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STRENGTHENING INDIA'S BATTERY WASTE MANAGEMENT POLICIES FOR ELECTRIC VEHICLES: LEGAL PERSPECTIVE

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ABSTRACT

Climate Change is one of the most spoken topics globally for the past decade, every country comes up with new policies to overcome the effects of climate change and the ultimate goal as agreed in the Paris Agreement (2015) is to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels." It is a proven fact that fossil fuel is the largest contributors to climate change, accounting for over seventy-five per cent of global greenhouse gas emissions. Transportation is a significant facet of this, which accounts for nearly one-quarter of Global Greenhouse gas emissions. To curb the emissions caused by road transportation, conventional vehicles run by fossil fuels are being replaced with electric vehicles globally. India, being a developing country, has embarked on this technology, and the Government is coming up with new policies and investment upsurges to develop new technologies. The pace of transition is rapid and necessitates equal swift solutions to the problems arising consequently. This paper analyses the legal framework in India and government policies to combat the challenges of battery waste of electric vehicles.

1. INTRODUCTION

Globally, the adoption of electric vehicles surges exponentially. Electric vehicles (EVs) have the potential to solve interrelated problems such as air pollution, depletion of non-renewable energy sources, increasing oil prices, rising oil imports, and demands for "green" development¹. The Government of India has set an ambitious target of 30% EV penetration by 2030². As of July 08, 2024, India saw a 16% rise in EV registrations in the first half of 2024, compared to the same period in 2023. This upward trajectory not only underscores the nation's commitment towards sustainable transportation but also reflects the growing consumer confidence and market readiness for greener alternatives on Indian roads. As of June 06, 2024, India has 16,344 public charging stations, including 7,471 public charging points, and 10,756 fast charging points, boosting EV adoption³. These targets and outcomes also imply the growing need for batteries. Industry journals estimate that Indian demand for EV lithium batteries will surge to 139 GWh by 2035, a jump from 4GWh in 2023. Most of the demand increase is projected to come from the economically vital light vehicle segment⁴. An initiative or a scheme will always have synergies and trade-offs; the success of the scheme lies in balancing the two. Likewise, the adoption of electric vehicles has certain drawbacks, amongst which the recycling of batteries and waste battery management occupies a significant portion. Policies and legal frameworks that are drafted must balance these.

Most of the studies concerning battery waste management have been conducted in China, which dominates the EV market globally by producing major raw materials for battery manufacturing and in the U.S.A. and developed European countries. Study by Guzek et al., (2024) on environmental aspects

¹ L.W. Bradley, *From Early Adopters to Early Quitters*, *Nat. Energy* 1–2 (2021)

² *Electric Vehicles*, Principal Scientific Adviser, <https://www.psa.gov.in/mission/electric-vehicles/36> (last visited February 5, 2025).

³ Press Information Bureau, *Government Launches New Electric Vehicle Initiative* (July 4, 2024),

https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=151933&ModuleId=3®=3&lang=1#_ftn1 (last visited February 5, 2025).

⁴ International Trade Administration, *India Electric Vehicle Battery and Storage Trends* (Feb. 15, 2025), <https://www.trade.gov/market-intelligence/india-electric-vehicle-battery-and-storage-trends>.



associated with the lifecycle of an electric vehicle concluded that the design stage makes for an important consideration, as the materials and raw materials selected should be recyclable to the greatest extent possible and later reused. In addition, the rare minerals and earth elements used constitute a need to adopt an appropriate system for their acquisition and distribution. Energy input is still required in the EV production phase. Recycling battery waste must be concentrated to increase the efficiency of EVs. S. Jiang et al., (2022) note the importance of the recovered lithium could meet 60% of the lithium demand for LIBs produced by 2050.

Studies conducted in India focused on policy noted that high initial price, driving range anxiety, lack of proper charging infrastructure, and underdeveloped battery technology are the main challenges in introducing Electric vehicles (Kumar et al., 2021). Another study conducted was Focused on India's EV policy and assumptions about the share of LABs and NCX batteries, with relation to projecting the number of EV vehicles, spent batteries, and the environmental impact of recycling EVs in India by applying methods like Gompertz Curve, Weibull Distribution, etc. reveals that the spent LAB waste will peak in 2027 while the spent LIB waste from two-wheelers and four-wheelers will accelerate from 2020 and the problem of battery waste in India will emerge sooner than in most developed countries because of the unique characteristics of the transport system in India i.e., the dominance of two-wheelers (Vivek et al., 2022). Another study observed the challenges in recycling batteries in India and opportunities for the transition of the Indian economy towards an emission-free circular economic model (Kala et al., 2021). A SWOC analysis was conducted to evaluate the strengths, weaknesses, opportunities, and challenges of EV implementation, and the results showed that India will benefit from central policies that provide incentives to support the national EV market in terms of both supply and demand but the study lacked the

