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 CAGR 2019-2025 of 30%.

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.

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

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


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

Report objectives 8

Executive summary 15

Market forecasts 75

> Market segmentation and methodology
> Li-ion battery recycling market shares
> 2019 – 2025 evolution of rechargeable Li-ion battery market
> COVID-19 impact on the market
> 2019-2025 and 2019-2040 total end-of-life Li-ion batteries - Split by application
> 2019-2025 and 2019-2040 Li-ion batteries recycling market - Split by application
> 2019-2025 Li-ion battery recycling market – Consumer goods and e-mobility
> Share of manufacturing scrap in battery recycling market
> 2019-2025 and 2019-2040 value of raw materials present in end-of-life Li-ion batteries (in $ million)
> 2019-2025 and 2019-2040 value of raw materials present in Li-ion batteries going for recycling (in $ million)

Market trends 103

> Main battery application market trends
> How is Li-ion battery demand growing?
> Main battery market drivers, by application
> Consumer electronics
> Stationary storage application
> Electric mobility
> Impact of growing Li-ion battery volume on waste problem
> Li-ion battery life-time by application
> Time difference between production and recycling battery volumes
> Global EV battery recycling market - Top impacting factors
> Main drivers for Li-ion battery recycling

Supply chain 126

> Li-ion battery raw material suppliers – Cobalt and Lithium
> Li-ion battery recycling companies – Geographic overview and recycling processes
> Recycling companies and their Li-ion batteries’ recycling capacity

> Transportation and packaging solutions for end-of-life Li-ion batteries
> Recycling of Lithium-Ion Battery - Process flow and company positioning
> Recycling of electric vehicle batteries
> Two options for end-of-life EV batteries - Recycling directly or reuse (second-life)?
> Companies involved in EV battery recycling
> Li-ion battery recycling supply chain
> Li-ion battery recycling supply chain movement – Partnerships, joint ventures and mergers and acquisitions
> Options 2 for end-of-life EV batteries - Second-life before recycling
> Companies involved in second-life battery applications
> Second-life battery partnerships, supply chain trends and projects
> How EV batteries are affecting Li-ion battery recycling business?

Technology trends 175

> Battery cells and packs
> Li-ion batteries - Recycling process
> Li-ion battery recycling - Packaging and transportation of batteries
> Li-ion battery recycling - Disassembly of large battery packs
> Disassembly of EV battery packs – Challenges
> Battery pack disassembly/ dismantling methods - Technical trend
> Li-ion battery recycling - Chemical processes
> Li-ion battery recycling process - Hydrometallurgical method
> Advantages and disadvantages of pyrometallurgical and hydrometallurgical process
> Which chemical process is the best for recycling?
> Second-life batteries - Drivers and challenges
> Second-life applications - Trends
> Li-ion battery recycling – Challenges
> Recycling of electric vehicle’s batteries – Challenges

Take away and outlook 220

Yole Développement presentation 233

RELATED REPORTS, MONITORS & TRACKS

• Power Electronics for Electric & Hybrid Electric Vehicles 2020
• Li-ion Battery Packs for Automotive and Stationary Storage Applications 2020
• Status of Rechargeable Li-ion Battery Industry 2019

More information and details about our offers and bundles opportunities on www.i-micronews.com
Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 120 collaborators worldwide covering MEMS and Image Sensors, Compound Semiconductors, RF Electronics, Solid-state Lighting, Displays, Software, Optoelectronics, Microfluidics & Medical, Advanced Manufacturing, Power Electronics, Batteries & Energy Management and Memory.

