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Unlocking The Second-life Battery Opportunity



VOLUME 3

SCALING THE SECOND-LIFE BATTERY ECOSYSTEM

Strategies, Partnerships, and Roadmaps for India

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Strategies, Partnerships, and Roadmaps for India

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Note:

This report was prepared as part of a study titled 'Mainstreaming and Scale-up of the use of Repurposed EV Battery Solutions for Circularity within the EV Supply Chain'.

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Preface



India's accelerating transition to electric mobility, in the coming years, will see a substantial volume of traction batteries retire from vehicular service. A significant proportion of these batteries will retain sufficient capacity for deployment in stationary energy storage and other suitable applications prior to recycling. Extending their service life in this manner can strengthen the country's critical mineral security and advance its clean energy transition.

Recognizing this potential, The Energy and Resources Institute (TERI) undertook the study *Mainstreaming and Scale-up of the Use of Repurposed EV Battery Solutions for Circularity within the EV Supply Chain*, with technical guidance and strategic support from Energiva Ventures. Drawing upon market assessment, a review of the policy and regulatory framework, international experience and wide-ranging stakeholder consultations, the study identifies the conditions necessary for safe, sustainable and commercially-viable adoption of second-life battery solutions in India.

The study's findings have been synthesized into the knowledge series *Beyond Mobility: Unlocking the Second-Life Battery Opportunity*. Together, they draw on global experience to assess India's market potential and ecosystem readiness and set out a roadmap for scaling up the use of second-life EV batteries, including in emerging BESS programmes.

It is my hope that this work will serve as a valuable reference for policymakers, industry and other stakeholders, and will inform coordinated action towards sustainable battery lifecycle management in India.

I place on record my sincere gratitude to the Ministry of Heavy Industries (MHI), Government of India for its guidance and support throughout this initiative. I commend the TERI project team for the rigour of its research and analysis, and convey my thanks to Energiva Ventures for its technical guidance and strategic support. I am also grateful to the many experts and stakeholders whose insights and contributions have informed this study.

Dr Vibha Dhawan
Director General
The Energy and Resources Institute

Foreword

विजय मित्तल
संयुक्त सचिव
VIJAY MITTAL
Joint Secretary

भारत सरकार
भारी उद्योग मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF HEAVY INDUSTRIES



Foreword

India's journey towards Viksit Bharat 2047 will depend on the ability to secure, manage, and efficiently use the critical minerals across their lifecycle. As the country expands clean energy and electric mobility, battery-grade minerals such as lithium, cobalt, nickel, and manganese are becoming increasingly important to resilient battery supply chains.

Initiatives of the Ministry of Heavy Industries, including the PLI Scheme for Auto, Auto Components, Advanced Chemistry Cell (ACC) and PM E-DRIVE are fostering domestic capabilities in battery manufacturing and electric mobility. Repurposing EV batteries with adequate residual capacity for applications such as grid storage, EV charging, and decentralised energy systems can extend their useful life, enhance resource efficiency, and advance battery circularity.

In this context, TERI has undertaken a study on *'Mainstreaming and Scale-up of the Use of Repurposed EV Battery Solutions for Circularity within the EV Supply Chain'*. The findings are presented through knowledge-product series, *Beyond Mobility: Unlocking the Second-Life Battery Opportunity*, covering India's market opportunity, and a roadmap for scale-up.

I commend the TERI team for their work and hope this study contributes to informed discussion among policymakers, industry, researchers, and investors on the opportunities and challenges associated with second-life batteries.

22/9/2026

(Vijay Mittal)

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This report, *Scaling the Second-life Battery Ecosystem Strategies, Partnerships, and Roadmaps for India* has been prepared as a part of the project *Mainstreaming and Scale-up of the Use of Repurposed EV Battery Solutions for Circularity within the EV Supply Chain*. The study reflects a collaborative effort to advance circular economy principles and sustainable transitions within India's electric mobility and energy storage ecosystem.

The preparation of this report was based on thorough secondary research, including peer-reviewed literature, policy documents, technical reports, project documentation, magazine articles, and publicly available databases. The authors gratefully acknowledge all researchers, institutions, and practitioners whose published work has informed the analysis and findings.

The authors also acknowledge Battery 360's Working Group on Second-Life Batteries. This facilitated in-depth discussions on the technical, economic, and social dimensions of second-life batteries. The insights shared during these deliberations have enhanced the study results.

The authors extend sincere gratitude to the senior officials from Ministry of Heavy Industries (MHI) for their valued support and guidance. The authors gratefully acknowledge the technical guidance and strategic support provided by Energiva Ventures during the project. Their constructive feedback, continued engagement, and forward-looking perspective on battery circularity have been instrumental in shaping the scope, direction, and quality of this analysis.

The authors would also like to place on record their appreciation for the efforts of the project team, whose rigorous research, systematic analysis, and diligent coordination made this report possible. This report aims to synthesize and build upon those collective efforts in support of informed decision-making and sustainable battery lifecycle management.

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Executive Summary

India's electric vehicle transition has moved decisively from policy ambition to market reality. The batteries powering this transition will, within this decade, begin retiring from service in significant volumes arriving as domestically available, lower-cost storage resource precisely when India's renewable energy integration and energy access commitments demand storage at scale. The scale of this opportunity is significant. A cumulative repurposing potential of 0.9–1.4 TWh exists in India.

This report is Volume III in the *Beyond Mobility: Unlocking the Second-Life Battery Opportunity* series. Volume I documented international policy frameworks, business models and case studies across Europe, North America, Asia, Africa and Australia–Pacific. Volume II quantified India's domestic market opportunity and assessed ecosystem readiness against global practice. This volume completes the progression from evidence to execution. It sets out a strategic framework and a time-bound action plan for scaling the repurposed use of second-life EV batteries in India, defining what must be done, by whom, in what sequence, and against what measures of progress.

The report is organized into six chapters. Chapter 1 establishes the strategic context and the case for acting ahead of the retirement wave. Chapter 2 assesses India's readiness, its institutional foundations, and the alignment of second-life batteries with national missions. Chapter 3 examines the current landscape of pilot-demonstrations and the priority application segments through which early demand can be built. Chapter 4 presents an eight-pillar strategic framework, identifying the specific interventions required under each. Chapter 5 translates that framework into a phased ten-year action plan with defined actions, lead institutions and target outputs. Chapter 6 presents the consolidated recommendations and the way forward.

Potential applications

Lithium Iron Phosphate (LFP) is certainly regarded as a suitable battery chemistry with viable repurposing pathway. It is widely used in stationary applications due to thermal stability, predictable degradation characteristics and relatively lower re-qualification requirements. Five application segments (Figure 1) identified through stakeholder consultations provide a direction for scaling pilot projects to large-scale deployments. These applications share low to moderate duty cycles, predictable load profiles and acute price sensitivity.

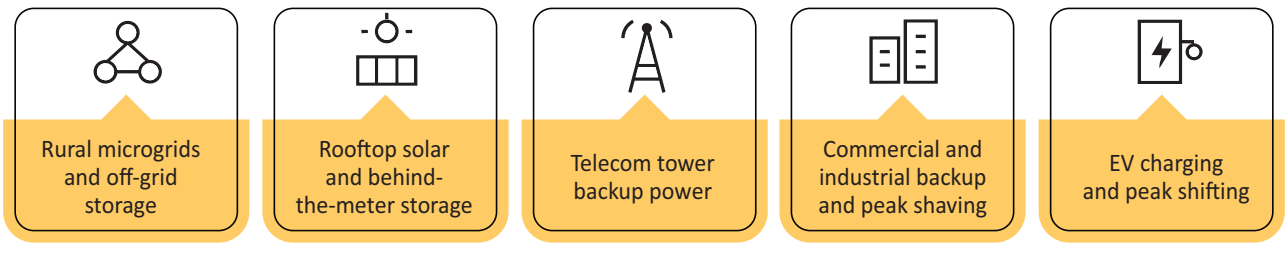


Figure 1: Priority battery demand segments for SLB adoption in India

Strategic framework

The study proposes an eight-pillar strategic framework (Figure 2) to be used for enabling the battery ecosystem for repurposing of used EV batteries. All areas are closely interlinked and require targeted action. For example, financing mechanisms will be difficult to develop without credible standards and performance data, while

investment in repurposing facilities will be difficult to justify without reliable battery supply and traceability. Similarly, regulatory clarity without testing infrastructure produces batteries that cannot be certified. Financing without standards produces projects that cannot be banked. Industrial capacity without traceable supply produces stranded assets. Sequencing is therefore as consequential as the interventions themselves.

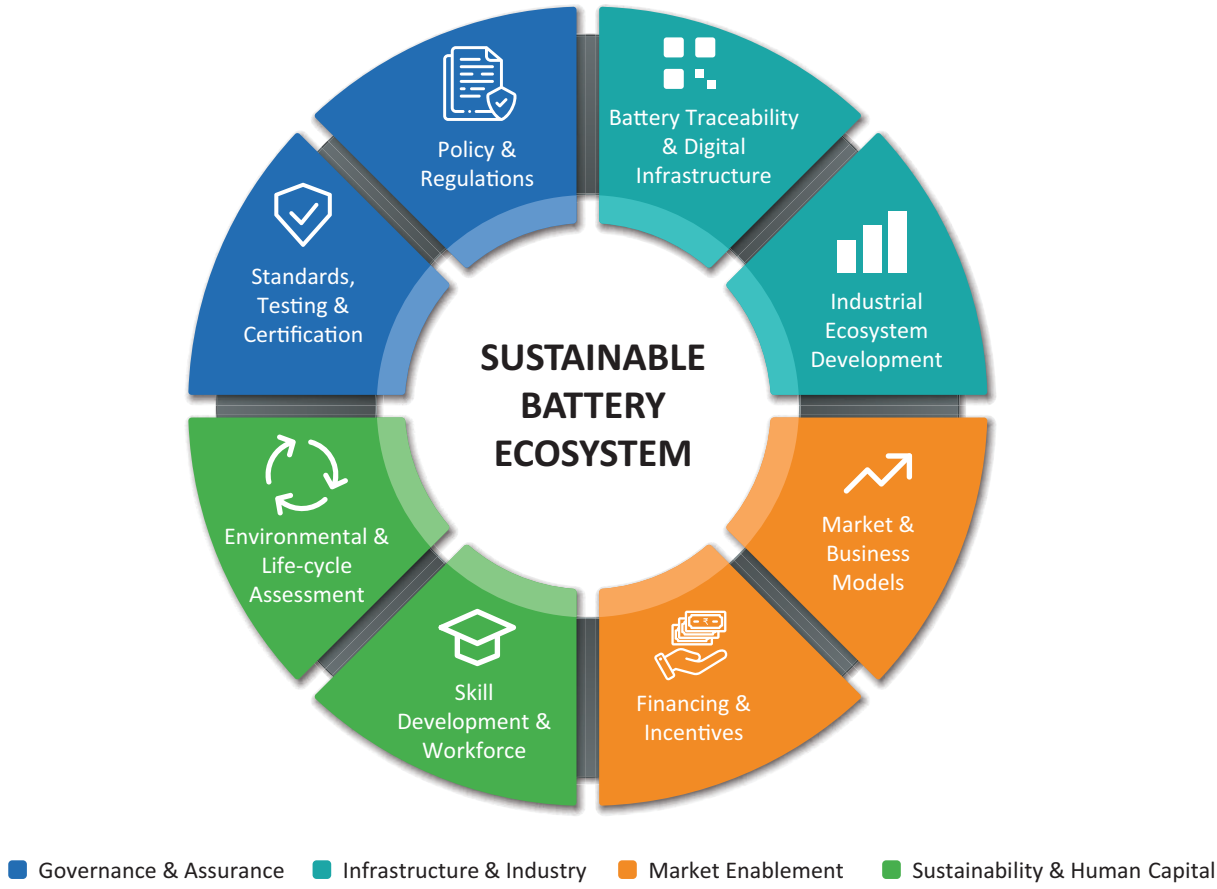


Figure 2: Framework for SLB adoption in India

Strategic action plan

The framework is translated into a phased action plan across three temporal horizons (Figure 3). Detailed actions along with key stakeholders and measurable target outputs are presented in this study. The key study recommendations are as follows:

» Policy and Regulations
  - Recognize certified SLB systems under ESS regulations, ESO, and public procurement.
  - Codify a reuse–repurposing–recycling hierarchy within the BWMR.
  - Clarify taxation and accounting treatment for refurbished batteries, leasing, BaaS and SaaS structures.

