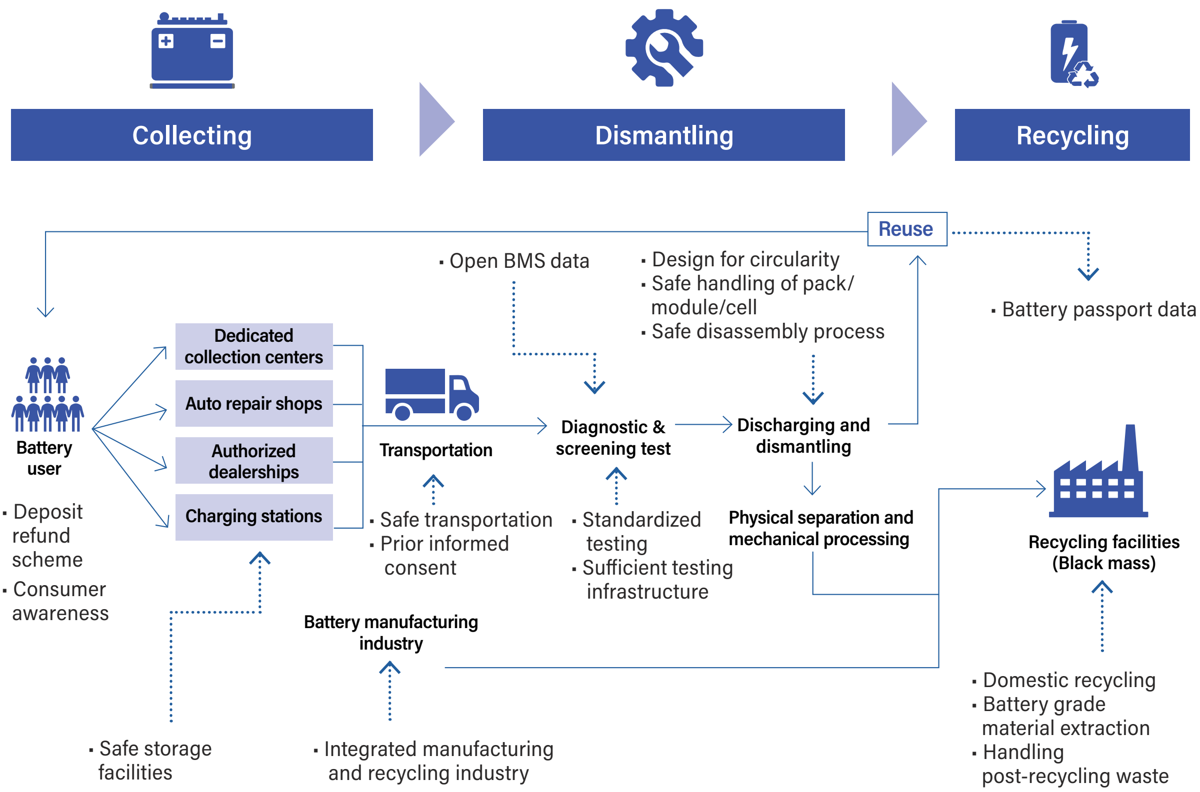
## REVERSE LOGISTICS OF SPENT BATTERIES

The reverse logistics of batteries involves several key steps, starting with collecting batteries from the end consumers and safely returning them to refurbishers and recyclers. Intermediate steps in this process include the safe transportation, storage, diagnostics, and testing of batteries. A major challenge is the lack of a well-defined infrastructure and reverse logistics mechanism, which hinders the establishment of a safe and formal collection process for repurposing and recycling retired batteries.

In Europe, transportation accounts for 30 percent (Nicholson et al. 2022) of the total recycling expenses. Many leading players in Europe are adopting a hub-and-spoke model to efficiently manage waste loops and logistics, offering opportunities for scaling, particularly given regional recycling dynamics. In this model, the initial dismantling occurs near major supply hubs, and the black mass processing is centralized, to optimize cost efficiency.

As of 2020, data indicate that 70 percent of retired batteries in India were collected by informal aggregators, 20 percent by original equipment manufacturers (OEMs), and only 10 percent directly by formal waste management entities (Gattu et al. 2022). In the case of lead acid batteries (LABs), the informal sector plays a critical role in the collection and recycling process, which compromises the safety of both workers and the environment (Kumar and Mulukutla 2023). Factors contributing to this situation include the lack of consumer awareness about the risks associated with improper battery handling and the 18 percent GST levied on retired batteries in the formal sector (ClearTax n.d.), which incentivizes the informal sector to play a significant role in the recycling industry. Developing a formal reverse logistics mechanism for LIBs is crucial to ensure worker safety and to protect the environment. Figure 3 depicts the pathway for an ideal reverse logistics practice in India.

