

LITHIUM-ION BATTERY RECYCLING MARKET & TECHNOLOGY TRENDS 2020

Market & Technology Report - July 2020

The value of Lithium-ion battery recycling will be catalyzed by proper waste regulation.

KEY FEATURES

- 2019-2025 end-of-life Lithium-ion (Li-ion) batteries market by applications (in tons of cells/year)
- 2019-2025 Li-ion batteries recycling market by applications (in tons of cells/year)
- 2019-2025 value of raw materials present in end-of-life Li-ion batteries (in \$ million)
- 2019-2025 value of raw materials present in Li-ion batteries going for recycling (in \$ million)
- Insight into different Li-ion cell technologies, related technology trends and their impact on battery recycling market
- Supply chain analysis for Li-ion battery recycling
- Technology trends in Li-ion battery

REPORT OBJECTIVES

- Provide the market value (in \$ million) of raw materials and market size (in tons/year) of rechargeable Li-ion battery recycling for consumer goods, e-mobility, stationary storage, and other applications
- Demonstrate the strong, consistently growing business potential of Li-ion battery recyclers and players involved in Li-ion batteries' second-life applications
- Provide the Li-ion battery recycling supply chain landscape, including the key players for battery cells, battery packs, Li-ion battery recycling, and associated business models
- Discuss market opportunities for players that can pack and transport the end-of-life batteries
- Provide insight into different Li-ion cell technologies, related technology trends and their impact on battery recycling market
- Analyze different Li-ion battery recycling technologies

THE LITHIUM-ION BATTERY RECYCLING MARKET IS MAINLY DRIVEN BY BOOMING EV MARKET

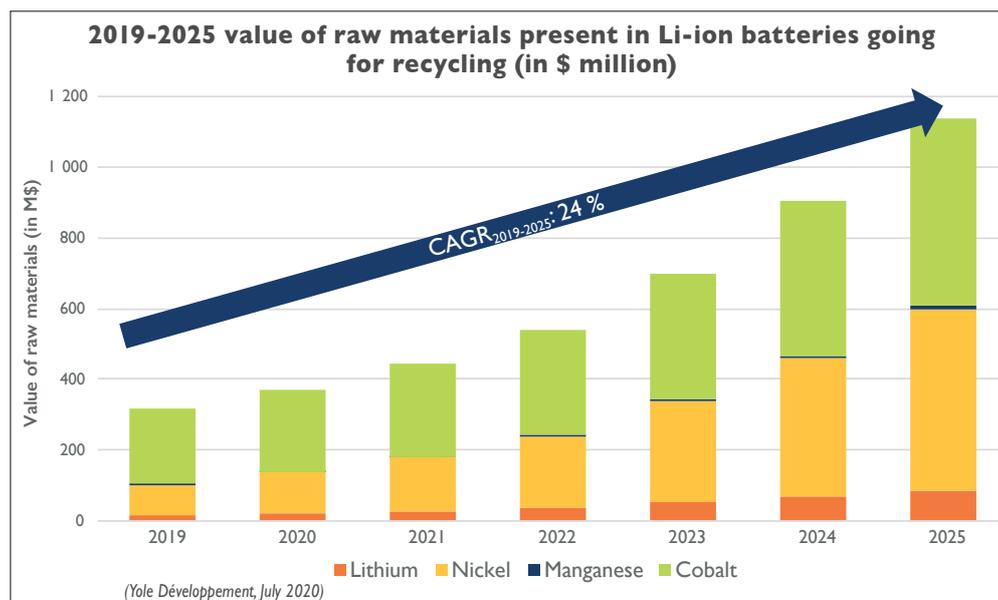
Lithium-ion (Li-ion) batteries are widely used in consumer goods, electric and hybrid electric vehicles, stationary energy storage and other applications. Rapid growth in the electric vehicle market is crucial to solve the looming climate crisis and to meet the global target of reduced carbon dioxide emission. However, growing numbers of electric vehicles present a serious waste-management challenge for Li-ion battery recyclers at end-of-life. As the popularity of electric vehicles grows explosively, so does the pile of end-of-life lithium-ion batteries that once powered those environmentally friendly cars.

According to Yole Développement (Yole), there will be about 705,000 tons of end-of-life Li-ion batteries by 2025, and by 2040 they will hit 9 million tons per year.

Currently, only a small portion of Li-ion batteries are recycled, and the rest are unfortunately going to landfill. The total Li-ion battery recycling market was about 93,800 tons in 2019, which will grow to 459,369 tons by 2025 with CAGR₂₀₁₉₋₂₀₂₅ of 30 %.

