Deloitte.

# Recycling and second life use of lithium-ion batteries

## Key insights

### Objective: Identifying key opportunities and challenges for lithium-ion battery recycling and second life applications in India

As India moves towards the wide-scale adoption of Electric Vehicles (EVs), the demand for lithium-ion batteries will increase significantly in the next few decades. In addition, the Central Electricity Authority (CEA) has projected requirement of 58 –108 GWh of Battery Storage Energy Systems (BESS) for grid scale stationary storage, largely to meet the grid's flexibility needs.[1]

**What questions are we trying to answer?**

**Why would battery recycling and second life become critical?**

- Need for battery recycling and second life use of battery
- How does it work – second life or recycling?
- Analysis of various techniques/ methods in commercial use
- Various revenue streams of second life applications and the battery recycling industry

**What are the major challenges?**

- Identifying the major challenges in scaling up battery recycling and second life refurbishing units
- Identifying infrastructure and policy bottlenecks

**What steps can be taken to address the challenges?**

- Measures to boost growth and competition in this industry
- Identify the roles of the industry, government, and academic institutions in shaping up the battery recycling industry and refurbishment units for second life of battery

[1] Scenarios as presented in the report on Optimal Generation Capacity Mix for 2029-30 by Central Electricity Authority, issued in January 2020 -

## Key insights and implications

### Assessing the need for battery recycling and second life applications

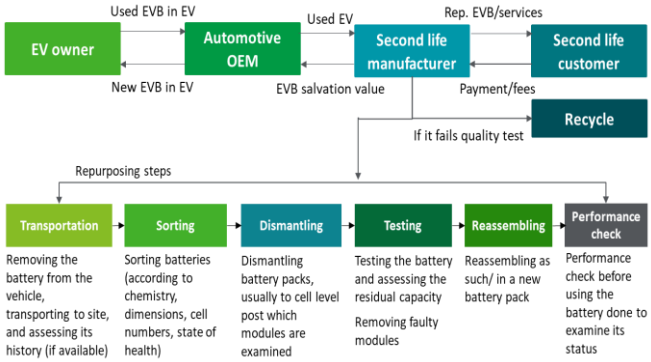
- As India embarks on the journey of decarbonising its vehicle fleet by transitioning towards EVs, the government and industry need to gear up and plan for repurposing or recycling these EV batteries, as these batteries last for (in EVs) ~5 years. Even if these batteries fall short of the high-performance requirement of powering electric motors in EVs, a considerable amount of second life remains in such batteries.
- These retired batteries can be either repurposed for a second life in alternate applications or recycled to recover raw materials.
- Loss of battery capacity limits the driving range of the electric car and declared to be unfit[2] for use in EV anymore. These batteries are expected to retain ~70 percent of their initial capacity and could provide adequate capacity for less demanding applications in their "second life".
- As new technology evolves in India, lithium-ion batteries will be in demand in the near future. Lithium Nickel Manganese Cobalt (NMC) oxide and lithium Iron Phosphate (LFP) chemistries are the most popular for commercial use.
- In addition to a high percentage of heavy metals (such as copper, nickel, and lithium), organic chemicals and plastics present in the battery have a high chance of contaminating soil and water, if not disposed off appropriately. Incinerating lithium-ion batteries releases toxic gases, resulting in air pollution.
- High-value metals, such as cobalt and nickel, are concentrated and found in select regions of the world. Hence, recycled and extracted metals provide a substantial cost advantage to battery OEMs as well as additional security from supply disruptions.

### Battery second life or recycling?

- Recycling could be the last step undertaken only when batteries cannot be repurposed or reused. LFP has been a popular chemistry in commercial use of EVs and stationary storage globally. Second use of LFP batteries makes great sense as unlike NMC or NCA batteries, LFP batteries do not contain high-value metals. Besides, LFP has a better cycle life and safety performance.
- Second life batteries could be 50–70%[3] cheaper than the new ones.

### Second life of battery

- As the life of batteries used in EVs ends, these batteries are transported to processing plants where they are dismantled and tested by second life battery manufacturers. Batteries are then grouped according to their remaining capacity and performance, assembled and delivered to customers (for second life use), after the final performance check.
- Cost incurred by a second life battery manufacturer involves salvation value (to Original Equipment Manufacturers, OEM), testing and assembly cost, capital expenditure, and transportation. Estimated second life battery cost varies from US$40-160/kWh4 depending on repurposing cost.[4]