**FIGURE 3** | **Pathway for an ideal reverse logistics process in India**




*Note:* BMS = battery management system.
*Source:* Compiled by the authors.

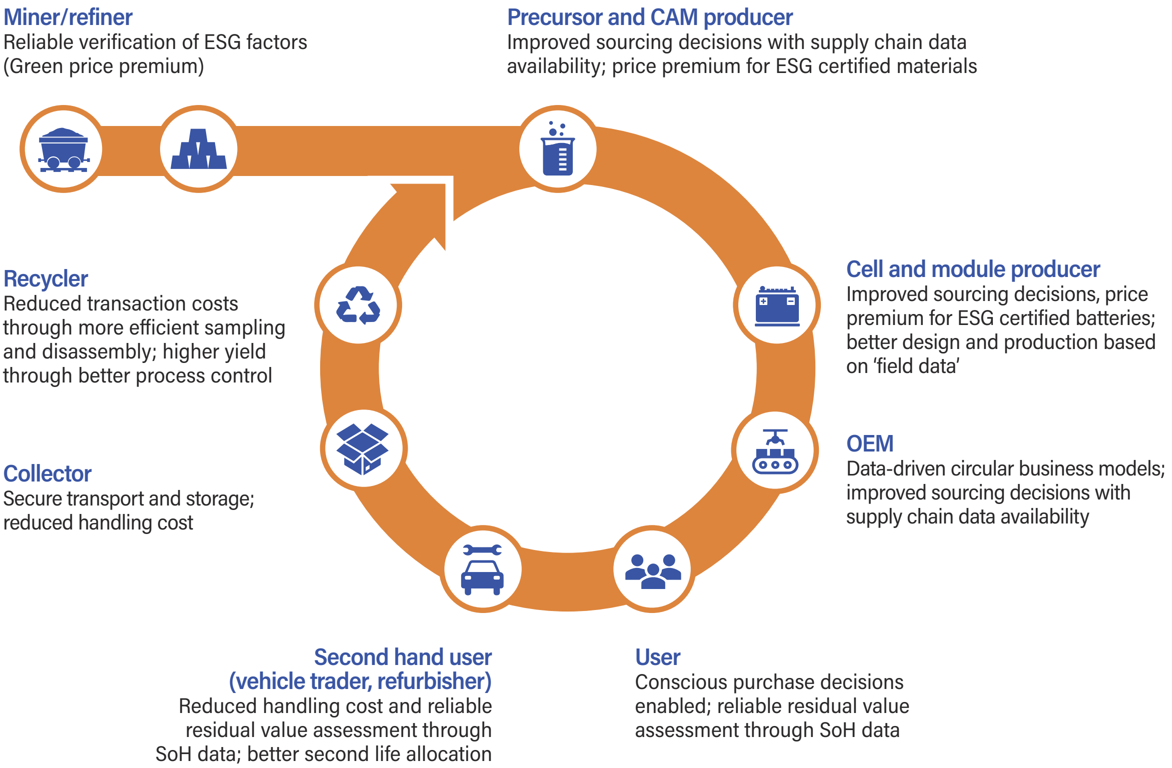
## BATTERY DATA MANAGEMENT

Effective data sharing and management are crucial for the proper handling and recycling of batteries. Currently, labeling is the most common method used, but given the material richness and recyclability of batteries, technical data storage throughout a battery's life cycle is essential for informed decision-making at various stages (Kumar et al. 2024).

In 2018, China introduced a unique identification number (UIN) for batteries, allowing information about each battery to be stored in an administrative platform. The EU, starting in 2027, will implement a battery passport system for batteries larger than 2 kWh. This system will provide detailed information about batteries, including their material origin, status, and carbon footprint, through a digital quick response (QR) code (EUR-Lex 2023).

In contrast, India lacks a comprehensive system for storage and sharing of battery data. Although the draft battery swapping policy includes a provision for battery UINs, it has not yet been implemented. The office of the Principal Scientific Advisor (PSA) in India has identified 34 research and development (R&D) sectors for an electric mobility roadmap, which includes a proposal for "Battery Aadhar", a traceability mechanism aimed at improving battery recycling efficiency in the country (Office of the PSA, GoI 2024).