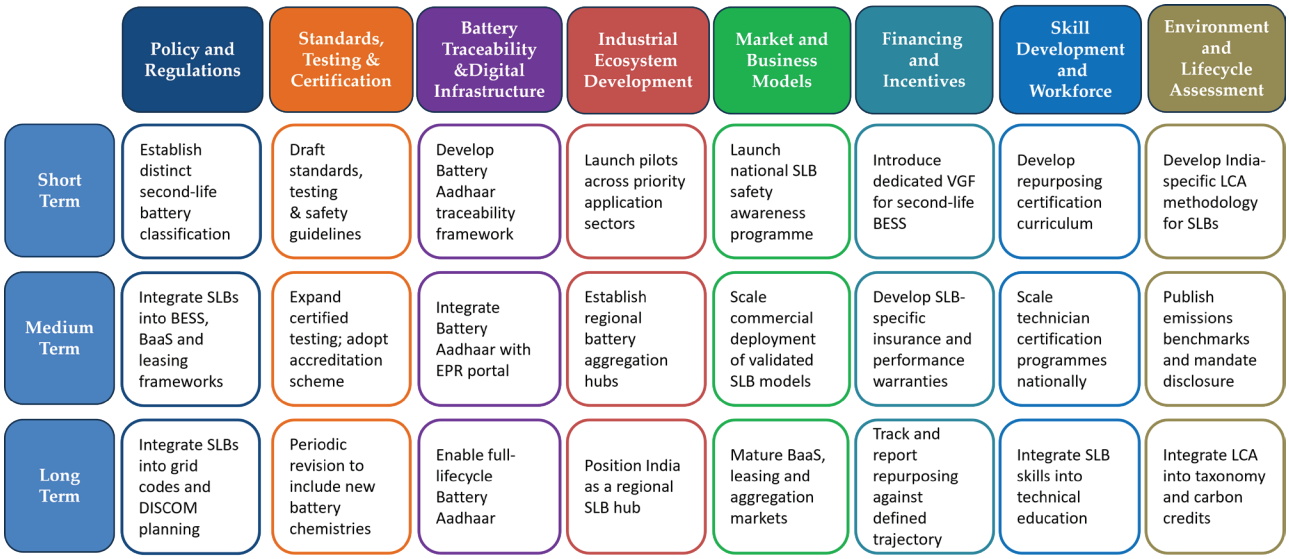


Figure 3: Key highlights of the strategic action plan for SLB adoption in India

» Standards, Testing and Certification
  - Develop a second-life safety and installation code overlaying IS 17092 (mixed-SoH modules, thermal propagation, transport, siting).
  - Institute a standards-review mechanism under BIS with a defined revision cycle.
» Battery Traceability and Digital Infrastructure
  - Build an inter-operable national battery registry linked to EPR reporting, OEM databases, repurposers and recyclers, with defined access rights.
» Industrial Ecosystem Development
  - Support regional repurposing and aggregation clusters co-located with EV manufacturing hubs.
  - Formalize informal collectors and aggregators into the traceable value chain.
» Market and Business Models
  - Anchor early demand through public procurement and eligibility under PM Surya Ghar and PM KUSUM.
  - Establish a structured pilot-to-market programme with standardized, published performance reporting for addressing high-priority battery demand sectors.
» Financing and Incentives
  - Create VGF window for second-life deployment in cost-sensitive segments.
  - Pursue green taxonomy inclusion, develop standardized warranty and insurance products.
» Skills Development and Workforce
  - Launch technician/safety-officer certification via ASDC, sequenced to facility rollout.
  - Embed battery-circularity modules into ITI, polytechnic and engineering curricula.

» Environmental and Life Cycle Assessment

- Commission an India-specific LCA methodology and publish comparative emissions benchmarks.
- Incorporate environmental disclosure into facility accreditation.
- Adopt a national repurposing-rate and cumulative-capacity target as the headline indicator, reported annually.

Coordinated implementation needed

Responsibility for implementing this proposed action plan spans across different Ministries and several regulators, alongside state nodal agencies and distribution utilities. A standing inter-ministerial coordination mechanism, maintaining a shared implementation timeline and monitoring dependencies, is the principal safeguard against that outcome and among the earliest actions recommended.

India is well positioned with battery retirement volumes still modest, storage demand large and growing, the dominant fleet chemistry well suited to stationary reuse, and standards development already underway. The task is to complete the enabling architecture before the volumes arrive. Executed within this decade, the agenda set out in this report would convert retired EV batteries from an emerging waste management challenge into a domestic, low-cost and traceable component of India's energy storage and circular economy systems.

1. Introduction and Strategic Context

1.1 Pilot Demonstration to Large-scale Projects

India's second-life battery ecosystem evolved over the past few years, moved from a niche technical curiosity to a subject of active policy and industry attention. Pilot deployments by battery repurposers such as LICO Materials, LOHUM, Nunam, Bridge Green Upcycle, Attero, and BatX Energies, alongside OEM-led demonstrations, have shown that retired EV batteries can be safely redeployed into stationary storage applications. The Volume II of this series, titled *India's Market Opportunity and Ecosystem Readiness-Demand Potential, Value Chains, and Ecosystem Strengthening*, presented a quantitative assessment on the scale of this opportunity and benchmarked India's readiness against leading international markets.

A dedicated, implementation action-oriented scale-up strategy has been absent; a document that translates the evidence base into a sequenced programme of interventions, assigns institutional leadership, and defines the milestones against which progress can be assessed. This report addresses that gap, and its structure is oriented towards execution linking responsible actors and timelines.

1.2 A Strategic Window of Opportunity for India

India is approaching an important inflection point in the development of its battery ecosystem. The convergence of rapid EV adoption, rising energy storage demand, and growing global momentum towards battery circularity creates a strategic opportunity to establish a robust second-life battery ecosystem. While large-scale battery retirements are only beginning to emerge, the next few years offer a valuable window to develop the regulatory, technical, and market foundations necessary for long-term scale. Three converging dynamics make near-term action on second-life batteries a genuine strategic priority for India, rather than a matter that can be deferred to the next planning cycle.

- **The Post-2030 Battery Retirement Wave**: EV batteries sold in India today will begin retiring from vehicle service in substantial volumes from 2030 onwards. Cumulative retired battery capacity is projected to rise from approximately 9 GWh in 2030 to several hundred GWh by 2040 and into the terawatt-hour (TWh) range by 2050. Building the regulatory, technical, and institutional infrastructure required to responsibly absorb this volume takes an estimated five to seven years meaning that preparatory work needs to begin now, well ahead the peak volumes hit.
- **The Scale of India's Storage Demand**: India's National Electricity Plan (NEP) projects a requirement of 208 GWh of Battery Energy Storage Systems (BESS) by 2030 to support the integration of India's 500 GW non-fossil energy capacity target.[1] India's total annual battery demand across key sectors will reach 1,094 GWh by 2047.[2] As India scales up its battery manufacturing and energy storage ecosystem, as

[1] https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/09/20230901125607 1349.pdf

[2] https://heavyindustries.gov.in/sites/default/files/2026-07/report_on_aggregation_of_multi-sectoral_long-term_battery_storage_capacity_demand_and_long-term_action_plan.pdf

reflected in the MHI's efforts to build domestic ACC capacity and assess long-term battery storage demand, the efficient utilization of batteries across their full life cycle will become increasingly important. New battery procurement alone represents a significant capital expenditure; second-life batteries, priced 30–50% below new systems, can improve the affordability of storage for cost-sensitive applications while extending battery utilization beyond their initial mobility use. This exemplifies first-mover advantage in an evolving global market. The European Union, South Korea, Japan, China, and Australia have begun to formalize second-life battery regulation and standards over the past two to three years. India's large and LFP-dominant EV fleet, combined with its substantial telecom and commercial energy storage demand base, positions it well to establish a competitive domestic second-life ecosystem provided the enabling framework is established while the market is evolving.

1.3 Objectives

This report has three linked objectives: first, to consolidate a national strategic framework spanning all dimensions of second-life battery deployment; second, to translate that framework into a phased, time-bound action plan with clearly assigned institutional roles; and third, to anchor both the framework and the action plan with recommendations of India's second-life battery stakeholder community, gathered through structured consultations during 2026.

The scope of the report spans the complete second-life battery value chain, from battery retirement, collection, testing, and repurposing to deployment in secondary applications and eventual recycling. It examines the enabling conditions required across key application segments, including telecom infrastructure, commercial and industrial energy storage, EV charging, distributed renewable energy systems, community energy storage, and rural energy applications. Emphasis is placed on the sequencing of interventions needed to support the transition from pilot-scale projects to a safe, commercially viable, and nationally integrated second-life battery ecosystem in the coming decade.

2. EV Battery Repurposing Readiness in India

India's second-life battery ecosystem currently revolves around a key question: whether the country is institutionally, commercially, and strategically prepared to scale battery repurposing. Volumes I and II (in this series) clearly established that retired EV batteries represent significant domestic energy storage resources, with applications across backup power, commercial and industrial energy management, renewable energy integration and distributed energy systems. The previous reports also identified major regulatory, technical and market barriers that currently limit large-scale deployment.

Building on that evidence, this chapter assesses India's readiness to transition from pilot scale demonstrations to commercial deployment. It examines the structural drivers that make India particularly well positioned for second-life battery development, the institutional and regulatory foundations that are already in place, and the extent to which second-life batteries align with the country's broader energy transition, circular economy, and industrial development objectives.

Furthermore, this chapter showcases that India has already developed several important building blocks for a second-life battery ecosystem, including a rapidly expanding EV market, a battery waste management framework, emerging standards initiatives, and growing demand for stationary energy storage. However, these elements have not yet evolved into a coherent national ecosystem capable of supporting safe, bankable, and large-scale repurposing. The purpose of this chapter therefore is to identify the extent of India's current readiness and establish the rationale for strategic interventions proposed in the subsequent chapters.

2.1 Relevance of India's Development Priorities

India is distinctively well positioned to lead the development of a large-scale second-life battery market, for four structural reasons. First, India's EV fleet composition is heavily weighted towards LFP chemistry, which is also the chemistry best suited on grounds of thermal stability, predictable degradation, and re-qualification cost to second-life stationary storage applications. Second, India's roughly 8 lakh telecom towers, alongside a large and growing base of commercial and industrial energy users, already rely on battery-based backup power, creating a ready-made, technically compatible demand base for early second-life deployment. Third, India's near-total dependence on imported battery-grade critical minerals (lithium, cobalt, nickel, and manganese) makes every unit of repurposed capacity a direct contribution to resource security. Fourth, India's most storage-constrained populations (rural communities, small commercial users, and decentralized solar PV adopters) stand to benefit disproportionately from the 30–50% cost advantage that second-life systems could offer over new BESS.

2.2 Institutional and Thematic Readiness

India's institutional foundation for a second-life battery ecosystem, while still developing, is more substantial than it is sometimes recognized. The Battery Waste Management Rules (BWMR), 2022 updated through the 2025 Amendment Rules already establish Extended Producer Responsibility (EPR) obligations, collection and recycling requirements, and QR/barcode-based traceability anchored to the Central Pollution Control Board (CPCB). The Bureau of Indian Standards (BIS) has constituted a dedicated working group (ETD 11/WG 06) to draft Indian standards on the repurposing of secondary batteries. The Ministry of Power (MoP) and the Ministry

of New and Renewable Energy (MNRE) have both advanced ESS policy instruments, including Viability Gap Funding (VGF) schemes and national ESS roadmaps. The Battery 360 and other organizations, convened with participation from OEMs, recyclers, financiers, and research institutions, provide an active multi-stakeholder platform for continued coordination.