analysis of frameworks regarding battery waste management in India (Singh et al., 2021). Relevant policies of the Government of India concerning electric vehicles (including battery electric vehicles, hybrid electric vehicles, plug-in hybrid electric vehicles, and fuel cell electric vehicles), the legal frameworks on waste battery management were analyzed and a doctrinal methodology is followed in the paper. The paper aims to answer the following questions

- What are the challenges of electric vehicles?
- Are the policies and initiatives undertaken by the government of India sufficient to solve the problems of electric vehicles regarding battery waste management?
- Are the Waste Battery Management Rules, 2022 effective in ensuring sustainable battery waste management in India?

2. ENVIRONMENTAL IMPACTS OF ELECTRIC VEHICLES

Electro-mobility offers a major opportunity to solve the external negative effects associated with internal combustion engines, without constraining the vital role of vehicles⁵. However, the transition and popularization of electric vehicles cause certain problems. Undoubtedly, the advantages of EVs include zero emissions of pollutants and noise in the tank-to-wheel phase. However, there are environmental concerns that include the impact of EVs on the environment during the production phase, the purity of the electricity used to charge these vehicles, and the risks associated with recycling.

Therefore, it is imperative to study the life cycle assessment of electric vehicles. The period from the sourcing of materials, production, assembly, operation and disposal of the vehicle is referred to as their life cycle. By considering the life cycle of a vehicle, it is possible to have a closer look at the emissions at each stage of the cycle (LCA method—Life Cycle Assessment) and to estimate the total cost (LCC—Life

⁵ M. Noon, *EVUE Electric Vehicles in Urban Europe, Vehicule Electrice în Europa Urbană* (2012).



Cycle Cost)⁶. LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave)⁷. The LCA includes the following stages⁸:

- Design stage;
- The manufacturing stage, which also includes the extraction of raw materials, the manufacture of components and parts;
- The stage of assembling the vehicle and transporting it to the storage facility or the end user;
- The operational phase, consisting of the use and maintenance of the vehicle;
- The disposal stage, including dismantling, sorting, partial reuse, recycling, or landfilling.

2.1 MANUFACTURING OF EV BATTERIES

In the production of a complete vehicle, the Internal Combustion Vehicle (ICEV) has about 60% lower CO₂ emissions than electric vehicles⁹. This is mainly due to the pollution caused by the manufacturing of Batteries. As batteries are made of elements like Lithium, Cobalt, Nickel, Copper, Graphite, Zinc, and other rare earth metals and others, the mining process to extract these metals from ores and minerals, and the production of batteries involve high emissions of greenhouse gases.

While India is not rich in domestic reserves of minerals such as lithium, manganese, and cobalt that

many of today's common EV batteries require, India is building manufacturing capabilities that capture a significant portion of the value chain in this sector, as other countries are doing. Besides China, India also imports EV batteries from Japan and South Korea. According to the economic survey (2024-2025), "India sources 75 per cent of lithium-ion batteries from China." The economic survey expects the demand for lithium-ion batteries to grow at a CAGR of 23% by 2027. The need for lithium-ion batteries and the government's investments in building battery manufacturing units highlight the threat of environmental degradation, as the manufacturing process generates significant emissions, and steps must be taken to mitigate this. A study comparing EV and ICE emissions found that 46% of EV carbon emissions come from the production process¹⁰. There are also concerns about the depletion of resources, such as rare earth metals, through the mining and manufacturing processes of battery production.

2.2 OPERATIONAL PHASE OF EV

In the use phase, the environmental performance of EVs is strongly dependent on the size and energy capacity of the battery, and the type and method of power generation used to charge the battery¹¹. Currently, India's power source mix is topped by coal (47.40%), and around 50% of India's electricity is generated through the burning of fossil fuels¹². During the use of EVs, an important issue is how the electricity is produced, as this is the main cause of the environmental impact of EVs during the operational

⁶ M. Guzek et al., *Electric Vehicles—An Overview of Current Issues—Part 1—Environmental Impact, Source of Energy, Recycling, and Second Life of Battery*, **Energies** 17, 249 (2024).