**FIGURE 4** | **Benefits of battery data management**




*Note:*
CAM= Cathode active material
OEM= Original equipment manufacturer
ESG = Environmental, social, and governance.
SoH = State of Health.
*Source:* Battery Pass 2023.

## GROUP DISCUSSION OUTCOMES

The roundtable explored the following themes for discussion:

- The importance of battery circularity for India's critical material security
- Implementation challenges in the BWMR
- Challenges in developing an efficient reverse logistics mechanism for retired batteries
- Data collection and management techniques for battery circularity
- Standardization measures to enable a safe and efficient circular battery ecosystem
- Existing challenges in India's reuse and recycling market
- Public awareness and capacity-building requirements for an efficient circular battery ecosystem
- The need for stakeholder collaboration in establishing a sustainable and circular battery value chain

The deliberations from the roundtable led to the formulation of the following key enabling actions for battery circularity in India (see Figure 5).

**FIGURE 5 | Key enabling actions to enable battery circularity in India**

### POLICY SUPPORT

- Mandate necessary battery data sharing
- Assign nodal agency for data management
- Assign nodal agency for recycling activities
- Allocate land for recycling park
- Support reuse activities financially and technologically
- Promote circularity-integrated battery designs
- Provide value-addition-based financial incentives
- Facilitate technology transfers for efficient reuse and recycling technology
- Issue advisory for integrated policy support

### IMPLEMENTATION MEASURES

- Fully functional EPR porttal with audit function
- Third party validation of producer declarartions
- Chemistry-augmented EPR pricing
- Combined collection responsibility of recyclers and producers
- Unrestricted movement through state boundaries
- Critical mineral and waste battery traceability dashboard

### RESEARCH AND INNOVATION MEASURES

- Support mission-oriented R&D
- Support start-ups in the battery reuse and recycling industry
- Design an India-specific battery passport
- Develop indigenous recycling technology
- Develop enhanced efficiency and material purity technology

### SAFETY AND STANDARDIZATION MEASURES

- Develop standards for batteries in line with global standards
- Define reuse, refurbishing, repurposing, and remanufacturing activities
- Develop standards for battery collection, transportation, and storage
- Develop standards for shredding and electrolyte release

### ECOSYSTEM READINESS AND MARKET DEVELOPMENT

- Develop a marketplace for recycled battery material
- Provide international market access with G2G partnerships
- Develop a self-sustaining financing mechanism for reuse and recycling
- Develop an innovative business model for reverse logistics
- Design new skilling curriculums in accordance with the evolution of technology

### COLLABORATIVE PLATFORMS

- Facilitate efficient decision-making with murtual cooperation
- Promote process optiomization
- Address industry issues

*Note:* EPR = extended producer responsibility. G2G = government-to-government.

*Source:* Compiled by the authors

# KEY LESSONS AND ENTRY POINTS FOR ACTION

## Policy support

- Policies must be updated to keep pace with technological advances, particularly in battery management.
- LIBs are material rich, and their reusability depends on various data points across their life cycle. Stakeholders in the value chain understand the minimum data requirements for effective battery life cycle management. Effective battery repurposing relies on capturing and utilizing critical data, such as details regarding battery chemistry and battery health. Battery traceability is crucial for recovering valuable raw materials and ensuring environmental compliance in LIB recycling. Relevant battery data for life cycle management, along with specific technical battery information, also need to be captured.
- Manufacturers are concerned about data privacy. All stakeholders in the battery value chain should be incentivized to participate in data sharing through decentralized finance mechanisms, which would help distribute responsibilities as well as costs. A credible nodal agency must be identified to store and manage these data and oversee data management effectively.
- India faces a critical shortage of essential mineral feedstock, highlighting the need for strategic partnerships and free trade agreements (FTAs) with other countries to secure these vital resources. Recycling should be viewed as a resource management activity, with recyclers recognized as frontline entrepreneurs. Mapping and providing unique identities to recyclers will facilitate their access to government schemes and incentives.
- As manufacturing in India expands, managing virgin cathode and anode waste will become increasingly critical. Producers will need assistance in finding suitable recycling partners for this waste. In other countries, industrial parks have been established specifically for batteries, where companies producing cathode materials and cells, and recyclers operate within a 4–5 km radius. This approach enhances efficiency and collaboration. A geographic information system (GIS)-based mechanism should be developed to identify potential locations for recycling parks, that can function as dismantling plants. Many existing infrastructures can be repurposed to support the development of these parks.
- EVs should be designed with serviceability and recyclability in mind, and they should be rated based on these criteria. Incentives, taxes, and penalties could be introduced to encourage recycling-friendly designs. As new battery technologies such as solid-state batteries emerge, they should be designed for easier disassembly. Manufacturers using such technologies should be incentivized, through tax benefits or other rewards, to integrate recycling-friendly designs.
- Additionally, the economic viability of LIB recycling in India is uncertain. The prices of raw materials (LIB waste), which are sourced largely from the informal sector, fluctuate frequently. Also, disposal of the recycling residue into the environment after extracting precious minerals is a concern. Policies and government intervention are needed to create a more stable environment for recyclers.
- Extending the production linked incentive (PLI) scheme to both reuse and recycling, linked to the production of finished and value-added goods such as cathode active materials (CAMs), is important. Incentives under the PLI scheme should be based on the value addition to the supply chain from the recycling process. Although the PLI scheme primarily benefits larger actors, cluster development policies could support small and medium enterprises (SMEs) in this sector. The PLI scheme currently focuses on cell manufacturing, but attention should also be given to cathode materials and other aspects of the recycling value chain.
- Currently, the responsibility for activities related to battery circularity is divided among multiple government ministries. A single nodal agency is needed for comprehensive management of all related activities. Given that the Ministry of Heavy Industries (MHI) oversees EVs, placing LIB recycling under its jurisdiction would ensure a more integrated approach.