What remains is to connect these individually valuable building blocks into a coherent, second life-specific regulatory and institutional architecture, the central purpose of which is detailed in Chapter 4.

2.3 Alignment with National Goals

A dedicated second-life battery strategy for India is closely aligned with the country's major energy, climate, manufacturing, and circular economy objectives. As mentioned earlier, the value of second-life batteries lies in their ability to support multiple energy transition goals simultaneously, including renewable energy integration, affordable energy storage, domestic manufacturing, critical mineral security, and resource efficiency. Integrating second-life batteries into existing policy frameworks can accelerate implementation while reducing the need for entirely new institutional mechanisms.

India's energy transition priorities and objectives are also interconnected: the expansion of renewable energy is increasing the requirement for energy storage; the rapid electrification of transport is creating a growing stock of EV batteries; and emerging battery-waste regulations are establishing the framework for managing these batteries at the end of their first-life use. Together, these developments create both the supply of batteries available for repurposing and the demand for cost-effective storage applications.

Accelerating India's clean energy transition through its Panchamrit commitments, India announced its target of 500 GW of non-fossil electricity capacity by 2030 at COP26 in November 2021.[3] The target was subsequently incorporated into national energy planning and India's climate commitments. This will require large-scale deployment of energy storage to manage the variability of solar and wind generation. The Central Electricity Authority (CEA) estimates that the country will require approximately 208 GWh of BESS by 2030.[4] Meeting this requirement entirely through new battery systems would involve substantial capital expenditure and increase dependence on imported battery materials. Certified second-life batteries can provide a lower-cost storage alternative for applications such as behind-the-meter storage, peak shaving, and backup power. Their deployment can improve the affordability of storage expansion while supporting grid flexibility and renewable energy integration.

Energy Storage Obligations (ESOs)

India is progressively introducing policy mechanisms that encourage utilities and distribution companies to procure energy storage capacity. The ESO framework was introduced by the Ministry of Power in 2023 to promote deployment of energy storage alongside renewable energy expansion.[5,6] As ESO frameworks evolve,

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3 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1795071®=48&lang=2

4 https://cea.nic.in/wp-content/uploads/document_upload/2023/06/nep_jan_2018.pdf

5 https://www.energy-storage.news/india-adds-energy-storage-obligation-policy-to-renewable-energy-purchase-scheme/

6 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1983650&reg=48&lang=2

second-life battery systems can be recognized as an eligible storage asset class, subject to appropriate safety, performance, and certification standards. This would expand the range of storage technologies available to distribution utilities, and enable cost-effective compliance pathways, particularly for distributed and medium-duration storage applications.

EV transition programmes

India's electric mobility transition has been supported through a combination of demand incentives, manufacturing incentives, and domestic raw material production initiatives.[7] The Faster Adoption and Manufacturing of Electric Vehicles (FAME) Scheme was launched in 2015, with FAME-II announced in 2019 to accelerate EV adoption across vehicle segments. Furthermore, the PLI Scheme for ACC battery storage was approved in 2021 to establish domestic battery manufacturing capacity. More recently, the PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme was launched in 2024 to continue support for electric mobility and charging infrastructure.[8]

By 2047, India's total battery demand across key sectors is estimated to reach 1,094 GWh, with the EV sector accounting for approximately 80% (878 GWh) of the total demand. This significant share is expected to be driven primarily by large-scale electrification of passenger road transport. A functioning second-life battery market strengthens the economics of these programmes by creating a residual-value pathway for retired EV batteries. Instead of becoming an end-of-life liability, batteries can retain commercial value through repurposing for stationary storage applications. This improves the total cost of ownership of electric vehicles, creates additional revenue opportunities for OEMs and fleet operators, and supports the development of a circular battery value chain.

Circular economy and battery waste management

Second-life battery deployment directly advances the objectives of India's BWMR, 2022 and the 2025 Amendment Rules.[9,10] Within the battery circularity hierarchy, repurposing occupies a higher-value position than material recycling because it extends the productive life of battery assets before they enter end-of-life processing. Prioritizing technically suitable batteries for reuse and repurposing reduces premature recycling, improves resource efficiency, lowers lifecycle emissions, and maximizes value recovery from imported battery materials. A structured second-life ecosystem therefore complements, rather than competes with, the existing EPR framework.

Decentralized solar adoption schemes

India's rooftop solar and agricultural solarization programmes through programmes such as PM Surya Ghar: Muft Bijli Yojana and the PM KUSUM Scheme increasingly require affordable and reliable energy storage solutions.[11] Second-life batteries can serve as cost-effective storage options for residential rooftop solar systems, agricultural pumps, rural enterprises, community energy systems, and decentralized renewable energy

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7 https://www.ceew.in/sites/default/files/challenges-and-benefits-of-battery-swapping-system-policies-for-electric-vehicle-transition-india.pdf

8 https://www.ispp.org.in/indias-ev-policy-puzzle-incentivising-adoption-or-building-a-sustainable-ecosystem/

9 https://cpcb.gov.in/uploads/hwmd/Battery-WasteManagementRules-2022.pdf

10 https://eprbattery.cpcb.gov.in/upload/adminDoc/Battery_Waste_Management_(Amendment)_Rules,_2025.pdf

11 https://www.energetica-india.net/news/pm-surya-ghar-2-0-may-pair-capital-support-with-generation-linked-incentives

applications.[12] Their lower capital cost can improve the economics of distributed solar installations, enhance self-consumption, reduce grid dependence, and improve energy access in areas where storage affordability remains a significant barrier.

Make in India and Atmanirbhar Bharat

The development of a domestic second-life battery industry supports India's manufacturing and self-reliance objectives by creating new value chains in battery diagnostics, refurbishment, remanufacturing, systems integration, software development, testing, and lifecycle management. It also reduces dependence on imported new battery cells for stationary storage applications and creates skilled employment across engineering, manufacturing, logistics, and service sectors. By building domestic capabilities in battery circularity, India can strengthen its competitiveness in emerging global battery value chains while improving long-term resource security.[13]

Taken together, these linkages demonstrate that second-life batteries can be mainstreamed through existing national missions and sectoral programmes rather than requiring separate parallel policy architecture. The strategic priority is therefore to integrate certified second-life battery systems into existing energy storage, renewable energy, industrial, and circular economy frameworks, allowing a single intervention to contribute simultaneously to multiple national development objectives.

Mission LiFE: Promoting resource-efficient lifestyles

Mission LiFE (Lifestyle for Environment) was launched by the Government of India in October 2022, following its introduction by India at COP26. The initiative seeks to promote a shift from resource-intensive patterns of consumption towards mindful and deliberate use of resources. It focuses on encouraging behavioural changes such as saving energy, reducing waste and e-waste, reducing the use of single-use plastics, and adopting more sustainable lifestyles.

For the second-life battery ecosystem, Mission LiFE provides a broader sustainability rationale. Extending the life of EV batteries through safe reuse and repurposing can improve resource efficiency, reduce premature material waste, and defer the need for recycling and extraction of virgin resources. In this context, second-life batteries align with the underlying principles of Mission LiFE by promoting longer product utilization, resource conservation, and responsible consumption.

India's BWMR, 2022 (amended in 2025) already establish EPR obligations, collection and recycling requirements, and QR/barcode-based traceability a meaningful starting point that the regulatory actions to extend towards a distinct second-life asset classification, consistent with the direction taken by these five benchmark markets.

> ***Second-life battery interventions can, in several cases, be embedded within existing scheme architecture and budget lines rather than requiring entirely new instruments an approach with the fastest route to impact.***

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12 https://www.wri.org/insights/second-life-ev-batteries-clean-energy-access

13 https://iea.blob.core.windows.net/assets/cb39c1bf-d2b3-446d-8c35-aae6b1f3a4a0/BatteriesandSecureEnergyTransitions.pdf

Table 1: India's policy landscape for shaping the second-life battery ecosystem

National Mission/ Targets	Relevance to Second-life Battery
500 GW non-fossil energy capacity by 2030	Meeting the associated 208 GWh BESS requirement (CEA, NEP) more affordably by blending repurposed capacity into the storage mix, particularly for distributed and behind-the-meter applications.
ESOs on DISCOMs	Second-life BESS can be explicitly recognized as an eligible asset class within evolving the ESO frameworks, expanding compliance pathways available to distribution utilities.
EV transition programmes (PM E-DRIVE, PLI-ACC)	A functioning second-life market improves the total-cost-of-ownership (TCO) proposition for EV buyers and OEMs by creating a residual-value pathway for retired batteries, reinforcing the broader EV transition.
Circular economy and battery waste management	Repurposing occupies the highest-value position in the battery circularity hierarchy—extending useful life ahead of eventual recycling—directly advancing the objectives of the BWMR, 2022 and the 2025 Amendment.
PM Surya Ghar Muft Bijli Yojana and PM KUSUM	Incorporating certified second-life batteries as eligible storage options within rooftop solar and agricultural solarization schemes can lower system costs and accelerate uptake.
Make in India and Atmanirbhar Bharat	A domestic repurposing and remanufacturing industry create skilled employment across diagnostics, refurbishment, systems integration, and software, while reducing reliance on imported new battery cells for storage applications.
Mission LiFE	Promotes sustainable consumption, resource efficiency and waste reduction; supports the broader circular-economy rationale for extending battery life through reuse and repurposing.

3. Second-life Battery Applications from Emerging Pilots to Scalable Deployment

Chapter 2 established that India possesses several structural advantages for second-life battery deployment, including a technically compatible and rapidly growing demand base. This chapter builds on that assessment, and on the demand-side analysis presented in Volume 2 of this study, to set out the priority application segments where repurposed batteries can be deployed at commercial scale, the technical and chemistry considerations that govern application fit, and the way these segments map onto the strategic interventions detailed in Chapter 4.

This chapter examines how these applications can become entry points for ecosystem development. It considers the emerging demonstration activity in India, the lessons that can be derived from early deployment, the barriers preventing replication, and the interventions required to move from isolated demonstrations to commercially viable deployment.

The strategic objective is therefore not to promote second-life batteries uniformly across all possible applications. Instead, India should adopt an application-led scale-up approach, in which batteries are matched to applications according to their technical condition, chemistry, remaining useful life, operating profile and economics, while the supporting regulatory, testing, financing and business-model infrastructure is developed in parallel.

This approach is particularly important because second-life battery inventory will not be homogeneous. Retired batteries will differ in chemistry, capacity, voltage, degradation history, thermal exposure, usage profile and remaining useful life. Volume II therefore proposed a structured application-matching process involving battery intake and characterization, eligibility screening, application matching, chemistry filtering, ranking and deployment.

3.1 Current Landscape of Second-life Battery Demonstrations in India

India's second-life battery ecosystem has begun moving beyond laboratory-level experimentation towards field demonstrations and early commercial activity. Over the past several years, domestic repurposers and technology companies have undertaken deployments and demonstrations involving retired EV batteries, particularly for stationary energy storage applications.

The current report identifies pilot and demonstration activity involving repurposing organizations such as Bridge Green Upcycle, LOHUM, Attero and BatX Energies, alongside OEM-led demonstrations. These activities provide early evidence that retired EV batteries can be tested, repurposed and redeployed into stationary storage applications.

The importance of these initiatives extends beyond the capacity of the individual projects. Their principal value is that they provide an opportunity to generate evidence on issues that cannot be resolved through theoretical assessment alone, including:

- Actual battery degradation under stationary operating conditions;
- Performance variation between battery packs and modules;
- Effectiveness of SoH and remaining useful life (RUL) assessment;
- Repurposing and reconfiguration requirements;
- BMS and power-conversion-system integration;
- Thermal management and safety performance;
- Operational reliability;
- Maintenance requirements;
- Warranty and insurance requirements;
- Actual operating economics;
- Customer acceptance; and
- End-of-second-life management.