⁷ Int'l Org. for Standardization, **ISO 14044:2006, Environmental Management – Life Cycle Assessment – Requirements and Guidelines** (2006), <https://cdn.standards.iteh.ai/samples/38498/17324bfe9ec44e27a2f84e1a8ac3ca26/ISO-14044-2006.pdf>.

⁸ M.Z. Hauschild, R.K. Rosenbaum & S.I. Olsen, *Life Cycle Assessment* (Springer Int'l Publ'g 2018).

⁹ Qiao Q., Zhao F., Liu Z., Jiang S. & Hao H., *Comparative Study on Life Cycle CO₂ Emissions from the Production of Electric and Conventional Vehicles*

in China, 105 **Energy Procedia** 3584, 3584–3595 (2017).

¹⁰ Ricardo Energy & Environment, *Life Cycle Assessment of Electric and Internal Combustion Engine Vehicles*, **Fuels Inst.** (2021).

¹¹ R. Faria et al., *Impact of the Electricity Mix and Use Profile in the Life-Cycle Assessment of Electric Vehicles*, 24 **Renew. Sustain. Energy Rev.** 271, 271–287 (2013).

¹² NITI Aayog, **Electricity Generation**, India Climate and Energy Dashboard, <https://iced.niti.gov.in/energy/electricity/generation> (last visited February 5, 2025).



phase. Only when electricity used to charge the batteries is clean and essentially free of CO₂ emissions will electric vehicles be able to realise their full potential in reducing greenhouse gas emissions from transport. It is indeed for India to focus more on energy transition by generating electricity from cleaner sources like nuclear energy and other renewable energy sources.

2.3 EV BATTERY RECYCLING AND DISPOSAL

Lithium-ion batteries (LIBs) have emerged as the battery of choice used in electric vehicles (including battery electric vehicles, hybrid electric vehicles, plug-in hybrid electric vehicles, and fuel cell electric vehicles) as a result of the continuing process of improvement and refinement of energy storage devices¹³. Until 2020, India did not manufacture lithium-ion (Li-ion) cells, which were imported from China or Taiwan for assembly in India. Assembled battery packs were also being imported. India imported US\$1.23 billion worth of Li-ion batteries between 2018 and 2019¹⁴. Lithium-ion batteries are the cornerstone of modern electric vehicles (EVs), known for their high energy density, relatively long life cycles, and reliability. With these qualities, lithium-ion batteries provide vehicles with sufficiently high torque to achieve high speeds and a relatively long driving range. Li-ion batteries are rechargeable and designed to last for a long time: a Li-ion battery can perform between 500 to 10,000 cycles of charging and discharging.¹⁵

These batteries can be recycled or used in other applications. Recycling provides opportunities for reusing products, securing the supply chain, and overcoming dependency on imported raw materials. The recycling process becomes particularly important as it is estimated that the demand for key raw materials that are essential for battery production will increase, while their availability will decrease due to finite or exhaustible resources¹⁶.

EV battery waste poses a serious threat to the natural environment, and improper disposal of these wastes pollutes the environment, including the release of toxic chemicals. Eminent recycling technology is necessary in the present scenario to avoid pollution of the environment. At the same time, these batteries contain valuable rare earth metals which are sources to manufacture electrical and electronic equipment.

Recently, India, in its net-zero pledge, has increased the target of renewables to 500 GW and aims to make renewables account for 50 per cent of the total energy mix by 2030. These ambitious targets will certainly make India a significant consumer of LIBs. To make the supply chain of EV batteries sustainable, India needs to work on several aspects, like recycling and strengthening energy security¹⁷.

Thus, the answer to the first question is electric vehicles pose serious threats to the environment in its life impact assessment and the pollution caused is not less than the conventional vehicle. Nevertheless, these

¹³ Z. Said, A.A. Alshehhi & A. Mehmood, *Predictions of UAE's Renewable Energy Mix in 2030*, 118 **Renew. Energy** 779, 779–789 (2018).

¹⁴ Saurabh, *Indian Company Plans 10-Gigawatt Lithium-Ion Battery Plant*, **CleanTechnica** (July 17, 2019), https://cleantechnica.com/author/saurabh/page/24/#google_vignette.

¹⁵ U.N. Dep't of Econ. & Soc. Affs., *Frontier Technology Issues: Lithium-Ion Batteries: A Pillar for a Fossil Fuel-Free Economy?* (July 2021), https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/FTI_July2021.pdf.

¹⁶ A. Pražanová, V. Knap & D.-I. Stroe, *Recycling of Lithium-Ion Batteries from Electric Vehicles. Part I: Recycling Technology: Literature Review*, 15 **Energies** 1086 (2022).