**Entry points for action:** The roundtable participants emphasized that collecting and sharing data is crucial for enabling battery traceability and informing decisions on reusability and recyclability. EV and battery OEMs suggested establishing a nodal agency to collect and distribute these data within a common secure framework. Stakeholders from both the reuse and the recycling industries highlighted the need to address policy and regulatory gaps in order to facilitate battery second-life applications and efficient recycling. Stakeholders from the battery recycling industry suggested that strategic integration of the recycling industry with the upcoming battery manufacturing industry is critical to the handling of production scrap as well as EoL waste. Dismantlability should be considered an inherent characteristic of batteries manufactured in India. Given the early stage of the LIB reuse and recycling industry, viability gap funding should be provided. The PLI scheme should be extended to the battery reuse and recycling industry. In view of the vital role of the reuse and recycling industry in ensuring critical mineral security and environmental benefits, a dedicated nodal agency should be established to oversee these activities.

### Enhancing effective implementation of the existing regulations

- In India, although regulations for battery recycling have been established, effective implementation is a key challenge. Whereas the central government is instrumental in formulating strategies, goals, and mandates, state governments play a crucial role in executing these policies on the ground.
- Addressing gaps in the EPR portal is vital to ensure smooth operations and maximize stakeholder benefits. The complete digital EPR module must be made functional; for example, the audit module is not yet operational. Annual audits alone are insufficient to identify and address poor practices. The EPR implementation is hampered by inconsistencies due to its reliance on self-declared data, which often do not match the reported figures. To address this problem, the EPR process should include validation and data verification measures for all data entered into the portal. Guidelines for environmental compensation, storage, transportation, and EPR pricing should be developed by studying practices in other countries. Although the government should avoid setting EPR prices directly, it must oversee the process. EPR credit pricing should reflect the varying profitability of battery recycling depending on battery chemistry. For example, nickel manganese cobalt (NMC) recycling is more profitable than lithium iron phosphate (LFP), and the EPR floor price should be adjusted accordingly.
- To enhance battery recycling, a mechanism is needed to enable consumers to return batteries directly to recyclers. Current e-waste collection is minimal, and we must avoid a similar situation in battery recycling. To boost collection efficiency, the collection process should involve both recyclers and producers.
- In reverse logistics, the use of tracking data is essential to overcome challenges in collecting, transporting, and storing retired LIBs. Improper handling can lead to hazards, so developing comprehensive guidelines to prevent accidents is critical.
- India currently lacks a public platform for declaring production waste, EoL waste, or second-life applications. It is necessary to establish a dedicated platform for waste management and disposal.
- Further, a national dashboard should be developed to track the availability of critical minerals within the country.
- Unrestricted movement of LIB waste across state boundaries must be ensured.
- Standard operating procedures (SOPs) and industry standards for LIB recycling, which are currently lacking, need to be established. As these standards evolve, it is crucial that their implementation be rigorous.

**Entry points for action:** The industry stakeholders identified implementation as the biggest challenge for the current regulations. They suggested improving the coordination between central and state government departments to streamline the implementation of national policies. For effective implementation, the recycling industry stakeholders suggested developing standards and SOPs for the collection, storage, and transportation of retired batteries. The EPR portal needs to be fully functional, and a proper audit mechanism needs to be set up to track discrepancies in the system. A scientific approach needs to be adopted for EPR pricing. A centralized platform should be established to report all waste containing critical minerals within the country and monitor the movement of those minerals. The capacities of state government stakeholders need to be enhanced to enable them to implement battery circularity systems and processes.