The emergence of these pilots indicates that India has moved beyond the question of whether second-life batteries are technically possible. The more important question is now how successful demonstrations can be converted into repeatable, certifiable and financeable deployment models.

It is important, however, to distinguish between the existence of pilots and the existence of a mature market. The current evidence base remains fragmented. Demonstrations are generally undertaken by individual companies for specific customers or applications, with limited standardization in battery grading, system configuration, performance reporting, warranties and operating conditions.

Consequently, the present phase should be regarded as an early validation phase rather than a mature commercial deployment phase.

Table 2: Current status of India's second-life battery market

Market Dimension	Current Status	Need for Scale-up
Technology	Repurposing procedures, and battery diagnostics capabilities are emerging	Standardized testing and certification processes
Applications	Multiple stationary applications have been implemented	Application-specific exploitation pathways
Battery supply	Retired EV battery volumes remain relatively limited today	Need early aggregation and OEM partnerships
Standards	Standards development is underway but not yet fully institutionalized	Need nationally accepted SoH, RUL, grading and safety protocols
Data	Battery history and BMS data are not consistently accessible	Need data-sharing and traceability frameworks
Market confidence	End-user concern's about reliability and residual life exist	Need performance data, warranties and insurance

Table 2: Current status of India's second-life battery market

Market Dimension	Current Status	Need for Scale-up
Financing	Pilot projects supported by OEMs/ development agencies	Need VGF, concessional finance and aggregation
Business models	Predominantly project-specific or asset-sale models	Need BaaS, SaaS and performance-based models
Deployment scale	Predominantly pilot and demonstration scale	Need structured replication mechanisms
Recycling linkage	Repurposing and recycling pathways are not yet fully integrated	Need lifecycle tracking and defined end-of-second-life pathways

The stakeholder evidence supports this interpretation. Stakeholders have indicated that the Indian ecosystem is currently more standards and validation-constrained than pilot-constrained, with technical uncertainty around the battery health and regulatory ambiguity identified as major barriers. A 30–50% cost advantage is generally expected to compensate purchasers for the perceived risk associated with SoH variability and warranty uncertainty.

This means that the next generation of pilots should not simply aim to demonstrate that a second-life BESS can operate. They should be designed as structured evidence-generating projects capable of informing standards, certification, procurement specifications, financing mechanisms and future replication.

3.2 Priority Application Segments for Second-Life Deployment

Volume II in this series identified five application segments that represent the most commercially actionable near-term demand for second-life BESS in India. Each was selected on the basis of its natural fit with the technical characteristics of repurposed batteries namely low-to-moderate C-rates, tolerance for a degraded SoH, and acute cost sensitivity combined with the scale and predictability of the underlying demand base. Collectively, these segments span rural energy access, distributed rooftop solar, telecom infrastructure, commercial and industrial power quality, and EV charging, as summarized in Table 3.

3.3 Technical Fit and Battery Chemistry Considerations

Each application segment carries a distinct technical profile in terms of capacity, DC voltage, C-rate, and annual cycle frequency, and these requirements determine whether a given pool of second-life inventory is a viable match. Volume II sets out this requirement matrix in detail and finds that LFP is the dominant and preferred chemistry across a large majority of stationary second-life applications, owing to its thermal stability, predictable degradation trajectory, and comparatively low re-qualification cost. This is structurally advantageous for India, where EV fleet is heavily weighted toward LFP chemistry, as established in Chapter 2.

Table 3: Priority application segments for second-life BESS deployment

Application Segment	Key Characteristics	Strategic Relevance for Second-life BESS
Rural microgrids and off-grid storage	Low C-rate; predictable load profile; acute cost sensitivity	The 30–50% cost advantage of repurposed systems is directly decisive for project viability and is closely aligned with India's universal energy access commitments.
Rooftop solar and behind-the-meter storage	Evening peak-shifting; backup during outages	Demand is accelerating under PM Surya Ghar Muft Bijli Yojana and MNRE schemes, making this one of the largest near-term demand pools.
Telecom tower backup power	~8,00,000 standardized sites; displacing lead-acid and diesel	A sophisticated, cost-conscious early-adopter segment already reliant on battery backup, with strong regulatory pressure to reduce diesel consumption.
Commercial and industrial backup and peak shaving	Stable, predictable load profiles; moderate SoH variability tolerated	Long asset-holding periods and acute cost sensitivity make the economic case for second-life BESS particularly compelling.
EV charging and peak-shifting	Moderate cycle frequency; buffer absorbs off-peak energy	Reduces distribution and grid-connection costs, enabling charging infrastructure deployment in capacity-constrained locations.

Volume II further proposes a six-stage benchmarking and application-matching process intake and characterization, eligibility screening, application matching, chemistry-suitability filtering, ranked deployment, and commercial deployment through which incoming battery packs can be systematically matched to the most appropriate end use. Applying this process, industrial peak-shaving and data-centre UPS applications rank strongly across multiple criteria, confirming their importance as near-term demand channels, while telecom and residential applications, though commercially significant, are constrained by voltage requirements and small energy ranges that increase repackaging costs relative to the cost advantage second-life systems can offer.

4. Strategic Framework for Scaling Up

The assessment presented in Chapter 2 demonstrates that India possesses several of the foundational elements required for a successful second-life battery ecosystem, including a growing EV market, an emerging battery circularity framework, increasing demand for energy storage, and institutional support through relevant national missions and policy initiatives. However, the existence of battery supply and market demand alone is insufficient to enable large-scale deployment. International experience demonstrates that second-life battery markets become commercially viable only when supported by coordinated interventions across regulation, standards, traceability, industrial infrastructure, market development, financing, and workforce capabilities.

Scaling second-life batteries in India therefore requires coordinated progress that addresses ecosystem gaps while creating the enabling conditions for safe, bankable, and commercially viable deployment. Based on stakeholder consultations, global experience and the assessment of India's existing ecosystem, eight strategic pillars have been identified as the foundation for long-term scale up. No single pillar, pursued in isolation, is sufficient: regulatory clarity without testing infrastructure produces uncertifiable batteries; financing without standards produces non-bankable projects; and industrial capacity without traceable supply produces stranded assets. The eight pillars set out below form the structural backbone of the strategic action plan detailed in this report.

4.1 Policy and Regulations

India's BWMR 2022 establish an EPR framework for the collection, refurbishment, and recycling of waste batteries, including EV batteries.[14] However, the current regulatory framework treats retired batteries primarily through the lens of end-of-life waste management, without a distinct regulatory category for second-life repurposing. While the rules recognize refurbishment as an activity under the EPR regime, they do not explicitly address repurposing of retired EV batteries for second-life applications such as stationary ESS. As a result, critical issues relating to ownership transfer, safety certification, performance standards, liability, and the treatment of second-life batteries under EPR obligations remain inadequately defined. Establishing a dedicated regulatory category for second-life batteries and clarifying its interaction with the existing EPR obligations is therefore a foundational, sequencing-critical step on which several other pillars depend. Addressing this requires coordinated regulatory action spanning asset classification, recognition within energy storage and procurement frameworks, a defined reuse-repurposing-recycling hierarchy, tax clarity for emerging business models, access to grid flexibility markets, and integration with climate finance frameworks.

Regulatory status of second-life batteries

As second-life battery repurposing emerges as a valuable component of India's circular battery ecosystem, there is an opportunity to formally recognize retired EV batteries as a distinct asset category, positioned between new batteries and end-of-life waste. Establishing a dedicated 'second-life battery' classification, separate from both new batteries and end-of-life batteries, would enable tailored safety, performance, and lifecycle management requirements suited specifically to repurposed batteries, while supporting their efficient movement across successive stages of use.

[14] https://www.pib.gov.in/PressReleasePage.aspx?PRID=1854433&reg=48&lang=2

This recommendation builds on the institutional foundation already in place through the BWMR, 2022, as updated through the 2025 Amendment Rules, which have established EPR obligations, collection and recycling requirements, and QR/barcode-based traceability anchored to the CPCB. It also complements the ongoing work of the Bureau of Indian Standards (BIS), which has constituted a dedicated working group (ETD 11/WG 06) to draft Indian standards for the repurposing of secondary batteries reflecting that the technical groundwork for this classification is already underway. A formal asset category would connect these two efforts, giving the BIS working group's emerging standards a defined regulatory home, and extending the BWMR circularity framework to explicitly differentiate repurposing from recycling.

Recognition within energy storage frameworks

Second-life battery systems are already technically capable of meeting many of the performance requirements expected under India's evolving energy storage policies. Explicitly recognizing them as an eligible technology within ESS regulations, ESOs, and public procurement frameworks would open access to the fast-growing stationary storage market and to public-sector demand, which is often a critical early anchor for emerging technologies. The ESO framework, introduced by the MoP in 2023 to promote storage deployment alongside renewable energy expansion, offers a natural pathway for this recognition. As the framework evolves, second-life battery systems can be included as an eligible storage asset class, subject to appropriate safety, performance, and certification standards, directly expanding the range of technologies available to distribution utilities and enabling cost-effective compliance pathways, particularly for distributed and medium-duration storage. This eligibility could extend further into schemes such as PM Surya Ghar Muft Bijli Yojana, where certified second-life batteries could serve as a cost-effective storage option for residential rooftop solar systems, lowering system costs and supporting faster household adoption.

Repurposing within the battery circularity hierarchy

Establishing a clear, legally defined hierarchy between reuse, repurposing, and recycling presents an opportunity to ensure batteries with viable residual capacity are directed towards their highest-value use before material recovery. Such a hierarchy would strengthen resource productivity and extend battery lifetimes across the ecosystem and would directly reinforce the objectives of the BWMR, 2022, and the 2025 Amendment Rules. As these frameworks recognize, repurposing occupies the highest-value position within the battery circularity hierarchy, extending useful battery life ahead of eventual recycling. A formal hierarchy would translate this principle into an operational regulatory pathway that complements, rather than competes with, the existing EPR framework.

Tax clarity for emerging business models

Business models such as Battery-as-a-Service (BaaS), battery leasing, and Storage-as-a-Service (SaaS) offer a promising route to accelerating second-life battery deployment at scale. Providing regulatory clarity and appropriate tax treatment for these models would lower transaction costs and encourage greater private investment. These models align closely with the broader EV transition programmes supported through FAME, FAME-II, and the PM E-DRIVE Scheme, by creating a residual-value pathway for retired batteries. This strengthens the total cost of ownership proposition for EV buyers and OEMs, reinforcing the economics of India's existing electric mobility incentive architecture.

Participation in grid flexibility and ancillary service markets

Second-life battery systems are technically well-suited to participate in grid flexibility services and ancillary service markets. Enabling certified second-life battery systems to participate in these markets and in DISCOM resource planning frameworks, subject to applicable technical and safety requirements, would create additional revenue streams and strengthen project bankability. This builds on the ongoing ESS policy instruments advanced by the MoP and MNRE, including Viability Gap Funding (VGF) schemes and national ESS roadmaps, by extending the reach of these existing instruments to a wider pool of certified storage assets.

Repurposing benefits within climate finance frameworks

India's carbon market and green finance frameworks present a valuable opportunity to formally recognize the resource-efficiency and emissions-reduction benefits of battery repurposing, improving access to climate-aligned capital that can accelerate scale-up. This complements India's Panchamrit commitments and its target of 500 GW non-fossil energy capacity by 2030, announced at COP26. Repurposed batteries can support this target by offering a lower-cost storage option for behind-the-meter storage, peak shaving, and backup power, improving the affordability of the 208 GWh BESS requirement estimated by the Central Electricity Authority.