¹⁷ Tom Moerenhout et al., *Understanding Investment, Trade, and Battery Waste Management Linkages for a Globally Competitive EV Manufacturing Sector*, **Indian Council for Research on International Economic Relations (ICRIER)** (Apr. 2022), https://www.icrier.org/pdf/Understanding_Investment_Trade_and_Battery_Waste_Management_Linkages_for_a_Globally_Competitive_EV_Manufacturing_Sector.pdf.



negative impacts can be mitigated if steps like the use of renewable sources of energy in charging the batteries and proper recycling of the battery is done to improve the efficiency of EVs paving the way for a sustainable circular economy.

3. INDIA'S ELECTRIC VEHICLE POLICY

In (2010-12), the Ministry of New and Renewable Energy (MNRE) incentivized the purchase of electric vehicles through its Alternate Fuels for Surface Transportation Program (AFSTP) scheme which had an outlay of Rs 95 crores¹⁸. The government of India approved the National Mission on Electric Mobility in 2011 and subsequently, The National Electric Mobility Mission Plan (NEMMP) 2020 was unveiled in 2013. NEMMP is a National Mission document providing the vision and the roadmap for the faster adoption of electric vehicles and their manufacturing in the country. This plan has been designed to enhance national fuel security, to provide affordable and environmentally friendly transportation and to enable the Indian automotive industry to achieve global manufacturing leadership¹⁹.

As a part of the mission, The Department of Heavy Industry Enterprises under The Ministry of Heavy Industry & Public has formulated the FAME-India, (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India) scheme intending to support the xEV market development and its manufacturing ecosystem to achieve self-sustenance²⁰. This phase of FAME India Scheme had four focus areas i.e. technological development, demand generation, pilot project and charging

infrastructure components²¹. FAME works in different phases, the PHASE-1 of the scheme functioned from April 2015 to March 2019 with a total budget allocation of Rs.895 Crore. The scheme significantly provided incentives for buyers through an upfront reduction in purchasing price, where the subsidiary amount is deducted from the price of the vehicle directly. The scheme provides demand incentives for different categories of hybrid and electric vehicles based on their technology and battery specifications. The 1st phase of the scheme, was successful in adoption of electric vehicle in India.

The 2nd phase of this scheme began in April 2019 and extended till March 2024, with total budget of Rupees 10,000 Crore²², where 86% fund had been allocated for demand incentives. The Phase-II of FAME India Scheme was implemented through three components, Demand Incentives, Establishment of network of Charging Stations and Administration of Scheme including Publicity, IEC (Information, Education & Communication) activities²³.

Under this phase, major emphasis was placed on electrification of public transportation that includes shared transport. Around 4,69,315 Electric Vehicles have been supported by way of Demand Incentive amounting to about Rs. 1869 crores (as on July 11, 2022). 6315 e-buses sanctioned to 65 cities/STUs/CTUs/ State Govt. entities for intracity and intercity operations across 26 states/UT under the Scheme. 2877 charging stations sanctioned in 68 cities across 25 states/UTs, 50 Original Equipment Manufacturers (OEMs)²⁴, both start-up and

¹⁸ Dep't of Heavy Indus., *National Electric Mobility Mission Plan 2020*, **Ministry of Heavy Indus.** (Aug. 2012), <https://heavyindustries.gov.in/sites/default/files/2023-07/NEMMP-2020.pdf>.

¹⁹ Gov't of India, Ministry of Heavy Indus. & Pub. Enters., *Implementation of National Electric Mobility Mission Plan*, **Press Information Bureau** (July 8, 2019), <https://pib.gov.in/newsite/PrintRelease.aspx?relid=191337>.

²⁰ Dep't of Heavy Indus. Enters., *Revised General Operating Guidelines for Registration of OEMs and Vehicle Models*, F21(37)/NAB/DIDM/2014 (Apr. 27, 2015).

²¹ *Ibid.*

²² *ibid*

²³ Ministry of heavy industries and public enterprise, S.O. 1300(E) (notified on 8th March 2019)

²⁴ **Press Information Bureau**, Ministry of Heavy Indus., *Electric Vehicles Manufacturers Registered Under FAME-India Scheme Phase-II* (Mar. 15, 2022),



established manufacturers, have registered and revalidated their 106 electric vehicle models and Sale of electric two wheelers vehicles have increased manifold²⁵.