### Research and innovation for technology improvement

- India is a cost-effective hub for R&D in the recycling sector, but a greater focus on mission-oriented R&D is needed to achieve high technology readiness levels (TRLs). Integrating advanced technology with specific knowledge domains is crucial for effective advancement. To enhance its role in the global recycling market, India requires more targeted government support and initiatives. Also, incentives or grants should be provided to support private basic research initiatives.
- In the realm of cell technology, India has a strong foundation in the chemical industry, allowing competitive technologies to be developed at lower costs. Start-ups in India are working to translate research findings into marketable products by seeking venture capital investment.
- The battery passport concept, similar to the digital product passport, will help create a comprehensive data bank for tracking and managing batteries. Data sharing is challenging due to trust issues. Blockchain technology can ensure data immutability, transparency, and interoperability. When designing battery passports for India, it is crucial to create a system tailored to the country's specific needs. Some progress related to battery passports has already been made in establishing battery swapping standards in collaborations between R&D labs, industry, and academia.
- There is substantial market potential for second-life batteries, as evidenced by the growing number of industry players developing related products, assessing their value, and creating software solutions. This indicates a strong interest within the broader ecosystem to capitalize on these opportunities. However, technological and innovation support from the government is essential to fully realize this potential.
- Circular economy and mineral security aspects are crucial and must be addressed simultaneously. Understanding the nuances of virgin versus recycled materials is important. Battery recycling technology should be chemistry agnostic, and the industry must develop a clear roadmap for technological advances in LIB recycling. Although India has advanced battery recycling technologies, there is room for improving the extraction efficiency and the purity of the recovered minerals. The environmental impact of unmanaged cobalt and lithium waste is a concern and needs to be assessed accurately through further studies. In recycling R&D, a pilot plant could serve as the baseline for process development.
- Currently, recycling units often crush the products, which makes the process inefficient. Instead, dismantling should be prioritized to enhance recyclability. Reuse and recycling friendly technologies, which involve a series of process steps, can be further improved for better efficiency.
- The Department of Science and Technology (DST) can support R&D projects to address technological gaps. Key areas for development include direct extraction methods for anode and cathode materials and innovative solutions to reduce environmental pollution. In addition, DST can support the development of standards and technological innovations to advance these goals. The Ministry of Mines has issued notifications to support start-ups with innovative technologies for material extraction and mineral processing, and similar support can be planned for battery reuse and recycling.

**Entry points for action:** The roundtable participants emphasized that because domestic cell technologies are advancing, India has the potential to excel in the global market, especially with the support of upcoming start-ups. They suggested developing innovative solutions for battery passport and battery refurbishment/remanufacturing to meet India's specific needs. At the end of the batteries life cycle, an efficient reverse logistics mechanism, together with supporting infrastructure, needs to be developed for India. Given the material criticality and environmental sustainability requirements, India should work on developing innovative chemistry-agnostic recycling technologies for widespread industrial adoption. The participants also highlighted India's potential as a low-cost R&D hub, suggesting that the battery recycling industry should take advantage of this by identifying research needs crucial for effective and innovative recycling operations.

### Safety and standardization measures

- The manufacturing, design, and testing of battery cells must adhere to global standards. To ensure quality and safety, it is crucial that batteries assembled in India meet these standards. To improve the relevance of these standards in battery recycling, it is important to distinguish between recycling, refurbishing, reusing, and repurposing, which are separate processes. For example, UL 1974 is a standard developed by UL Standards and Engagement  a safety and sustainability science company, specifically for battery repurposing.
- Understanding the distinctions between recycling, refurbishing, reusing, and repurposing will help refine standards for extraction efficiency and material purity while minimizing the environmental impact. Standards for battery operations and maintenance are necessary, and there is a need to develop standards for various aspects of battery management, including transportation, shredding, and electrolyte release. Although creating standards for packaging and transportation may be a complex task, efforts are underway to address the same. The existing standards for hydrometallurgy and shredding can be adapted for battery applications, eliminating the need to start from scratch.
- Due to the rapid evolution of technology, it is impractical to develop detailed standards at the beginning. Instead, high-level standards should be established initially, with the flexibility to adapt as the industry matures.