The primary source of waste batteries is the end-of-life batteries especially in the case of consumer goods. However, manufacturing scrap generated during the manufacture of Li-ion cells has also a non-negligible share. In the case of e-mobility, manufacturing scrap has a significant share of the total Li-ion recycling market. Therefore, in their Li-ion battery recycling market forecast model, Yole analysts have included the shares of manufacturing scrap generated during the production of cells, end-of-life Li-ion batteries, and end-of-second-life Li-ion batteries.

Recycling of end-of-life batteries can provide an opportunity for the battery recyclers to recover the valuable materials which make up the battery. The total value of raw materials present in end-of-life Li-ion batteries is around \$921 million, which will reach up to \$1,960 million by 2025 and \$26,381 million by 2040. As only a few percent of Li-ion batteries are recycled, the value of raw materials present in Li-ion batteries going for recycling is around \$315 million, which will reach up to \$1,137 million by 2025 and \$23,812 million by 2040.



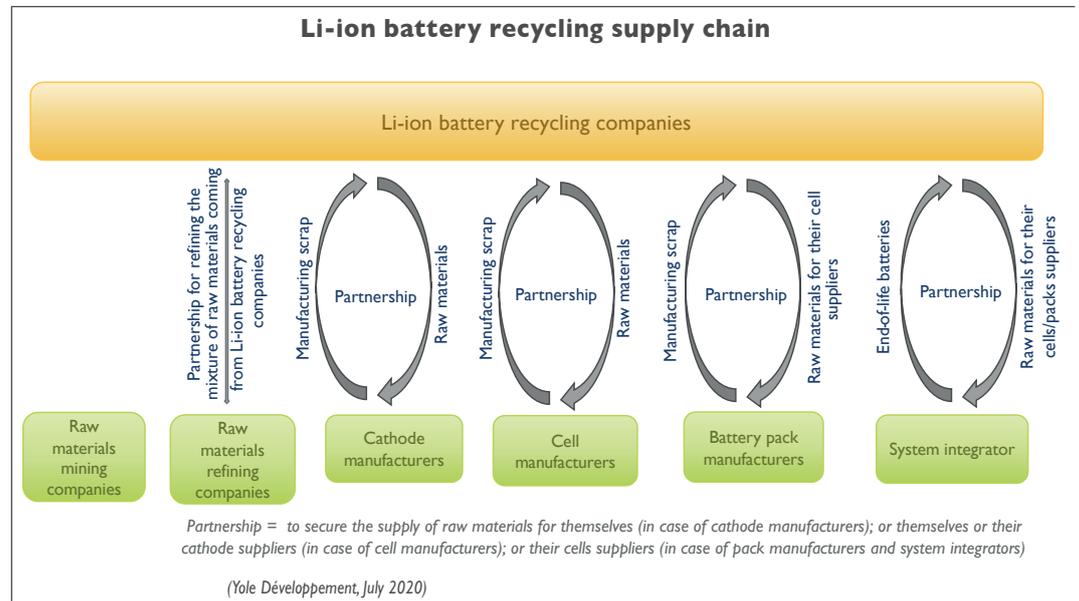
COMPANIES INVOLVED IN VARIOUS LEVELS OF THE BATTERY RECYCLING SUPPLY CHAIN ARE INTERLINKED WITH EACH OTHER

The Lithium-ion battery market is growing exponentially. The increased demand for Li-ion batteries has highlighted potential problems in the raw material supply chain (e.g., cobalt, lithium...)

needed for their manufacture. There are risks associated with the geopolitical concentration of these elements. Battery recycling can reduce this risk as battery recycling can supply a significant

fraction of these materials. There is currently a lot of movement in the Li-ion battery recycling market. Many new partnerships have been formed within the supply chain (from raw material mining companies to the system integrators) to secure the supply of raw materials. For example, partnership between

cell manufacturers and battery recyclers (e.g. LG Chem and Envirostream); or system integrators and recyclers (e.g. Audi and Umicore) to secure the supply of raw materials for themselves or for their cell/cell component suppliers.