The government has approved the Production Linked Incentive (PLI) Scheme for Automobile and Auto Components Industry in India 2021 for Enhancing India's Manufacturing Capabilities for Advanced Automotive Products with a budgetary outlay of Rs. 25,938 crores²⁶. This scheme functions in two parts, Champion OEM Incentive Scheme and Component Champion Incentive Scheme. Under Champion OEM (Original Equipment Manufacturer) Incentive Scheme, incentives are given to manufacturers of Battery Electric Vehicles and Hydrogen Fuel Cell Vehicles of all segments and under the Component Champion Incentive Scheme, incentives are provided to manufacturers of pre-approved Advanced Automotive Technology components of all vehicles²⁷.

The Government of India, Ministry of Power, launched the "Go Electric" Campaign on 19th February 2021. The objective of this campaign is to create awareness among the masses about the benefits of switching over to Electric Vehicles (EVs), including various initiatives taken by the Centre & State Governments to enhance the acceptability of Electric Vehicles, and Electrical Cooking²⁸.

After the review of FAME policies, to maintain continuity of support for electric two-wheelers (e-2Ws) and electric three-wheelers (e-3Ws), MHI launched the Electric Mobility Promotion Scheme

2024 (EMPS-2024) with an outlay of ₹500 crore, which was subsequently enhanced to ₹778 crore, for the period from 1st April 2024 till 30th September 2024. Further, after review of FAME-II and EMPS-2024, Ministry of Heavy Industries (MHI) formulated PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) scheme with an outlay of ₹10,900 crore, shall be implemented from 1st October 2024 to 31st March 2026, for faster adoption of electric vehicles (EVs), setting up of charging infrastructure and development of EV manufacturing eco-system in the country by providing Demand incentives for electric vehicles including e-ambulances, Grants for creation of capital assets like e-buses, establishment of network of charging stations & upgradation of testing agencies identified under this Scheme Administration of Scheme including IEC (Information, Education & Communication) activities and fee for project management agency (PMA)²⁹.

The Anusandhan National Research Foundation (ANRF) launched the **Mission for Advancement in High-Impact Areas -Electric Vehicle (MAHA- EV) Mission**. The MAHA-EV mission focuses on the development of key EV technologies to reduce dependency on imports, promote domestic innovation, and position India as a global leader in the EV sector. It Concentrates on three critical technology verticals-- Tropical EV Batteries and Battery Cells, Power Electronics, Machines, and Drives (PEMD) and Electric Vehicle Charging Infrastructure. The mission will enhance domestic capabilities in the design and development of essential EV components³⁰.

<https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1806139>.

²⁵ Ministry of Heavy Indus., *Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India)* (July 11, 2022), <https://static.pib.gov.in/WriteReadData/specifidocs/documents/2022/jul/doc202271169601.pdf>

²⁶ Ministry of heavy industries, S.O. 3946(E), (Notified on 23rd September, 2021)

²⁷ Ministry of Heavy Indus., *Guidelines for the Production Linked Incentives (PLI) for Automobile and Auto Component Industry* (Sept. 23, 2021).

²⁸ Ministry of Power, *"Go Electric" Campaign, Press Information Bureau* (Mar. 22, 2022), <https://pib.gov.in/PressReleasePage.aspx?PRID=1808261>.

²⁹ Ministry of Heavy Industries S.O. 4259(E) (Notified on September, 29th, 2024)

³⁰ Ministry of Sci. & Tech., *Anusandhan National Research Foundation Launches First Two Initiatives: Prime Minister Early Career Research Grant (PMECRG) and Mission for Advancement in High-Impact Areas - Electric Vehicle (MAHA-EV) Mission, Press Information Bureau* (Oct. 14, 2024),



The Scheme for Promotion of Manufacturing of Electric Passenger Cars in India (SPMEPCI) was notified on 15th March, 2024, to promote the manufacturing of electric cars in India³¹. This requires applicants to invest a minimum of ₹4150 crore and to achieve a minimum DVA of 25% at the end of the third year and a DVA of 50% at the end of the fifth year³².

In addition to national-level policies, several state governments have announced their own incentives and support mechanisms to promote the EV industry. These state-level policies include tax exemptions, EV purchase subsidies, and local charging infrastructure investments. States such as Maharashtra, Karnataka, and Tamil Nadu are leading the way with comprehensive EV policies that aim to create favourable conditions for both consumers and manufacturers.