> ***The scale-up of second-life batteries in India is contingent upon the establishment of a distinct regulatory classification, formal recognition within energy storage and public procurement frameworks, and a clearly defined hierarchy governing reuse, repurposing, and recycling. These measures, complemented by tax clarity for emerging business models, access to grid flexibility markets, and integration with climate finance mechanisms, would provide the regulatory certainty necessary to mobilize investment and enable deployment at scale.***

4.2 Standards, Testing and Certification

Standards, testing and certification represent the most immediate pre-requisite for scaling second-life deployment. India currently lacks standards equivalent to international standards such as IEC 63338, IEC 63330-1, or UL 1974 for repurposing qualification. Building this technical foundation requires coordinated action spanning testing infrastructure, standardized health assessment protocols, battery grading, facility certification, performance benchmarking, and safety evaluation.

Establish national second-life battery testing centres

A strong testing infrastructure is essential for ensuring safe and reliable deployment of repurposed battery systems at scale. Establishing national second-life battery (SLB) testing centres, potentially anchored to existing BIS, ARAI, or CSIR-NML infrastructure, would provide standardized and accessible testing capacity across major EV-manufacturing regions. This builds directly on the work of BIS working group (ETD 11/WG 06), by giving these emerging standards a physical testing infrastructure through which to be applied and validated. Such centres would also provide the foundation for future certification, facility accreditation, standards validation, and performance benchmarking activities.

Standardized SoH and RUL assessment protocol

The development of a trusted second-life battery ecosystem requires a consistent and nationally accepted framework for evaluating battery health and residual life. Finalizing a standardized SoH and RUL assessment protocol would enable uniform battery qualification practices, improve transparency and comparability across battery assets, and support efficient deployment, valuation, and lifecycle management decisions. The protocol should serve as the basis for battery grading, certification, and deployment decisions across the second-life ecosystem.

Establish a nationally accepted battery grading framework

A nationally accepted battery grading framework, based on SoH, RUL, safety conditions, and application suitability, would provide a common reference for assessing battery quality and residual value. This complements the traceability infrastructure already established under the BWMR, QR/barcode system anchored to the CPCB, extending traceability data into a functional grading system that supports transparent market transactions. The grading framework should be integrated within the national SoH/RUL assessment methodology and linked to application-specific deployment criteria.

Facility-level accreditation and certification framework for repurposing operators

A facility-level accreditation and certification framework for repurposing operators, modelled on the auditable process requirements of UL 1974, would establish recognized quality, safety, and operational benchmarks for the industry. This aligns with the multi-stakeholder coordination already taking place through the Battery 360 and other platforms, which brings together OEMs, recyclers, financiers, and research institutions, offering a natural platform for developing and socializing operator certification standards.

Performance benchmarking protocols

Performance benchmarking protocols would facilitate the systematic assessment and application-specific deployment of repurposed battery packs. Such protocols support the diverse application landscape relevant to second-life batteries, including backup power for telecom towers, commercial and industrial energy management, renewable energy integration, and distributed energy systems, by ensuring batteries are matched to the applications best suited to their performance profile. The benchmarking framework should establish application-specific performance requirements for priority segments including telecom backup, commercial and industrial storage, EV charging infrastructure, and rural microgrids.

Second-life battery safety and installation framework

Dedicated safety evaluation protocols covering thermal runaway risks, transportation, storage, integration, installation, and operational safety would provide the foundation for a national second-life battery safety and installation framework tailored to the specific characteristics of repurposed battery systems. These protocols would complement the safety and traceability foundation already established under the BWMR, 2022 and 2025 Amendment, extending the existing regulatory safety architecture to address the specific technical characteristics of second-life systems.

Establish a continuous standards review and update mechanism

Battery technologies, chemistries, applications, and safety requirements are expected to evolve rapidly over the coming decade. Establishing a formal standards review mechanism under BIS, supported by industry and

research institutions, would enable periodic updates to the testing methodologies, grading systems, certification requirements, and safety protocols. Such a mechanism would ensure that India's standards ecosystem remains aligned with technological developments and international best practices.

> ***"Repurposed battery systems carry a distinct risk profile across their lifecycle spanning transportation, storage, integration, and operation that calls for safety evaluation protocols specifically tailored to second-life use, including dedicated assessment of thermal runaway risk. These protocols would complement the safety and traceability foundation already established under the BWMR, 2022 and 2025 Amendment, extending the existing regulatory safety architecture to address the specific technical characteristics of second-life systems".***

4.3 Battery Traceability and Digital Infrastructure

Reliable, standardized battery history data is the single most consequential enabler of low-cost repurposing where usage history is available, testing costs and repurposing timelines can be reduced significantly, making traceability a foundational input to the broader second-life ecosystem. Building this traceability foundation requires coordinated action spanning a standardized battery passport system, formal data-sharing frameworks between OEMs and repurposers, an inter-operable national digital registry, and the adoption of predictive analytics for battery health assessment.

Developing an India-adapted battery passport system

A battery's value in its second life depends heavily on the completeness of its usage record from first life onwards. Developing an India-adapted Battery Passport System, integrating SoH, chemistry, usage history, and ownership data across first-life, second-life, and end-of-life stages, would provide this continuous record. This builds on the QR/barcode-based traceability infrastructure already established under the BWMR, 2022 and its 2025 Amendment, anchored to the CPCB, and can further draw on the design principles of India's broader digital identity infrastructure under the Digital India programme, extending a similar lifecycle-tracking logic to battery assets.

Data-sharing frameworks between OEMs and repurposers

Access to Battery Management System (BMS) data is central to enabling faster, more accurate assessment of a battery's condition at end-of-first life. Establishing data-sharing frameworks and protocols governing the transfer of BMS data from OEMs to repurposers, with appropriate commercial and liability safeguards, would formalize this exchange. This complements the ownership transfer and liability considerations already identified under the second-life asset classification proposed in Section 3.1, giving practical effect to the data flows that classification is intended to support.

Building inter-operable national digital registry platforms

A national registry accessible across ecosystem stakeholders would allow battery data to move as efficiently as the batteries themselves. Building inter-operable national digital registry platforms, potentially integrated with the existing Battery Aadhaar and EPR-linked QR framework, as well as OEM databases, battery passport

systems, repurposers, and recyclers, would provide the shared digital infrastructure required for end-to-end lifecycle traceability. Designed to be affordable, scalable, and suited to India's connectivity conditions, such platforms would support seamless data exchange, compliance monitoring, lifecycle tracking, and ecosystem-wide analytics. This directly extends the traceability architecture already in place under the CPCB-anchored EPR framework described in Chapter 2, strengthening its role as a live, inter-operable data platform rather than a compliance record alone.

> ***Reliable battery traceability underpins the scale-up of second-life batteries in India, supported by an India-adapted Battery Passport System, formal OEM to repurposer data-sharing frameworks, and inter-operable national digital registries built on the existing EPR-linked QR infrastructure. Complemented by AI-enabled analytics and digital twin technologies for predictive assessment, these measures would reduce testing costs, shorten repurposing timelines, and strengthen confidence in deployment decisions across the ecosystem.***

4.4 Industrial Ecosystem Development

A repurposing industry capable of absorbing the projected battery retirement wave must be built well ahead of peak volumes. This requires not only physical repurposing infrastructure but also a supportive ecosystem comprising battery aggregation networks, reverse logistics systems, OEM partnerships, testing facilities, start-up ecosystem and innovation-driven enterprises. Building these capabilities in advance will be critical to ensure that retired batteries are efficiently collected, assessed, repurposed, and redeployed at scale. These objectives can be advanced through the establishment of regional repurposing clusters, structured OEM-repurposer collaboration models, a supported domestic start-up ecosystem, and early demonstration deployment across high-potential applications.

Regional repurposing clusters

Reverse logistics costs are a significant determinant of second-life battery economics, making the physical location of repurposing infrastructure a strategic consideration. Supporting the establishment of regional repurposing clusters, co-located where possible with existing EV manufacturing hubs in Tamil Nadu, Maharashtra, Gujarat, Karnataka, and Uttar Pradesh, would minimize these logistics costs by situating repurposing capacity close to the point of battery retirement. These clusters can also serve as focal points for battery aggregation, pre-screening, testing, refurbishment, and reverse logistics activities, supporting the efficient movement of batteries through the traceable value chain. This builds on India's existing EV manufacturing geography and the PLI-ACC-supported battery manufacturing base described in Chapter 2, allowing repurposing infrastructure to develop alongside, rather than separate from, established industrial capacity. Over time, these clusters can evolve into centres of excellence for battery diagnostics, repurposing technologies, and system integration, supporting India's emergence as a regional hub for second-life battery solutions and services.

Structured OEM-repurposer collaboration models

Formal collaboration between OEMs and repurposers can significantly reduce the uncertainty associated with battery sourcing, condition data, and commercial terms. Encouraging structured OEM-repurposer collaboration models, including joint ventures, licensing arrangements, and long-term offtake agreements, would provide

this structure, drawing on international precedents such as Nissan's 4R Energy and Renault's partnership with Connected Energy. These models would also give practical commercial effect to the data-sharing frameworks proposed under Section 3.3, providing a contractual foundation through which BMS data transfer and liability arrangements between OEMs and repurposers can be operationalized

Domestic repurposing and diagnostics start-up ecosystem

Innovation in diagnostics, testing, and repurposing processes is often best driven by a dynamic start-up ecosystem operating alongside larger industrial players. Fostering this ecosystem through incubation support, targeted grants, and streamlined regulatory sandboxes for pilot deployment would encourage new entrants to test and scale innovative approaches to battery assessment and repurposing. This complements the Make in India and Atmanirbhar Bharat initiatives discussed in Chapter 2, extending India's self-reliance and domestic manufacturing agenda into the emerging battery circularity value chain.

Early deployment in high-potential application segments

Demonstrable operational experience is essential to building confidence among financiers, regulators, and end users ahead of large-scale deployment. Prioritizing early and monitored deployment in high-potential application segments such as telecom towers, commercial and industrial (C&I) backup systems, EV charging infrastructure, community energy storage, and rural microgrids would generate this experience while creating demonstrable demand. This aligns closely with the structural demand base identified in Chapter 2, particularly India's roughly 8 lakh telecom towers and its growing base of commercial and industrial energy users that already rely on battery-based backup power.

> ***Industrial ecosystem readiness for second-life battery scale-up in India is contingent upon regional repurposing clusters co-located with EV manufacturing hubs, structured OEM-repurposer collaboration models, a supported domestic start-up ecosystem, and early deployment across high-potential application segments such as telecom towers and commercial and industrial backup systems. Together, these measures would build the operational capacity and market confidence necessary to absorb the projected battery retirement wave at scale.***

4.5 Market and Business Models

Stakeholders expressed a clear and consistent preference for service-based and shared-ownership models that lower upfront investment and operational risk for end users over direct-purchase models. The successful development of second-life battery markets will depend not only on the technical suitability of repurposed batteries, but also on the creation of commercially viable business models, confidence-building mechanisms, and demand-generation pathways that support long-term market adoption. Building this market foundation calls for parallel progress on service-based ownership models, portfolio-level aggregation, performance-based contracting, standardized risk products, early public-sector adoption, and a structured pathway from pilot to commercial scale.

Supporting Battery-as-a-Service and Storage-as-a-Service offerings

End users are consistently more willing to adopt second-life storage when the associated technology and performance risk is retained by the service provider rather than transferred to them at the point of purchase. Supporting the growth of Battery-as-a-Service (BaaS) and broader Storage-as-a-Service (SaaS) offerings, under which repurposers or integrators retain asset ownership and end users pay for storage outcomes, would align with this stakeholder preference. This directly reinforces the regulatory and tax clarity for BaaS and SaaS models proposed under Section 3.1, translating that regulatory foundation into active commercial offerings in the market.

Enabling aggregation platforms across multiple sites

Individual second-life storage installations are often too small to independently attract project finance or insurance on favourable terms. Enabling aggregation platforms that pool retired batteries and second-life storage assets across multiple sites can potentially address this concern by improving bankability and unlocking access to financing and insurance at portfolio scale. This complements the national digital registry infrastructure proposed under Section 3.3, which would provide the underlying traceability data needed to aggregate and manage distributed battery assets reliably across sites.