**Entry points for action:** The participating stakeholders, especially those from the reuse and recycling industry, highlighted the need to establish quality and safety standards for batteries assembled in India. Creating standards for the reverse logistics process, particularly in transportation and storage, is crucial for the adoption of best practices under the BWMR in India. They suggested that when developing these standards, it is important to differentiate between battery reuse, refurbishment, repurposing, and recycling.

### Ecosystem readiness and market development for battery circularity

- It is important to uphold a free-market approach with minimal intervention in the international operation of the recycling market, ensuring unrestricted movement of goods for import and export. Government-to-government (G2G) partnerships are also necessary.
- For an effective LIB recycling ecosystem in India, several actions are needed: providing long-term business clarity and certainty from the government and eliminating import duties on LIB waste to acknowledge its value as a resource. Because pricing and value regulations can distort the recycling market, the government should focus on establishing frameworks for business activities rather than directly regulating them.
- The LIB recycling industry should expand beyond merely producing black mass to include commercializing processes for metal extraction. Alongside building recycling capacity to recover battery-grade materials from retired LIBs, there is a parallel need to create a market for these materials by advancing LIB manufacturing. This involves establishing a marketplace for recycled and refurbished products, implementing a battery passport system, developing a pricing module for EoL and production waste, and setting standards for output materials.
- Shifting from mandated to incentivized approaches is crucial. One potential initiative is the PLI scheme for recycling. Currently, recycling operates under a liability model, but it should be transformed into a self-sustaining system. Subsidies cannot be provided indefinitely; hence, a self-sustaining incentive mechanism should be created through a sustainable business model.

- The costs associated with reverse logistics processes are significant, impacting the overall recycling value chain. Although the BWMR set targets for producers, often recyclers bear the associated costs. In addition, transporting certain types of scrap is costly, necessitating the development of business models to mitigate financial losses.
- Currently, there is a lack of public data on battery waste, which coupled with widespread lack of awareness, funnels batteries into the informal waste stream. The reverse logistics supply chain in India predominantly involves the informal sector, making it crucial to integrate informal players (such as informal scrap dealers) into the formal system. Reducing taxes could help shift more activity from the informal to the formal sector, thereby enhancing material circularity.
- Skill development across all levels, including the government, industry, academia, and other stakeholders, is vital, given the complexity and challenges of LIB reuse and recycling. Establishing adequate labs for battery-related training and testing is necessary to improve battery diagnostics mechanisms. Raising awareness about EV battery EoL management is crucial, particularly at the grassroots level among students and micro, small, and medium enterprises (MSMEs).
- There is also a pressing need to address the shortage of electro-tech engineers, who play a critical role in advancing battery technology. Although some academic research exists, commercial applications remain underdeveloped. Building awareness, facilitating data exchange, and strengthening governance and accountability systems will be crucial for supporting this evolving sector.

**Entry points for action:** The roundtable participants emphasized intergovernmental cooperation among countries for free movement of retired batteries in the international market. Providing a long-term import license will help the industry players set up import-based recycling businesses. They suggested integrating domestic material refining capacity with black-mass-recovering industries to ensure production of value-added goods. Safe applications need to be identified where recycled and refurbished products can be utilized without any safety challenges. Raising awareness about unsafe LIB handling practices and skilling informal sector workers are vital for designing a safe circular battery ecosystem. Skill set requirements should be mapped and technical curriculums designed, to align with anticipated technological advances.

### Stakeholder coordination and the need for a collaborative platform

- A collaborative platform would give the smaller industry players a voice and help entrepreneurs with promising technologies navigate the market. It would also address challenges, such as data availability, material evaluation, value enhancement, and data sharing. By focusing on specific problems such as second-life applications, the platform can promote data transparency, and bridge mobility and energy transitions.
- At present, there is a significant disconnect between the industry, academia, and the government, leading to prolonged development timelines for clean energy technologies. The government must align its initiatives with industry needs. Academia often bears the responsibility of identifying and resolving the industry's issues single-handedly. For academia to effectively tackle industry's challenges, it must closely align with the industry's requirements, and a close partnership is required to solve these problems efficiently. Strong collaboration between industry and the government is vital for advancing new recycling technologies.
- To develop effective policies and regulations, collaboration between the industry and the government is crucial. The supply chain involves diverse actors with varying capacities; hence, any policy design must account for this diversity and provide appropriate support.
- To effectively manage battery circularity and reverse logistics, it is essential to bring together all the stakeholders, including battery and EV OEMs. A collaborative platform will help ensure that the system functions as intended. It will also enhance the system by streamlining data and information sharing among stakeholders. India's data scarcity leads to suboptimal decision-making, highlighting the

need for effective policy execution. The platform should enable efficient decision-making and resolve industry constraints by bringing stakeholders together for optimal business operations. Demonstrating success through pilot projects involving all the stakeholders will further validate the platform's approach and benefits.