The Government of India has set an ambitious target of 30% EV penetration by 2030. Additionally, our vision of Viksit Bharat by 2047 necessitates the creation of a robust R&D landscape that can enable the creation of a self-reliant domestic EV ecosystem³³. India is also committed to achieving the Net Zero emission target by 2070. India also implemented CAFE schemes in phases to regulate the automobile industries³⁴.

To achieve these targets, many policies and programs are initiated by the Government and the state invests large amounts in the manufacture of EVs and their components. These targets are appreciated laterally

but not holistically, as the policies overlooked waste battery management and recycling. No investments are made in this arena. Waste battery management is a huge problem that will bust in future. Thus, the answer to the second question is that the policies for adoption of electric vehicles in India are well build but these are not sufficient to tackle the problem of battery waste management, which will be a huge catastrophe in the future, leading to various problems. Investments encouraging domestic production of batteries must also be balanced by providing incentives for recycling of the batteries.

3. ISSUE OF BATTERY WASTE MANAGEMENT AND THE LEGAL FRAMEWORK

3.1 THE GLOBAL SCENARIO

Waste is considered to be one of the major sustainability issues impacting all three pillars of sustainable development, i.e., environment, society, and economy. Effective waste management is essential for achieving sustainability and improving the quality of life. Environmental impacts of badly managed waste, such as inadequate collection and open dumping or burning, are well-known³⁵. A major issue in vehicle electrification is the battery waste that will accumulate in the coming years. However, there is no common definition of battery waste globally, and it is included within the purview of electric waste globally. EEE refers to all products with circuitry or electrical components and a power or battery supply³⁶.

<https://pib.gov.in/PressReleaseDetailm.aspx?PRID=2064660®=3&lang=1>.

³¹ Ministry of Heavy Industries S.O. 1363(E) (Notified on March, 15th, 2024)

³² Ministry of Heavy Indus., *New Electric Vehicle Policy*, **Press Information Bureau** (Dec. 10, 2024), <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2082743>.

³³ **Principal Scientific Adviser**, *Electric Vehicles*, <https://www.psa.gov.in/mission/electric-vehicles/36> (last visited Mar. 10, 2025).

³⁴ **Bureau of Energy Efficiency**, *Corporate Average Fuel Efficiency (CAFÉ) Standards*, **UDIT**, <https://udit.beeindia.gov.in/cafes/> (last visited Mar. 10, 2025).

³⁵ Nicola Ferronato & Vincenzo Torretta, *Waste Mismanagement in Developing Countries: A Review of Global Issues*, 16 **Int'l J. Env'tl. Res. & Pub. Health** 1060 (2019), <https://www.mdpi.com/1660-4601/16/6/1060/htm>.

³⁶ **StEP Initiative**, *One Global Definition of E-Waste, Solving the E-Waste Problem (StEP) White Paper*, UNU 3576, at 8 (June 2014).



The 62 million tonnes of e-waste generated in 2022 would fill 1.55 million 40-tonne trucks, roughly enough trucks to form a bumper-to-bumper line encircling the equator, according to the report from ITU and UNITAR. The report also says that on track to rise another 32%, to 82 million tonnes, in 2030. Billions of dollars' worth of strategically-valuable resources squandered, dumped; Just 1% of rare earth element demand is met by e-waste recycling.

The report underlines that if countries could bring the e-waste collection and recycling rates to 60% by 2030, the benefits - including through minimizing human health risks - would exceed costs by more than US \$38 billion. It also notes that the world "remains stunningly dependent" on a few countries for rare earth elements, despite their unique properties crucial for future technologies, including renewable energy generation and e-mobility³⁷.

Globally, battery waste is primarily governed by the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989), which regulates the international movement of hazardous waste, including batteries containing lead, cadmium, mercury, and other toxic substances. It covers both hazardous and non-hazardous e-waste, which includes most types of batteries. The goal is to ensure the environmentally sound management of battery waste through proper recycling and disposal³⁸.

3.1 THE LEGAL REGIME FOR BATTERY WASTE MANAGEMENT IN INDIA

Under the Indian constitution, there is no explicit provision for waste battery management, and the function is taken by the central government³⁹. The

National Environment Policy, 2006, also stresses recycling, treatment and proper disposal and also stresses the importance of developing technologies in waste management by supporting the R&D. It highlights that the polluter is responsible for the pollution and must bear the expenses incurred in the removal of pollutants. Bharatiya Nyaya Sanhita 2023, Chapter XV – Of Offences Affecting the Public Health, Safety, Convenience, Decency and Morals, addresses the issue of waste management by implication. The Five-Year Plans also charted out the mechanism, funding and means of dealing with the waste.