Promoting performance-based contracting structures

Aligning repurposer revenue with the actual system performance strengthens incentives for quality repurposing and ongoing asset maintenance. Promoting performance-based contracting structures, including capacity leasing and peak-shaving service agreements, would establish this alignment between repurposer revenue and demonstrated system performance. Such structures would draw directly on the performance benchmarking protocols proposed under Section 3.2, using standardized performance data as the basis for contractual terms.

Enabling early public-sector adoption through targeted procurement

Public-sector demand often plays a catalytic role in establishing market credibility for emerging technologies before broader commercial adoption follows. Enabling government agencies, public utilities, smart city programmes, and renewable energy projects to act as early adopters of certified second-life battery systems, through targeted procurement guidelines and pilot deployment mandates, would create this catalytic demand. This builds directly on the public procurement recognition proposed under Section 3.1 and aligns with programmes such as PM Surya Ghar Muft Bijli Yojana and PM KUSUM as discussed in Chapter 2, which offer natural early-adoption pathways for certified second-life systems.

Establishing a structured pilot-to-market programme

Successful pilot demonstrations do not automatically translate into commercial-scale deployment without a structured pathway to support replication. Establishing a 'pilot-to-market' programme that identifies successful second-life battery demonstrations, evaluates their performance, and supports replication at commercial scale through targeted financing, procurement support, and technical assistance, would provide this pathway. The programme should also include dissemination of performance data, case studies, and stakeholder outreach activities to support wider market awareness and confidence in certified second-life battery systems. This programme would draw on evidence generated through the early deployment prioritized under Section 3.4, creating a systematic mechanism to scale successful demonstrations rather than allowing them to remain isolated pilots.

The development of commercially viable second-life battery markets in India is contingent upon service-based ownership models such as BaaS and SaaS, portfolio-level asset aggregation, performance-based contracting, standardized warranty and insurance products, early public-sector adoption through targeted procurement, and a structured pilot-to-market programme. Together, these measures would build the commercial confidence and demand pathways necessary to support long-term market adoption at scale"

4.6 Financing and Incentives

Financing constraints were consistently ranked by stakeholders as secondary to standards and regulatory clarity, but they remain a necessary condition for scale. A blended mix of concessional, commercial, and market-based instruments will be required across different stages of the ecosystem's development. In the near term, financing interventions should focus on reducing perceived technology and performance risks, while over the longer term, the objective should be to mainstream second-life battery projects within conventional infrastructure and clean-energy financing channels. Advancing this financing foundation calls for parallel progress on targeted capital subsidies, access to green and carbon finance, formal inclusion within India's green taxonomy.

Extending capital subsidies and VGF to second-life deployments

Cost-sensitive segments such as rural microgrids and small commercial and industrial users often face the greatest affordability barriers, despite standing to benefit most from the cost advantage of second-life systems. Extending capital expenditure subsidies and VGF support to second-life BESS deployments in these segments would help offset this barrier. This builds directly on the VGF schemes and national ESS roadmaps already advanced by the MoP and the MNRE, described in Chapter 2, extending their reach to explicitly include second-life storage assets.

Facilitating access to green bonds and carbon finance instruments

Aggregated second-life BESS portfolios present a strong case for climate-aligned financing, given their demonstrated lifecycle emissions-reduction benefits relative to new battery systems. Facilitating access to green bonds and carbon finance instruments for these portfolios, supported by the underlying market assessment's emissions-reduction case, would help mobilize this category of capital. This builds on the carbon market and green finance integration proposed under Section 3.1, translating that regulatory recognition into active access to financing instruments.

Pursuing formal inclusion within India's green taxonomy

Institutional investors increasingly rely on formal taxonomies to guide ESG-linked allocation decisions, making taxonomy inclusion a significant determinant of access to institutional capital. Pursuing formal inclusion of second-life battery systems within India's evolving green taxonomy would improve their eligibility for ESG-linked financing and institutional investment. This complements India's broader climate commitments discussed in Chapter 2, including its Panchamrit commitments and 500 GW non-fossil energy capacity target, reinforcing the role of battery circularity within India's formal climate finance architecture.

Developing standardized warranty and insurance products

Perceived technology risk remains a significant barrier to customer and investor confidence in second-life battery systems, even where technical performance is proven. Developing standardized warranty and insurance products that certify second-life battery systems would help address this perception gap. These products would build directly on the facility-level certification system proposed under Section 3.2, using certified operator status as a basis for extending standardized coverage.

Supporting the transition to mainstream commercial finance

Second-life battery projects are expected to move progressively from grant and incentive supported deployment towards greater reliance on commercial debt, private investment, and institutional capital as standards, certification systems, and operational track records mature. Supporting this transition through appropriate risk-mitigation mechanisms, portfolio aggregation approaches, and performance-based financing structures would strengthen project bankability and facilitate long-term market sustainability. Such measures would complement the financing instruments proposed above while supporting the gradual integration of second-life battery projects into mainstream clean-energy and infrastructure financing markets.

> ***The scale-up of second-life batteries in India is contingent upon a blended financing approach, comprising targeted capital subsidies and VGF for cost-sensitive segments, access to green bonds and carbon finance for aggregated portfolios, formal inclusion within India's green taxonomy. Together, these measures would reduce perceived technology and performance risk and support the mainstreaming of second-life battery projects within conventional financing channels.***

4.7 Skill Development and Workforce

Stakeholders identified significant workforce gaps in battery diagnostics, safe dismantling, refurbishment, and safety management gaps that will widen as repurposing volumes scale unless addressed proactively. Developing a skilled workforce will be essential not only for ensuring safe battery handling and deployment, but also for improving operational efficiency, supporting innovation, and building long-term market confidence.[15] Capacity-building efforts should therefore address the full spectrum of skills required across the second-life battery value chain, ranging from technicians and safety personnel to engineers, auditors, data analysts, and battery diagnostics specialists. Meeting this need calls for parallel progress on structured training curricula, recognized technician certification, connected training ecosystems, integration into formal education, and specialized safety training.

Developing structured battery diagnostics and refurbishment training curricula

Battery diagnostics and refurbishment require specialized technical skills that are not yet widely embedded within India's existing vocational training landscape. Developing structured training curricula for battery diagnostics, refurbishment, testing, certification, and lifecycle assessment skills, in partnership with sector skill councils

[15] https://iki-india.com/public/uploads/resources_attachments/1787818518_BESS%20Skill%20gap%20report.pdf

such as the Automotive Skills Development Council (ASDC), would help build this capability in a coordinated, industry-aligned manner. This builds on the sector skill council architecture already established under India's national skill development framework, extending its coverage into the emerging second-life battery value chain.

Establishing recognized certification programmes for technicians and safety officers

Consistent, verifiable qualifications for repurposing technicians and facility safety officers are essential to ensuring safe and reliable operations across the industry. Establishing recognized certification programmes for these roles, aligned with the facility accreditation framework proposed under Section 3.2, would provide this assurance. This direct alignment ensures workforce certification and facility-level certification develop as single coherent system, rather than separate, potentially inconsistent standards.

Building training ecosystems that connect vocational institutions, facilities, and OEM networks

A steady pipeline of qualified personnel depends on strong linkages between where training is delivered and where skilled workers are ultimately needed. Building training ecosystems that connect vocational institutions, repurposing facilities, and OEM service networks would ensure a steady pipeline of qualified personnel across regional repurposing clusters. This complements the regional cluster development proposed under Section 3.4, ensuring that workforce availability grows in tandem with the physical repurposing infrastructure being established in Tamil Nadu, Maharashtra, Gujarat, Karnataka, and Uttar Pradesh.

Integrating battery circularity concepts into formal education and vocational training

A long-term skills pipeline requires battery circularity concepts to be embedded within mainstream education, rather than addressed solely through post-employment training. Integrating battery circularity, battery energy storage systems, repurposing technologies, and lifecycle management concepts into engineering, technical education, and vocational training programmes would build this foundational awareness earlier in the talent pipeline. This supports the Make in India and Atmanirbhar Bharat initiatives discussed in Chapter 2, strengthening India's long-term domestic capability in battery circularity and emerging clean-energy value chains.

Developing specialized training on battery safety and emergency response

Repurposed battery systems carry distinct safety risks, particularly around thermal runaway, that require dedicated training beyond general battery handling knowledge. Developing specialized training and certification programmes on battery safety, thermal runaway management, emergency response procedures, and safe transportation and storage of retired batteries would build this dedicated safety capability. This complements the dedicated safety evaluation protocols proposed under Section 3.2, while ensuring technical safety standards are matched by an equally well-trained workforce capable of implementing them.

> ***Workforce readiness for second-life battery scale-up in India is contingent upon structured diagnostics and refurbishment training curricula, recognized technician and safety officer certification, connected training ecosystems linking vocational institutions with industry, integration of battery circularity concepts into formal education, and specialized safety and emergency response training. Together, these measures would build the skilled, safety-conscious workforce necessary to support safe and efficient deployment at scale.***

4.8 Environmental and Life Cycle Assessment

The environmental case for battery repurposing rests on a specific, quantifiable claim that extending a battery's useful life through second-life deployment reduces lifecycle emissions and resource consumption relative to early recycling or new battery manufacture. Substantiating this claim with credible, standardized data is essential to unlocking carbon finance, green taxonomy, and ESG-linked capital pathways proposed elsewhere in this framework, and to building public and institutional confidence in the environmental integrity of second-life systems. Establishing this evidence base calls for parallel progress on a standardized LCA methodology, quantified comparative emissions benchmark, environmental disclosure requirements, and the integration of LCA data into certification and carbon finance mechanisms.

Developing a standardized life cycle assessment methodology for second-life batteries

Environmental claims about battery repurposing are currently made without a consistent, India-specific methodology for calculating lifecycle emissions and resource use. Developing a standardized LCA methodology, tailored to India's battery chemistry mix, grid emissions factors, and manufacturing base, would provide a common technical basis for evaluating the environmental performance of second-life systems. This methodology would draw on the SoH and RUL assessment protocol proposed under Section 3.2, using battery condition data as a key input for lifecycle emissions modelling, and would complement the technical standards work already underway through the BIS working group (ETD 11/WG 06) described in Chapter 2.

Quantifying comparative emissions benefits of repurposing relative to recycling and new manufacturing

Decision-makers across the ecosystem, from regulators defining the reuse-repurposing-recycling hierarchy to financiers evaluating green bond eligibility, require clear, quantified evidence of the emissions benefit that repurposing offers over alternative pathways. Quantifying these comparative emissions benefits, benchmarked against both early recycling and new battery manufacturing, would provide this evidence. The quantification would directly reinforce the circularity hierarchy proposed under Section 3.1.3, translating its qualitative preference for repurposing over recycling into a quantified, defensible environmental case, and strengthens the resource-security narrative around India's near-total dependence on imported battery-grade critical minerals.

Establishing environmental reporting and disclosure requirements

Consistent environmental reporting allows performance to be compared across operators, projects, and time, supporting both market transparency and regulatory oversight. Establishing environmental reporting and disclosure requirements for certified second-life battery operators, covering lifecycle emissions, resource recovery, and material efficiency metrics, would provide this consistency. This would build on the facility-level certification system proposed under Section 3.2.4, incorporating environmental disclosure as a component of the broader operator accreditation framework.

Integrating LCA data into certification and carbon finance mechanisms

The value of standardized LCA data is realized only when it is actively connected to the certification, taxonomy, and carbon finance mechanisms that depend on it. Integrating LCA data into the facility certification system, India's evolving green taxonomy, and carbon market mechanisms would complete this connection. This directly operationalizes the carbon market and green finance integration proposed under Section 4.1, and the green taxonomy inclusion and carbon finance access proposed under Section 4.6, giving those regulatory and financing pathways the underlying environmental data they require to function.

Establishing the environmental credibility of second-life batteries in India is contingent upon a standardized LCA methodology, quantified comparative emissions benchmarks, environmental disclosure requirements for certified operators, and the integration of this data into certification and carbon finance mechanisms. Together, these measures would substantiate the sector's environmental benefits and strengthen its access to climate-aligned capital.