- International cooperation is also essential for engagement at various levels, scales, and across sectors, which will bring in investments and foster technical advances.
- Such a platform will help stakeholders understand each other's challenges, align their efforts, and coordinate on various issues. It would enable capacity-building, cross-learning, and the adoption of global best practices, while also contextualizing solutions for India. Setting a common goal will motivate stakeholders to work toward a unified objective, demonstrating the value of investing in battery circularity. Stakeholder participation is crucial for any such initiative. A collaborative platform will give the smaller industry players a voice and help entrepreneurs with promising technologies navigate the market.

**Entry points for action:** The stakeholders emphasized that effective coordination among all of them is essential for making informed decisions regarding policy formulation, technological advancement, and market development in the battery industry. Given that the industry spans multiple sectors across the value chain, collaboration is especially important. Academia and government can play key roles in supporting the industry to achieve these goals. The stakeholders suggested that establishing a shared platform will help them communicate with each other and identify collaboration opportunities. This will give all of them a voice. A collaborative platform will also promote trust and transparency among stakeholders and streamline data and information, ensuring that the system functions as intended.

## NEXT STEPS

The stakeholders participating in the roundtable consultations offered the following recommendations to develop a sustainable and circular battery ecosystem in India:

- India needs to implement an advanced data management mechanism to track battery and battery lifecycle data from production to disposal.
- The government should encourage the development of technology and innovative business models for battery circularity through technology transfers and partnerships with other countries.
- To ensure consistent implementation of regulations, the central regulating body should provide high-level jurisdiction to state governments, based on which the governments can develop their own action plans.
- A strategic and data-driven reverse logistics model for India should be developed to address the anticipated manufacturing and EoL waste requirements.
- Basic standards and processes to promote battery circularity should be implemented at all levels of the battery value chain, with the flexibility to further tighten these measures as the industry matures and technology improves.
- Regulations and taxes in the formal recycling sector should be relaxed to support the integration of informal recyclers into the formal sector. Voluntary skill development programs, offered through corporate social responsibility (CSR) initiatives, can provide opportunities to integrate informal players into the formal value chain.
- Stakeholders should collaborate to promote battery circularity and ensure India's mineral security, fostering cooperation and knowledge exchange through a neutral platform.

## PARTICIPANTS

**K. Balasubramanian,** Director, NonFerrous Materials Technology Development Centre (NFTDC)

**Thirupathy Srinivasan,** Lead, Tamil Nadu EV Taskforce

**Suresh Babu,** Scientist 'E', Department of Science and Technology (DST), India

**Gaurav Dolwani,** CEO, LICO Materials Pvt. Ltd.

**Utkarsh Singh,** CEO, BatX Energies Pvt. Ltd.

**Rashi Gupta,** Founder & MD, Vision Mechatronics Pvt. Ltd.

**Abhijit Pegu,** CEO & Founder, LW3 Pvt. Ltd.

**Santhosh Kumar J,** Founder & Director, Li-Circle

**Prashant Rathee,** Cofounder, The Energy Company

**Darshan Virupaksha,** Cofounder, Nunam

**ALN Rao,** Independent Consultant

**Bhuwan Purohit,** Executive Director, Rubamin Pvt. Ltd.

**Pratyush Sinha,** VP – Special Projects, LOHUM Cleantech Pvt. Ltd.

**Abhinav Mathur,** Head – Strategy, Attero Recycling Pvt. Ltd.

**Parveen Kumar,** Head – R&D, Exigo Recycling Pvt. Ltd.

**Subrata Mitra,** Head – Government Relations and Policy, Ather Energy Limited

**Amit Singh,** Head – New Initiatives, Altigreen Propulsion Labs Pvt. Ltd.

**Dinesh Sekar,** Senior Manager, Amara Raja Advanced Cell Technologies Private Limited

**Sikander Sindhu,** Senior Manager, Ola Electric Technologies Pvt. Ltd.

**Vinoth Kumar R.,** Deputy Manager, SWITCH Mobility Automotive Ltd.

**Chetan Gunjal,** Sales & Marketing Manager, Maestrotech Systems Pvt. Ltd.

**Aradhana Patel,** SAP Business Intelligence (BI) & Advanced Business Application Programming (ABAP) Developer, Reliance Industries Limited