The Environment Protection Act 1986 also speaks about environmental pollution and the management of hazardous waste. With respect to the powers conferred by The Environment Protection Act 1986, the central government of India has enacted various rules and regulations, one such is, The Batteries (Management and Handling) Rules, 2001, amended in 2010, which was further amended as the Battery Waste Management Rules, 2022. Ministry of Environment, Forest and Climate Change, Government of India, published the Battery Waste Management Rules, 2022 on 24th August, 2022 to ensure environmentally sound management of waste batteries. The Battery Waste Management Rules, 2022 works on the policy of Extended Producer Responsibility (EPR), the responsibility of a producer for the environmentally sound management of the product until the end of its life⁴⁰. The rules on the whole enumerate the functions of producers, who manufacture, sell, and imports Battery, including refurbished batteries, battery equipment (Rule 3(u),4). The rules also enumerate the Functions of the Consumer (rule 5), Public Waste

³⁷ UNITAR, *Global E-Waste Monitor 2024: Electronic Waste Rising Five Times Faster Than Documented E-Waste Recycling*, UNITAR (Feb. 2024), <https://unitar.org/about/news-stories/press/global-e-waste-monitor-2024-electronic-waste-rising-five-times-faster-documented-e-waste-recycling>.

³⁸ Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Mar. 22, 1989, 1673 U.N.T.S. 57.

³⁹ India Const. art. 248 (Parliament has exclusive power to make any law with respect to any matter not enumerated in the Concurrent List or State List.)

⁴⁰ Central Pollution Control Board, FAQs, <https://eprplastic.cpcb.gov.in/plastic/downloads/FAQs.pdf> (last visited February 11, 2025).



Management Authorities (rule 6), entity involved in collection, segregation and treatment (rule 7), Refurbisher (rule 8), Recycler (rule 9), functions of the Central Pollution Control Board (rule 11), functions of the State Pollution Control Board (rule 12). Rule 13 provides for Action on violations and imposition of Environmental Compensation.

Rule 4 and Schedule II address the targets for EPR. As per the rules, the producers are responsible for collecting the waste batteries, and they can either recycle or refurbish them on their own or may transfer them to the Recycler or Refurbisher registered under the rule.

According to rule 10, Extended Producer Responsibility certificates will be generated by the Central Pollution Control Board through the centralised online portal based on the recycled or refurbished quantities and assigned to recyclers or refurbishers. The recyclers or refurbishers can sell the assigned Extended Producer Responsibility certificates to the producer in exchange for Waste Battery. These certificates are generated based on the formula. The functions of the Central Pollution Control Board and the State Pollution Control Board are to monitor the Producers and Recyclers and refurbishers, respectively and take action in case of violation of rules.

The Central Government has also established the EPR Battery portal (<https://www.eprbatteryepcb.in/>) to register online and an SOP for activities undertaken by the stakeholders under the rule. It is a proven fact that the main issue with environmental legislation is the implementation of it, the same rule applies to battery waste management too. The major issue in this framework is that the informal sectors that play a

major role in battery waste collection are neglected, and the responsibility is given into the hands of manufacturers who can dominate the market. The answer to the third question on the efficiency of battery waste management rules and further issues and solutions are discussed in the chapter below.

4. RECOMMENDATIONS AND SUGGESTIONS

Lithium, the white gold, is the main element used to manufacture batteries for electric vehicles. Globally, the electric vehicle market is dominated by China, starting from manufacturing to recycling technologies. Undoubtedly, the electrification of vehicles will push the need for lithium and its allied components for battery manufacturing to surge exponentially. In this scenario, it is crucial to use these elements sustainably, reflecting the concerns of the environment, the economy of India, and the geopolitical tensions in the supply chain.

It is found that less greenhouse gas and energy are used to produce metals by recycling than through mining. The recycling process emitted 58% to 81% less greenhouse gas emissions, used 72% to 88% less water, and 77% to 89% less energy^{41 42}. In the era of climate change, it is indeed crucial to measure the environmental cost of metal production, rather than solely focusing on the economic cost. To address geopolitical tensions and sustainability concerns, India, a major lithium importer for battery manufacturing, should develop its urban mining market for lithium and other battery components.

India adopted an Extended Producers Liability (EPR) regime for battery waste management. At present, India has 3229 registered producers, 361 registered recyclers, and 0 registered refurbishers⁴³. Generally, in the Indian household system, women take care of

⁴¹ Michael L. Machala et al., *Life Cycle Comparison of Industrial-Scale Lithium-Ion Battery Recycling and Mining Supply Chains*, 16 *Nat. Comm'ns* 988 (2025), <https://doi.org/10.1038/s41467-025-56063-x>.