The "More than Moore" market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and Blumorpho, supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

CONSULTING AND ANALYSIS
- Market data & research, marketing analysis
- Technology analysis
- Strategy consulting
- Reverse engineering & costing
- Design and characterization of innovative optical systems
- Financial services (due diligence, M&A)

More information on www.yole.fr

MEDIA & EVENTS
- i-Micronews.com website, application & related e-newsletter
- Communication & webcast services
- Events: TechDays, forums…

More information on www.i-micronews.com

REPORTS & MONITORS
- Market & technology reports
- Market and reverse technology quarterly monitors
- Structure, process and cost analysis and teardowns
- Cost simulation tool

More information on www.i-micronews.com/reports

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)
Definitions: “Acceptance” means by which the Buyer accepts these General Terms and Conditions of Sale in their entirety. It is done when the Buyer enters into the internal process of the Buyer or by the Buyer to the Seller. A “Buyer” means any user (i.e. any person acting in the course of its business activities for its business needs) placing an order pursuant to these General Terms and Conditions of Sale, with the exclusion of any individual consumer acting for his/her sole personal interest. “Loyale Développement” means an organisation which may be entitled to access a report pursuant to a Multi-User License, a Corporate License or a Licensing offer. “User” means a person or a legal entity or any other legal nature, being a business user buying the Products for its business use only, being a business user buying the Products for its business use only, being a business user buying the Products for its business use only. “Licensed Product” means any Product the Buyer or an identified user of the Company purchasing the report with an offer (i.e. subscription for a period of 12 calendar months). “Contracting Parties” or “Parties” means The seller on the one hand and the Buyer on the other hand. “Intellectual Property Rights” (“IPR”) means any rights held by the Seller or a Subsidiary of the Company in or relating to any registered models, designs, copyrights, inventions, commercial secrets and know-how, technical information, company or trading names and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not and including any pending registration of one of the above mentioned rights. “Product” means our products can be bought either on a unit basis or as a bundled offer (a description for a period of 12 calendar months). “Report” means Reports are established in PowerPoint and delivered in a PDF format with the possibility to change the format worldwide. Frequency of the release varies and according to the monitor or service (quarterly and monthly). All monitor products are eligible for a Corporate License. “Service” Yearly subscription to access a web-based interactive portal to view features and specs of a device or component or complete a complete technical document. “License” means for the reports 3 different licenses are proposed. Buyer has to choose: • One User License: The report is intended for only one identified user at the Company purchasing the report. Sharing is strictly forbidden. • Multi-User License: A report can be shared by an unlimited number of employees of said Company, working in the company where the identified user is based. No rights are granted to any employees of any Subsidiaries or Joint Ventures of the Company. • Corporate License: The report or monitor can be shared with an identified user of the Company purchasing the report with an offer (i.e. subscription for a period of 12 calendar months). A protected link that will allow the Buyer to access the monitor. “Price” means They are deemed to be inclusive of all taxes applicable in the country where the Seller is based (except for France where VAT will be added). The prices are re-evaluated from time to time by the Seller. The effective price is deemed to be the one applicable at the time of your order. “Payment” means The Buyer shall be sent by cheque payable to Yole Développement, or made by card or electronic transfer to the following account: HSBC, 1 place de la Bourse 69002 Lyon France Bank code: 0056 Branch code: 0056 Account n°: 0710 202 1565 87 BIC or SWIFT code: HSBCFRPP IBAN: FR76 3005 6001 7001 7020 0156 587 To secure the payments due to the Seller, the Seller reserves the right to request down payments from the Buyer. In such case, the latter shall be entitled to invoice interest on arrears at the same rate as the legal interest rate, plus 7 points, in accordance with article L.441-4 of the French Commercial Code. “Publication” means all the information contained in the Products has been obtained from reliable and unbiased sources. The Seller agrees to provide up-to-date data under a suitable public format. “Delivery” means All the information contained in the Products has been obtained from reliable and unbiased sources. The Seller agrees to provide up-to-date data under a suitable public format. “Buyer” means the Buyer, unless otherwise specified in writing to the Seller within 8 days following these General Terms and Conditions of Sale. “Contracting Parties” or “Parties” means The Seller on the one hand and the Buyer on the other hand.