THE LI-ION BATTERY RECYCLING MARKET IS GROWING AND ATTRACTING MORE PLAYERS

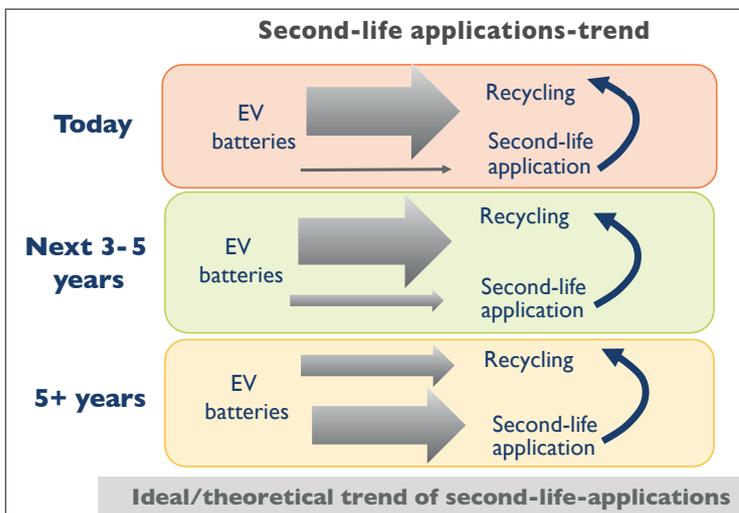
Li-ion battery recycling is a dynamic industry. With the rapid adoption of electric vehicles (EVs), the demand for Li-ion batteries as well as Li-ion battery recycling will grow significantly in the coming decades.

Currently, most of the recycling companies are located in China (e.g. Brunp, Huayou Cobalt, GEM) and Europe (e.g. Umicore, Akkuser, Accurec). Chinese recycling companies are at an advantage. They benefit from an already large battery market, enjoy extensive support from the state and have good access to the high volume of material to be recycled. Most of the recycling companies are

gradually increasing their recycling capacity to accommodate the growing volume of end-of-life batteries. Still, it again depends on the investment required to increase the capacity. To build a new recycling plant or increase the capacity of an existing plant needs high investment. High investment, the right strategies, and the rapid increase of recycling capacity are the key. Recycling players with high investment capability and the right approach may benefit. Therefore, today's smaller players or newcomers can increase their market shares, and the leaders can see their market shares decreasing, all depending on their approach.

As automotive makers are obliged to recycle their end-of-life batteries, most of the automotive makers are already evaluating different recycling companies and seeking the best battery recycling partners (e.g. partnership between Honda and SNAM; Audi's and MG Motors' partnership with Umicore) for their vehicles. The environmental criteria related to the recycling methods (pyrometallurgical, hydrometallurgical), various process steps and chemicals used, and the recycling capacity are amongst the most important evaluation factors.

EV's demand very high performance from their batteries, so once the battery's capacity declines to 70 - 80% (after 8-10 years), it needs to be swapped out. At that point, though, the battery can still handle a lot of charging and discharging, making it useful for storage in less intensive stationary applications. Currently, the majority of end-of-life batteries are going directly for recycling. However, many OEMs and energy storage companies have launched various pilot and business initiatives to explore



Real trend of second-life-application

second-life applications for used electric vehicle batteries (e.g. partnership between BMW and EVgo; Hyundai and Wartsila; Renault and Seine Alliance).

Second-life batteries provide tremendous value opportunities in the battery recycling supply chain. However, many technical, economic, and regulatory challenges exist that prevent

companies from putting in place an economically viable business model for second-life batteries.

There are many new partnerships, joint ventures and acquisitions ongoing within the supply chain. These reinforce companies' positions, secure access to strategic materials such as lithium and cobalt, ensure growth, and facilitate easier entry into new markets.

COMPANIES CITED IN THE REPORT (non exhaustive list)

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TABLE OF CONTENTS (complete content on i-Micronews.com)

Report objectives	8	> Transportation and packaging solutions for end-of-life Li-ion batteries
Executive summary	15	> Recycling of Lithium-Ion Battery - Process flow and company positioning
Market forecasts	75	> Recycling of electric vehicle batteries
> Market segmentation and methodology		> Two options for end-of-life EV batteries - Recycling directly or reuse (second-life)?
> Li-ion battery recycling market shares		> Companies involved in EV battery recycling
> 2019 – 2025 evolution of rechargeable Li-ion battery market		> Li-ion battery recycling supply chain
> COVID-19 impact on the market		> Li-ion battery recycling supply chain movement – Partnerships, joint ventures and mergers and acquisitions
> 2019-2025 and 2019-2040 total end-of-life Li-ion batteries - Split by application		> Options 2 for end-of-life EV batteries - Second-life before recycling
> 2019-2025 and 2019-2040 Li-ion batteries recycling market - Split by application		> Companies involved in second-life battery applications
> 2019-2025 Li-ion battery recycling market – Consumer goods and e-mobility		> Second-life battery partnerships, supply chain trends and projects
> Share of manufacturing scrap in battery recycling market		> How EV batteries are affecting Li-ion battery recycling business?
> 2019-2025 and 2019-2040 value of raw materials present in end-of-life Li-ion batteries (in \$ million)		Technology trends
> 2019-2025 and 2019-2040 value of raw materials present in Li-ion batteries going for recycling (in \$ million)		175
Market trends	103	> Battery cells and packs
> Main battery application market trends		> Li-ion batteries - Recycling process
> How is Li-ion battery demand growing?		> Li-ion battery recycling - Packaging and transportation of batteries
> Main battery market drivers, by application		> Li-ion battery recycling - Disassembly of large battery packs
> Consumer electronics		> Disassembly of EV battery packs – Challenges
> Stationary storage application		> Battery pack disassembly/ dismantling methods - Technical trend
> Electric mobility		> Li-ion battery recycling - Chemical processes
> Impact of growing Li-ion battery volume on waste problem		> Li-ion battery recycling process - Hydrometallurgical method
> Li-ion battery life-time by application		> Advantages and disadvantages of pyrometallurgical and hydrometallurgical process
> Time difference between production and recycling battery volumes		> Which chemical process is the best for recycling?
> Global EV battery recycling market - Top impacting factors		> Second-life batteries - Drivers and challenges
> Main drivers for Li-ion battery recycling		> Second-life applications - Trends
Supply chain	126	> Li-ion battery recycling – Challenges
> Li-ion battery raw material suppliers – Cobalt and Lithium		> Recycling of electric vehicle's batteries – Challenges
> Li-ion battery recycling companies – Geographic overview and recycling processes		Take away and outlook
> Recycling companies and their Li-ion batteries' recycling capacity		220
		Yole Développement presentation
		233