**Battery Second Life Value Chain** | Source: Deloitte Analysis

### Battery recycling

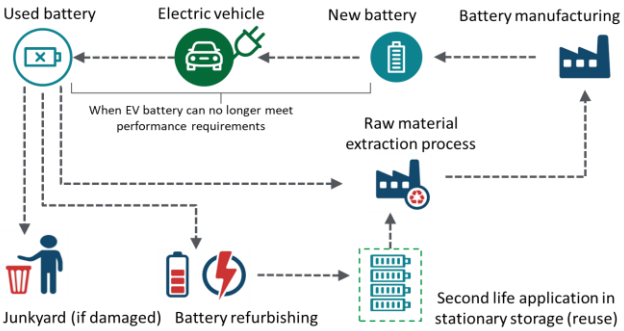
- In India, the battery recycling market is expected to pick up in the next 3-5 years, when lithium-ion batteries currently in circulation would reach the end of their life.
- Three main technologies for battery recycling are pyrometallurgy, hydrometallurgy, and direct recycling. Hydrometallurgy is the most accepted technology for battery recycling globally and in India. It generates least amount of waste and works with lesser energy compared with other forms of recycling. The quality of recovered material is better.[5]
- In India, mostly the battery recycling industry has been exporting the black mass (cathode materials as derived from battery dismantling). Net profit margin in such a value offering is limited to 3-5 percent because of limited value add.[6]
- The concentration of metal extractors is low due to the limited technological know how and substantial capital requirement for setting up these plants.
- The value realised from selling salts has been higher than the value realised from selling metals.[4] The cost of recycling is estimated at INR 90-100/kg and net profit margins realised are between 15% and 20%.[7]

[2] Maintaining 80 percent of the total usable capacity and achieving a resting self-discharge rate of only about 5 percent over a 24-hour period
[3] Second Life Industry insights
[4] Economic viability of second use electric vehicle batteries for energy storage in residential applications (May 2017)

5 Global lithium-ion battery recycling market, BIS Research (April 2020)
6,7 Battery recycling industry insights

## Key challenges

- Lithium-ion battery technology is constantly evolving. Hence, recycling poses a constant technological challenge.
- The large number of battery-pack designs on the market that vary in size, electrode chemistry, and format increases the complexity and cost of refurbishing. Each battery is designed by the battery manufacturer and automotive OEM to best suit a given EV model. This increases refurbishing complexity due to lack of standardisation and fragmentation of volume.
- The Draft Battery Waste Management Rules, 2020 states that central recycling capacities of minimum 10,000 MT/year need to be developed.8 SMEs feel that they have been marginalised due to a high capex requirement for setting up such large facilities. Also, clarity will be provided that this volume requirement is for cathode black mass or battery.
- At present, the battery recycling and refurbishment industry falls under the Ministry of Environment, Forest, and Climate Change. Land use restrictions are far higher than what other industries would have under the Ministry of Commerce and Industry, thus raising costs.
- As new batteries become cheaper, the cost differential between used and new batteries decreases, given that the rate of decline in refurbishment/recycling is expected to be lower than that in manufacturing cost.
- The industry has raised a concern that the uncertainty on tax regulations for second life applications of batteries is hindering EV adoption.
- Uncertainties over safety aspects exist especially at stages of removal, testing, and disassembly.
- Standardisation and regulations on second life battery quality or performance, and state-of-health disclosures are absent.
- There is no financial incentives, such as the PLI scheme in Advance Chemistry Cells (ACC) battery manufacturing, announced to promote the set up of battery recycling and refurbishing units, ignoring a part of the value chain.




**Electric Vehicle Battery Life Cycle** | Source: Deloitte Analysis

## Key recommendations

- A targeted action by industry bodies, regulators, policy makers, and end-users would be required to address the challenges discussed in the previous section.
- Automakers should design their EVs with second life applications in mind, thereby pushing standardisation and safety regulations. For example, Japan's first plant specialising in the reuse and recycling of lithium-ion batteries from EVs will be operated by a joint venture between a Japanese multinational automobile manufacturer and leading Japanese corporation (with a diversified portfolio in metal products and equipment business value chain).
- Scaling up recycling and refurbishment units is expected to achieve cost efficiencies and protect them from the falling costs of new lithium-ion batteries. Setting a 10,000 MT mark for centralised recycling plants is a positive step in that direction.
- Providing clarity on the minimum capacity for setting up a battery recycling plant in terms of black mass requirement or battery capacity would be useful for battery recyclers.
- Coordinated efforts of OEMs, various industry bodies, and associations, second-life refurbishment units, etc., in setting performance and safety standards, and classifying battery based on these standards will create the necessary transparency to spur demand.
- Establish Extended Producer Responsibility (EPR) to ensure battery manufacturers (include EV suppliers) are responsible for recycling batteries they have sold.
- Develop new business models to fully capture the value at hand. For example, a French multinational automobile manufacturer engages in both recycling and reuse of battery.

## Connect with us

**Debasish Mishra**
Partner
debmishra@deloitte.com

**Shubhranshu Patnaik**
Partner
spatnaik@deloitte.com

## Contributors

Anish Mandal
Himadri Singha

Deloitte.