4.9 Summary

Scaling repurposed EV batteries in India requires the coordinated development of a robust ecosystem that can unlock the full value of retiring battery assets. With a rapidly growing EV market, rising energy storage demand, evolving policy support, and increasing industry participation, India is well positioned to establish a vibrant and commercially viable second-life battery ecosystem.



Figure 4: Highlights of the strategic framework

The eight strategic pillars identified in this framework provide the foundation for a safe, reliable, and commercially viable second-life battery ecosystem. Together, these pillars seek to establish regulatory certainty, build market confidence through standards and certification, enable lifecycle traceability through digital systems, strengthen industrial infrastructure and partnerships, promote viable business models, improve access to finance, and develop the skilled workforce required to support ecosystem growth. Progress across each pillar will be mutually reinforcing, while gaps in any one area may constrain overall market development.

As India moves towards a future characterized by higher EV adoption and growing battery retirement volumes, early investments in these enabling conditions will be critical to unlocking the economic, environmental, and strategic value of second-life batteries. Beyond supporting battery circularity and resource efficiency, a well-functioning second-life ecosystem can contribute to national priorities related to energy security, affordable energy storage, renewable energy integration, industrial development, and critical mineral resilience.

Figure 4 summarizes the strategic framework for scaling repurposed EV batteries in India. Building on this framework, the next chapter outlines a phased strategic action plan, identifying priority interventions, responsible stakeholders, implementation timelines, and expected outcomes for scaling second-life battery deployment in India.

5. Strategic Action Plan

This chapter sets out the phased implementation roadmap through which the eight strategic pillars can be translated into measurable outcomes over a ten-year horizon. Actions are organized into three sequenced temporal horizons: short-term (0–2 years), medium-term (3–5 years), and long-term (5–10 years) each with defined lead and supporting institutions, target outputs, and pillar linkages. This structure follows directly from the phased approach validated by stakeholder consultation, which emphasizes sequencing standards and pilots ahead of large-scale financing and market instruments.

The strategic action plan follows a deliberate build-then-scale-then-mature logic. In the short term, the priority is to establish the technical and regulatory foundations standards, testing capacity, pilot demonstrations, and initial policy signals without which later-stage financing and market instruments cannot function credibly. In the medium term, the focus shifts to converting validated pilots into commercial-scale deployment, backed by strengthened aggregation infrastructure and blended financing mechanisms. In the long term, the objective is a self-sustaining, internationally competitive second-life battery market, fully integrated with national energy infrastructure.

5.1 Short-term Actions (0–2 Years)

Short-term actions concentrate on three priorities that stakeholders consistently identified as most urgent: developing testing and repurposing standards, launching monitored pilot projects across priority application segments, and introducing initial policy incentives and awareness measures.

Table 4: Short-term action plan with indicative targets

Action	Key Stakeholders	Target Output
Policy and Regulations		
Issue a regulatory notification establishing a distinct 'second-life battery' asset classification within ESS policy	MoP (lead), MNRE, BIS, CPCB	Policy circular/notification recognizing SLB as a defined ESS asset class
Standards, Testing and Certification		
Finalize a draft national SoH/RUL testing and grading standard for public consultation	BIS (lead), ARAI, CSIR-NML, UL, TUV, battery repurposers	Draft Indian standard circulated for stakeholder comment
Establish 2–3 pilot national SLB testing and certification centres in EV-manufacturing clusters	MHI (lead), MoP, BIS, State industry departments, ARAI	Operational testing centres with defined SOPs
Define transport and safety guidance for repurposed batteries	BIS (lead), MoRTH, transport agencies,	Circular on transport requirements for repurposed packs

Table 4: Short-term action plan with indicative targets

Action	Key Stakeholders	Target Output
Battery Traceability and Digital Infrastructure		
Develop a consultation draft of Battery Aadhaar traceability data schema	MoRTH (lead), MoP, manufacturers, EV OEMs, repurposers, platform providers	Draft data schema and pilot digital registry
Industrial Ecosystem Development		
Launch monitored demonstration pilots across telecom backup, C&I backup, rural microgrid, and EV-charging-buffer segments	MNRE/MoP/MHI (lead), EV OEMs, end-users, DISCOMs, repurposers	Minimum 10 MWh of monitored pilot deployment with published performance data
Market and Business Models		
Launch a national awareness programme on second-life battery safety and reliability for C&I buyers and public agencies	BEE (lead), EESL, MNRE, industry associations, repurposers	Awareness toolkit and campaign reaching priority buyer segments
Financing and Incentives		
Introduce a dedicated VGF window for second-life BESS demonstration projects	IREDA (lead), MNRE, DST, financial institutions	Scheme guidelines issued; first funding tranche disbursed
Skill Development and Workforce		
Develop a battery diagnostics and repurposing technician certification curriculum	ASDC (lead), Skill India, repurposers	Certified curriculum launched in 2–3 training institutes
Environmental and Life Cycle Assessment		
Commission development of an India-specific LCA methodology for second-life batteries	MoEFCC (lead), BIS, TERI, BIS, research institutions	Draft LCA methodology circulated for stakeholder consultation

5.2 Medium-term Actions (2–5 Years)

Medium-term actions build on validated short-term pilots to strengthen collection and aggregation systems, expand certified industrial capacity, and introduce the financing and market mechanisms needed to move from demonstration to commercial scale.

Table 5: Medium-term action plan with indicative targets

Action	Key Stakeholders		Target Output
Policy and Regulations			
Mainstream certified second-life batteries as an eligible storage option within BESS guidelines	MoP (lead), MNRE, State nodal agencies		Guidelines updated to include certified SLB systems
Provide regulatory and tax treatment of battery-leasing and BaaS structures	Ministry of Finance (lead), MoP, NBFCs, leasing companies		Clarificatory guidance on asset ownership, depreciation, and taxation for leased storage assets
Standards, Testing and Certification			
Expand certified testing infrastructure nationally and operationalize a facility accreditation scheme	NABL (lead), BIS, testing laboratories		Facility accreditation scheme operational across major manufacturing states
Develop a second-life-specific safety and installation code, overlaying IS 17092	BIS (lead),	Fire safety authorities, insurers	Notified installation code addressing mixed-SoH modules and thermal propagation
Battery Traceability and Digital Infrastructure			
Roll out a nationally integrated digital battery Aadhaar, linked to the EPR portal	CPCB / MoRTH (lead), MoP, NIC, OEMs, repurposers		National registry operational with SoH-linked traceability for repurposed packs
Industrial Ecosystem Development			
Establish regional battery aggregation hubs and formalize informal collectors into the traceable value chain	CPCB/SPCB (lead), urban local bodies, aggregators, recyclers		Aggregation hubs operational in high-EV-density states; registered collector network established
Market and Business Models			
Scale validated pilot models to commercial rollout across telecom, C&I, and rural microgrid segments	MNRE (lead), repurposers, ESCOs, DISCOMs		Commercial-scale deployment reaching defined cumulative MWh milestones per segment
Financing and Incentives			
Develop insurance and performance-warranty products tailored to second-life BESS risk profiles	IRDAI (lead), insurers, certification bodies		Commercially available insurance and warranty products for certified SLB systems

Table 5: Medium-term action plan with indicative targets

Action	Key Stakeholders	Target Output
Skill Development and Workforce		
Scale technician certification programmes nationally	ASDC (lead), Skill India initiative, SCGJ, repurposing industry	Defined cumulative number of certified technicians trained across regional clusters
Environmental and Life Cycle Assessment		
Publish quantified comparative emissions benchmarks and mandate environmental disclosure for certified operators	MoEFCC (lead), BIS, certification bodies	Published benchmark study; disclosure requirements incorporated into facility accreditation

5.3 Long-term Actions (5–10 Years)

Long-term actions consolidate the gains of the preceding phases into a mature, internationally competitive market—one that operates with diminishing reliance on concessional support and is fully woven into India's energy and industrial infrastructure.

Table 6: Long-term action plan with indicative targets

Action	Key Stakeholder	Target Output
Policy and Regulations		
Fully integrate second-life BESS into grid codes, ancillary services markets, and DISCOM resource planning	CEA (lead), MoP, DISCOMs, regulators	Second-life BESS formally recognized in grid planning and ancillary service eligibility
Mandate lifecycle carbon-footprint reporting for battery systems and integrate second-life BESS into carbon market mechanisms	BEE (lead), MoEFCC, verification agencies	LCA-based reporting framework operational; SLB projects eligible for carbon credit generation
Standards, Testing and Certification		
Institutionalize continuous evolution of standards, including the phased inclusion of additional battery chemistries as technology matures	BIS (lead), research institutions, industry	Permanent standards review mechanism operating on a defined revision cycle
Battery Traceability and Digital Infrastructure		
Achieve full lifecycle inter-operability of the Battery Aadhaar	MeitY (lead), NIC, OEMs, CPCB	Battery Aadhaar operating with automated lifecycle updates

Table 6: Long-term action plan with indicative targets

Action	Key Stakeholder	Target Output
Industrial Ecosystem Development		
Position India as a regional centre for second-life repurposing technology and services, including export of systems and know-how	Ministry of Commerce (lead), Invest India, industry	Established export pathways for repurposed BESS systems and repurposing services
Market and Business Models		
Mature domestic BaaS, leasing, and aggregation markets into asset classes	Industry (lead), (repurposers, ESCOs, OEMs), institutional investors	Established secondary market for second-life BESS assets
Financing and Incentives		
Achieve a repurposing rate of technically eligible battery capacity	NITI Aayog (lead), CPCB, MoP	National repurposing rate tracked and reported against defined trajectory
Skill Development and Workforce		
Institutionalize second-life battery diagnostics, repurposing, and safety competencies within mainstream technical and engineering education (polytechnics, ITIs, engineering colleges), moving beyond standalone certification programmes	AICTE (lead), Skill India, repurposing industry, academic institutions	Second-life battery modules embedded in accredited technical curricula nationally; self-sustaining talent pipeline requiring minimal industry-funded bridge training
Environmental and Life Cycle Assessment		
Fully integrate LCA data into green taxonomy classification and carbon credit generation for second-life BESS	MoEFCC (lead), BEE, verification agencies, MoP	LCA-linked carbon credit eligibility operational for certified SLB projects.

5.4 Enabling Conditions for Successful Delivery

The pace and quality of delivery against this action plan will depend on several enabling conditions being actively nurtured throughout implementation. These are framed below as positive success factors that the action plan is designed to build, rather than as constraints to be managed reactively.

Inter-ministerial coordination

Second-life battery policy spans the mandates of at least six central ministries and multiple regulators MoP, MNRE, BIS, CPCB, MeitY, and the Ministry of Finance, alongside state nodal agencies and DISCOMs, as set out in the institutional role matrix in Section 5.4. No single ministry can deliver the full agenda alone: MoP and MNRE

own the asset-classification and deployment mandates, BIS owns standards and certification, CPCB and MeitY own traceability, and the Ministry of Finance owns the tax and leasing treatment that underpins commercial business models. Left uncoordinated, this distribution of authority is precisely the condition that has historically stalled cross-cutting energy transition policy in India each ministry advancing its own instrument on its own timeline, with no shared view of sequencing or dependency.

Sustained alignment therefore requires more than periodic consultation. A dedicated inter-ministerial coordination mechanism whether a standing task force under MoP or NITI Aayog, or a Battery Storage Mission-style structure with representation from all six ministries would allow the phased sequencing set out in Sections 5.1 to 5.3 to be tracked jointly, with a shared timeline against which the classification, standards, traceability, and financing workstreams can be monitored and re-sequenced as bottlenecks emerge. This coordination mechanism should be established early in the short-term phase, since several Chapter 4 interventions (asset classification, VGF design, testing-centre siting) depend on parallel decisions by more than one ministry.