⁴² **Recycling Lithium-Ion Batteries Cuts Emissions and Strengthens Supply Chain**, Stanford News (Jan. 2025),

<https://news.stanford.edu/stories/2025/01/recycling-lithium-ion-batteries-cuts-emissions-and-strengthens-supply-chain>.

⁴³ Central Pollution Control Board, *National Dashboard for EPR Battery Management*, **EPR Battery Management Dashboard**, <https://eprbattery.cpcb.gov.in/user/nationaldashboard>.



the responsibility of waste segregation, like disposing of waste paper, plastics, utensils, and other metals to scrap dealers who belong to the informal sector of waste collection and management. The scenario in battery waste disposal should be altered to improve the efficient disposal, by making them to know the methods for proper disposal of the battery waste. They play a major role in battery waste management and must be equipped to deal with the same.

In India, according to the waste battery management rules, the ultimate responsibility is with the producers who manufacture, sale, and import batteries, and interestingly, the rules cover all kinds of batteries, including the electric vehicle battery. According to the rules, the producer can operate schemes such as a deposit refund system or buy back, or any other model may engage itself or authorise any other entity for the collection, recycling, or refurbishment of Waste Battery⁴⁴. Assigning responsibility for waste collection to producers is commendable, but the delegation of establishing deposit refund systems and aiding in the formalisation of waste collection should be re-evaluated as it can lead to market distortions, conflicts of interest, lack of transparency, monopolisation in the collection of waste and affect these informal waste collectors. Sustainable waste management is possible only when the reverse supply chain is handled formally with governmental interference. Let us take an illustration of GST and its rebate policy in the goods and services supply chain where all the stakeholders mandatorily pay tax and get a rebate amount refunded. Likewise, in battery waste management to organise the reverse supply chain, a repayable amount can be collected and refunded back to the consumers at the time of disposal or for recycling.

As far as India concerns one of the top recyclers who dominate the market is Recykal. The company has employed schemes like QR code and DRS (Deposit Refund Scheme), where QR codes are embodied in the products sold by the company, and a small amount is collected at the time of purchasing the product. After its use, when the product is given to specific collection centres set up by the company, the amount deposited is refunded by the DRS system⁴⁵. Recykal implemented this scheme at Kedarnath, a renowned pilgrim centre, where thousands of people visit day to day, and it was reported that 7,000 plastic bottles were collected and there was a significant reduction in waste generation⁴⁶.

Recykal has also implemented reverse vending machines which accept recyclable materials from consumers and offer them a reward, by DRS or bottle Bill program⁴⁷. These innovative schemes combined with technology will be greater solutions to waste battery management.

5. CONCLUSION

India is transversing through the electrification of vehicles to combat carbon and other greenhouse gas emissions. For a sustainable accomplishment of this project, it is essential to consider the effects on the horizon to avoid the blunder committed by the industrialised countries in the previous era. Developing an effective waste battery management ecosystem is crucial for India from both the perspectives of the economy and the environment. Hence, solving the loopholes and enhancing the policy and legal framework is essential to make the electrification of vehicles a successful solution to reduce greenhouse gas emissions. Once, there were transboundary movements of hazardous waste to

⁴⁴ Battery Waste Management Rules, 2022, G.S.R. 555(E), Rule 4(9)-(10) (India)

⁴⁵ **Recykal**, Refund Policy – Deposit Refund System, <https://recykal.com/refund-policy-drs/> (last visited Mar. 24, 2025).

⁴⁶ *7,000 Plastic Bottles Collected on Kedarnath Route to Manage Waste*, **Times of India** (Oct. 10, 2022, 12:41 PM),

<https://timesofindia.indiatimes.com/city/dehradun/7000-plastic-bottles-collected-on-kedarnath-route-to-manage-waste/articleshow/94748483.cm>

⁴⁷ **All You Need to Know About Reverse Vending Machines**, Recykal (Mar. 24, 2025), <https://recykal.com/blog/all-you-need-to-know-about-reverse-vending-machines/>.



underdeveloped and developing countries by the developed countries, but now the urban mining and circular economy, along with prevailing geo-political tensions is transforming the “meaning” of waste, especially the electric vehicle battery waste. The market of battery waste has started to bloom, and the Indian markets must be prepared to act wisely with an efficient framework of policies and legislation.

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