**Anuj Sharma,** Assistant Manager, SungEel India Recycling Pvt. Ltd.

**Abhijit Sen,** Scientist, Thermo Fisher Scientific Inc.

**Siddhartha Mukhopadhyay,** Professor, IIT Kharagpur

**Ganesh Madabattula,** Assistant Professor, IIT (BHU), Varanasi

**Avanish Tripathi,** Assistant Professor, IIT Delhi

**Abhishek Mishra,** Advocate, Supreme Court of India

**Gayatri Jain,** DVP, HDFC Bank

**Akshat Verma,** Assistant Director, Society of Indian Automobile Manufacturers (SIAM)

**I.V. Rao,** Distinguished Fellow, The Energy and Resources Institute (TERI)

**Amrita Goldar,** Senior Fellow, Indian Council for Research on International Economic Relations (ICRIER)

**Anjali Singh,** Senior Fellow, ICRIER

**V. Manjunath,** Regional Standards Manager, UL Standards & Engagement

**Priyami Dutta,** Policy Advisor, International Institute for Sustainable Development (IISD)

**Narayankumar Sreekumar,** Associate Director, Shakti Sustainable Energy Foundation

**Trupti Deshpande,** Senior Program Manager, Shakti Sustainable Energy Foundation

**Balaji Raparthi,** Senior Program Manager, Shakti Sustainable Energy Foundation

**Rishabh Sethi,** Program Manager, Shakti Sustainable Energy Foundation

**Jennifer Layke,** Global Director, World Resources Institute

**Pawan Mulukutla,** Executive Director, WRI India

**Chaitanya Kanuri,** Program Associate Director, WRI India

**Parveen Kumar,** Program Head – Sustainable Batteries, WRI India

## ABBREVIATIONS

**BMS:** Battery Management System

**BWMR:** Battery Waste Management Rules

**CAM:** Cathode Active Material

**CPCB:** Central Pollution Control Board

**CSR:** Corporate Social Responsibility

**DST:** Department of Science and Technology

**EoL:** End of Life

**EPR:** Extended Producer Responsibility

**EU:** European Union

**EV:** Electric Vehicle

**FTA:** Free Trade Agreements

**G2G:** Government to Government

**GIS:** Geographical Information System

**GoI:** Government of India

**GST:** Goods and Services Tax

**KABIL:** Khanij Bidesh India Limited

**LAB:** Lead Acid Battery

**LIB:** Lithium-ion Battery

**LFP:** Lithium Iron Phosphate

**MHI:** Ministry of Heavy Industries

**MoEFCC:** Ministry of Environment, Forest and Climate Change

**MSP:** Mineral Security Partnership

**MSMEs:** Micro, Small, and Medium Enterprises

**NMC:** Nickel Manganese Cobalt

**OEM:** Original Equipment Manufacturer

**PIB:** Press Information Bureau

**PLI:** Production Linked Incentive

**PSA:** Principal Scientific Advisor

**R&D:** Research and Development

**SOH:** State-Of-Health

**SOP:** Standard Operating Procedure

**SMEs:** Small and Medium Enterprises

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## ACKNOWLEDGMENTS

We thank Pawan Mulukutla, Executive Program Director, and Chaitanya Kanuri, Program Associate Director, WRI India, for their guidance and support. We also extend our gratitude to all the experts who participated in the roundtable for their valuable inputs toward enabling battery circularity with policy and regulatory suggestions and implementation strategies in India and for making the event successful. We appreciate the efforts of our colleagues, Anindita Bhattacharjee and Santhosh Mathew Paul for editorial support, and Safia Zahid for design support.

## FOR MORE INFORMATION

**Parveen Kumar,** Program Head, Sustainable Batteries.
Contact: Parveen.Kumar@wri.org

**Mitradev Sahoo,** Junior Program Associate.
Contact: Mitradev.Sahoo@wri.org

## ABOUT WRI INDIA

WRI India, an independent charity legally registered as the India Resources Trust, provides objective information and practical proposals to foster environmentally sound and socially equitable development. Our work focuses on building sustainable and livable cities and working toward a low carbon economy. Through research, analysis, and recommendations, WRI India puts ideas into action to build transformative solutions to protect the earth, promote livelihoods, and enhance human well-being. We are inspired by and associated with the World Resources Institute (WRI), a global research organization. Know more: www.wri-india.org

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LGF, AADI
2 BALBIR SAXENA MARG
HAUZ KHAS
NEW DELHI 110016, INDIA
WRI-INDIA.ORG