AUTHORS

Shalu Agarwal, PhD., is an analyst specializing in Power Electronics & Materials at Yole Développement (Yole). Shalu is engaged in the development of technology & market reports as well as the production of custom consulting studies within the Power & Wireless division. She has more than 10 years' experience in electronic material chemistry. Before joining Yole, Shalu worked as a Project Manager and Research Professor in the fields of electronic materials, batteries, and inorganic chemistry. Shalu received her master's and Ph.D. degree in Chemistry from the Indian Institute of Technology (IIT) Roorkee, India.



Dr. Milan Rosina is Principal Analyst, Power Electronics & Batteries, at Yole Développement (Yole), within the Power & Wireless division. Milan has 20 years of scientific, industrial, and managerial experience in equipment and process development. He also has experience in due diligence, technology, and market surveys in the fields of renewable energies, EV/HEV, energy storage, batteries, power electronics, thermal management, and innovative materials and devices. Dr. Rosina received his Ph.D. degree from National Polytechnical Institute (Grenoble, France). He previously worked for the Institute of Electrical Engineering in Slovakia; Centrotherm in Germany; Fraunhofer IWS in Germany; CEA LETI in France; and French utility company ENGIE.

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CONTACT



Western US & Canada

Steve Laferriere - steve.laferriere@yole.fr
+1 310 600-8267

Eastern US & Canada

Chris Youman – chris.youman@yole.fr
+1 919 607 9839

Europe and RoW

Lizzie Levenez – lizzie.levenez@yole.fr
+49 15 123 544 182

Benelux, UK & Spain

Marine Wybraniez - marine.wybraniez@yole.fr
+49 69 96 21 76 78

India and RoA

Takashi Onozawa – takashi.onozawa@yole.fr
+81-80-4371-4887

Korea

Peter Ok - peter.ok@yole.fr
+82 1040890233

Japan

Miho Ohtake – miho.ohtake@yole.fr
+81 34405-9204

Toru Hosaka – toru.hosaka@yole.fr
+81 90 1775 3866

Japan and Singapore

Itsuyo Oshiba – itsuyo.oshiba@yole.fr
+81-80-3577-3042

Greater China

Mavis Wang – mavis.wang@yole.fr
+886 979336809 +86 136 61566824

Sales Coordination & Customers Service

David Jourdan – david.jourdan@yole.fr
+33 472 83 01 90

Fayçal El Khamassi – faycal.khamassi@yole.fr
+33 472 83 01 95

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CONTACTS

For more information about :

- Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
- Reports & Monitors: David Jourdan (david.jourdan@yole.fr) & Fayçal Khamassi (faycal.khamassi@yole.fr)
- Marketing & Communication: Camille Veyrier (camille.veyrier@yole.fr)
- Public Relations: Sandrine Leroy (sandrine.leroy@yole.fr)

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8.2 The Seller may, from time to time, update these General Terms and Conditions of Sale, and the Buyer, shall be deemed to have accepted the latest version of such General Terms and Conditions of Sale, once they have been duly communicated to the Buyer by the Seller.

9. GOVERNING LAW AND JURISDICTION

- 9.1 Any dispute arising out or linked to these General Terms and Conditions of Sale or to any Licenses or Products purchased in application thereof shall be submitted to the French Commercial Court of Lyon, which shall have exclusive jurisdiction upon such issues.
- 9.2 French law (without reference to any applicable conflict of law provisions) shall apply to these General Terms and Conditions of sale and any agreement between the Buyer and the Seller made pursuant thereto.