Deepening OEM collaboration on battery data access

Access to BMS usage history charge-discharge cycles, thermal exposure, fault events, and SoH trajectory is the single largest driver of low-cost, rapid battery grading and repurposing, as established in Chapter 2. Where this data is unavailable, repurposers must substitute expensive, time-consuming physical testing, eroding the cost advantage that makes second-life BESS commercially viable in the first place. Today, however, OEM data-sharing remains inconsistent: battery history is treated by manufacturers as commercially sensitive, liability concerns discourage disclosure, and no standard data schema or access protocol yet exists to govern what is shared, with whom, and under what terms.

Closing this gap requires early, structured engagement between OEMs and the repurposing industry, rather than waiting for the Battery Aadhaar traceability platform proposed in Chapter 4 (Section 4.3) to mature. Pilot-stage data-sharing agreements covering a defined, limited set of BMS parameters, clear liability allocation, and confidentiality safeguards can begin building the trust and technical protocols that a national traceability system will later formalize. OEMs also have a direct commercial incentive to participate verified battery history materially raises the residual value a repurposer or aggregator will pay for a retired pack, and early engagement positions OEMs to shape the data-governance rules before they are set externally through regulation.

Investor confidence built through demonstrated performance

Bankability improves materially once certified facilities and monitored pilots generate a track record of reliable performance data. At present, financiers and insurers have little independent basis on which to price the risk of a second-life BESS asset: warranty terms vary project by project, degradation data is rarely disclosed in a standardized format, and no accepted benchmark exists against which a lender can compare one project's performance to another's. This uncertainty is reflected in the financing gap identified in Chapter 4 (Section 4.6), where conventional project finance remains largely inaccessible to early-stage second-life projects.

The short-term demonstration pilots proposed in Section 5.1, if designed from the outset as structured evidence-generating projects rather than one-off showcases, can directly close this gap. Consistent, third-party-verified performance reporting from even a small number of monitored pilots covering capacity retention, cycle life, and failure rates under real operating conditions would give financiers and insurers the empirical basis needed to develop the standardized warranty and insurance products envisaged in Chapter 4 (Section 4.6.4). Investor confidence should therefore be treated as a cumulative asset that compounds across pilot cycles; each additional

well-documented pilot lowers the perceived risk premium for the next, which is why standardizing performance reporting early is a higher priority than maximizing the number of pilots launched.

Workforce pipeline development keeping pace with facility growth

Certified repurposing capacity can only scale as fast as the availability of trained battery-diagnostics and safety personnel. Testing, grading, disassembly, and safe reconfiguration of retired packs require skills that do not yet exist at scale in India's technical workforce, and the certification centres and industrial clusters proposed in Chapter 4 (Sections 4.2 and 4.4) will each require a trained team before they can become operational. A facility that is built, accredited, but unable to hire qualified technicians is capacity only on paper.

The technician certification curriculum proposed in Chapter 4 (Section 4.7) must therefore be sequenced explicitly against facility roll-out, rather than developed in isolation. This means launching the pilot ASDC and Skill India curriculum in the same short-term window as the first testing centres (Section 5.1), so that a trained cohort is available as each new facility comes online, and scaling technician output through Section 5.2's medium-term expansion in tandem with the pace of facility accreditation rather than ahead of or behind it. Embedding second-life battery modules into mainstream ITI and polytechnic curricula, as envisaged in the long-term horizon (Section 5.3), further ensures the workforce pipeline becomes self-sustaining rather than dependent on repeated, industry-funded bridge training.

Consumer and institutional trust in second-life products

Market surveys among industry stakeholders identify customer confidence as a determining factor in second-life battery market success, and this study's own consultations reached the same conclusion: purchasers consistently require a 30–50% cost advantage over new systems specifically to compensate for the perceived risk associated with buying a used battery of uncertain history. Left unaddressed, this trust deficit constrains demand growth regardless of how much certified supply becomes available, since buyers, particularly public agencies and risk-averse commercial and industrial customers, will default to new equipment when second-life performance cannot be independently verified.

Certification frameworks of the kind proposed in Chapter 4 (Section 4.2) are the primary instrument for building this trust, but certification alone is not sufficient, it must be paired with visible, demonstrable proof points. The national awareness programme proposed in Chapter 4 (Section 4.5) and the short-term demonstration pilots in Section 5.1 both have a role to play. Public-sector procurement of certified second-life BESS, in particular, can serve as a visible anchor deployment that signals institutional confidence to the wider market, in the same way early government procurement has de-risked adoption of other emerging clean-energy technologies in India. Sustained investment in third-party verification, transparent performance reporting, and visible anchor deployments should therefore be treated as a continuous market-building activity throughout the ten-year action plan, not a one-time communications exercise front-loaded into the short-term.

5.5 Unlocking the Opportunity: Priority Actions

The interventions set out across this chapter and the strategic framework in Chapter 4 are not equally urgent. Of the full agenda, five actions stand out as first-order priorities: each one materially unlocks the others, each is achievable within the short-term (0–2 year) horizon defined in Section 5.1, and none of the medium or long-term milestones in Sections 5.2 and 5.3 are credible without them being addressed first. Table 7 sets these out, together with the immediate next step required on each.

Table 7: Priority actions and immediate next steps for SLB mainstreaming

Priority Action	Immediate Next Step
Inclusion of SLB in government schemes: Certified second-life batteries remain absent from PM Surya Ghar, PM KUSUM, and allied schemes and the ESO framework as an eligible storage asset. Without this, no public agency or scheme-linked buyer can procure SLB systems with confidence, regardless of how mature the supply side becomes.	MoP/MNRE to issue a clarificatory circular recognizing certified SLB as an eligible storage option under existing scheme guidelines.
Demonstration at scale for large-format applications: Most pilots to date are small, single-site, and company-specific. Utility-scale and large commercial and industrial applications, the segments capable of absorbing meaningful GWh volumes remain under-demonstrated, leaving procurement specifications and financing benchmarks undefined beyond distributed, small-scale deployments.	Commission at least one large-format demonstration (above 1 MWh) with standardized monitoring and public performance reporting, distinct from the smaller pilots already underway.
Cost-effective reverse logistics, transportation, and aggregation hubs: Reverse logistics is among the largest components of repurposing cost, and transport safety requirements add further cost and complexity. Fragmented, low-volume collection across a geographically dispersed EV market compounds this problem, keeping per-unit logistics cost high. Regional aggregation hubs are the structural fix, by consolidating retired batteries from multiple sources before onward transport, they are what make reverse logistics economical in the first place. Left unresolved, these combined costs will continue to erode the 30–50% price advantage that second-life BESS needs to compete with the new systems.	Identify two to three high-EV-density clusters to pilot dedicated aggregation hubs, co-located with the certified testing centres, and use these hubs to trial a shared collection and transport protocol with standardized battery labelling and packaging.
Standards for testing and transportation: The absence of an India-specific SoH/RUL grading standard and defined transport retest triggers is the single reason facility-level practice remains fragmented.	BIS to finalize the draft testing and grading standard for public consultation within the short-term window, aligned with UN 38.3 re-test triggers for repurposed packs.

These four actions are not sequential alternatives to be pursued one at a time—they are mutually reinforcing and should be pursued in parallel within the short-term window set out in Section 5.1. Government-scheme recognition creates the demand that justifies investment in aggregation hubs and logistics infrastructure; testing standards make performance data comparable across large-format demonstrations described above; and cost-effective reverse logistics and aggregation are what allow the cost advantage identified throughout this report to actually reach the priority applications set out in Chapter 3. Sequencing the remainder of the action plan—the medium-term scaling in Section 5.2 and the long-term institutionalization in Section 5.3 depends on these four foundations being in place first.

6. Conclusion

India's EV transition will generate a growing volume of retired batteries from 2030 onwards, reaching a cumulative repurposing potential of approximately 0.9–1.4 TWh by 2050. Building the regulatory, technical and market systems needed to absorb this volume takes a few years, so the interval between now and 2030 is the period in which the ecosystem must be built. Further, adopting second-life batteries aligns closely with India's national priorities such as advancing 500 GW non-fossil energy target, easing Energy Storage Obligations, complementing the PM E-DRIVE and PLI-ACC EV push, and supporting the circular economy goals.

Several pilot projects using second-life EV batteries have been initiated by various ecosystem players, over the past few years. These deployments were concentrated in commercial and industrial backup power, rooftop solar systems, EV charging infrastructure and other backup applications. The number of such projects has been increasing, there is growing interest in this area, and this presents an opportunity for creating enabling frameworks for commercial scale adoption of SLBs.

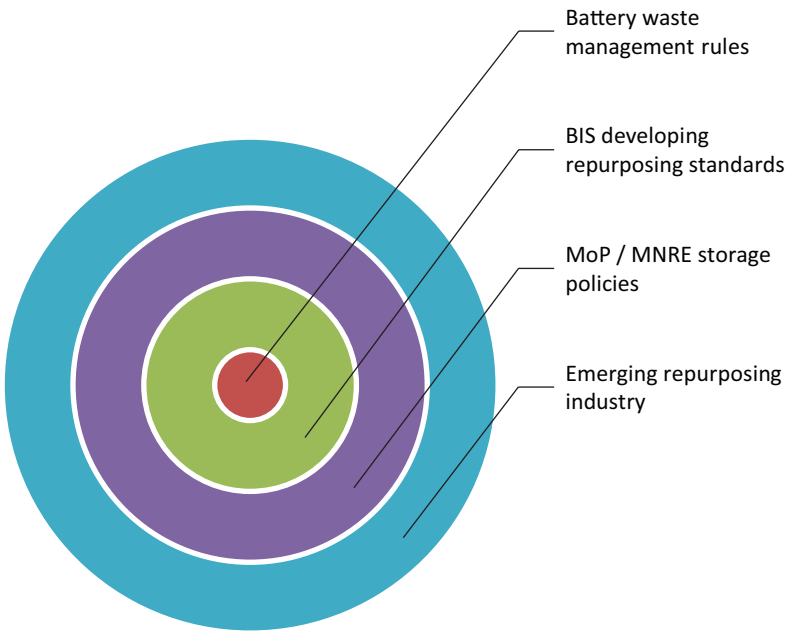


Figure 5: Existing foundations for battery repurposing

Five battery demand segments offer near-term, technically compatible demand: rural and off-grid storage, rooftop solar and behind-the-meter storage, telecom tower backup, commercial and industrial backup and peak shaving, and EV charging and peak shifting. India's LFP-dominant EV fleet is also the chemistry that best suits stationary reuse.

Several foundations for enabling repurposing of EV batteries already exist in India (Figure 5). A strategic action plan with enabling architecture that addresses asset classification definitions, SoH/RUL standards, accredited

testing and certification, mandated data access, financing and insurance instruments, etc., would enable policymakers and concerned authorities towards development of this sector.

Strategic action plan presented is based on the study findings and are backed by stakeholder consultations. The action plan is developed considering the following principles:

- Build on existing instruments: utilize second-life batteries into existing schemes and mandates.
- Sequence before scale: standards and testing must precede large-scale financing and deployment.
- Create evidence base: a well-defined, instrumented and published pilots for specific applications.
- Technical benchmarking: battery deployment should follow structured assessment.
- Compliment the recycling pathway: repurposing extends life; it does not replace end-of-life material recovery.

A detailed strategic framework was developed across eight pillars with each identifying the specific interventions required (given in chapter 4). This framework has been translated into a phased action plan sequenced across short-term, medium-term and long-term horizons, with actions, lead institutions and supporting stakeholders defined at each stage (given in chapter 5). Together, these chapters move the agenda from diagnosis to a structured, implementable programme, providing the basis for the recommendations.

India holds a unique opportunity for unlocking the EV battery repurposing potential with modest current retirement volumes, a large and growing storage market, an LFP-dominant fleet suited to reuse, and standards development in progress. With adequate actions and implementation within next few years, this repurposing agenda could harness retired EV batteries into a domestic, low-cost, traceable storage resource supporting the national missions and enhancing circularity indices.