

Perfect Closed Loop

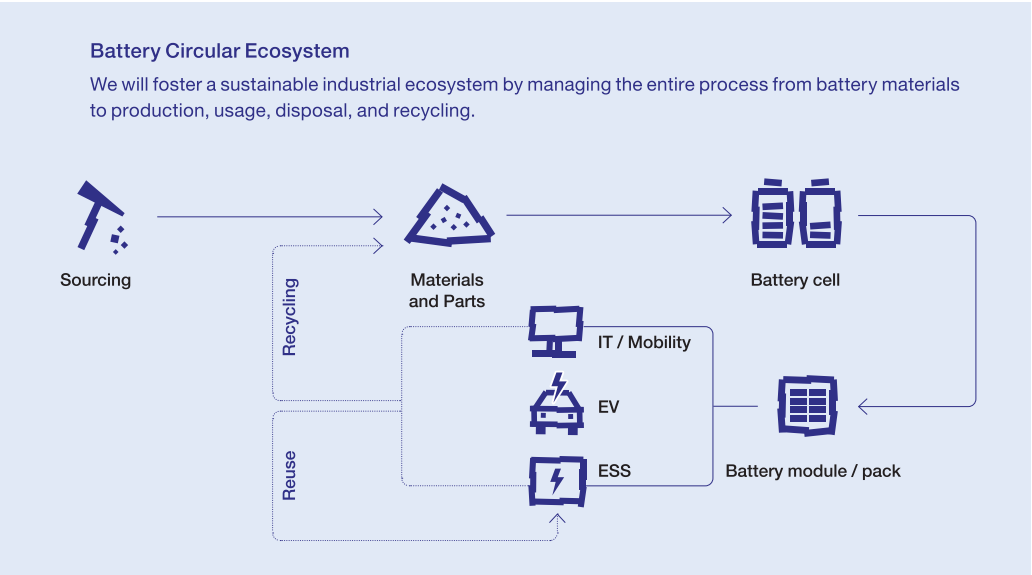


With the growth of the EV market and the rapid increase in demand for batteries, the disposal of used batteries has become an important issue. An EV battery no longer operates at sufficient capacity when the vehicle reaches the end of its life expectancy (the length of time in its original condition) or its lifespan. Used batteries, also called "end-of-life batteries", meaning that they have reached the end of their usefulness. The inappropriate disposal of used batteries will cause serious environmental pollution. Still, they can be turned into valuable resources through recycling and reuse.

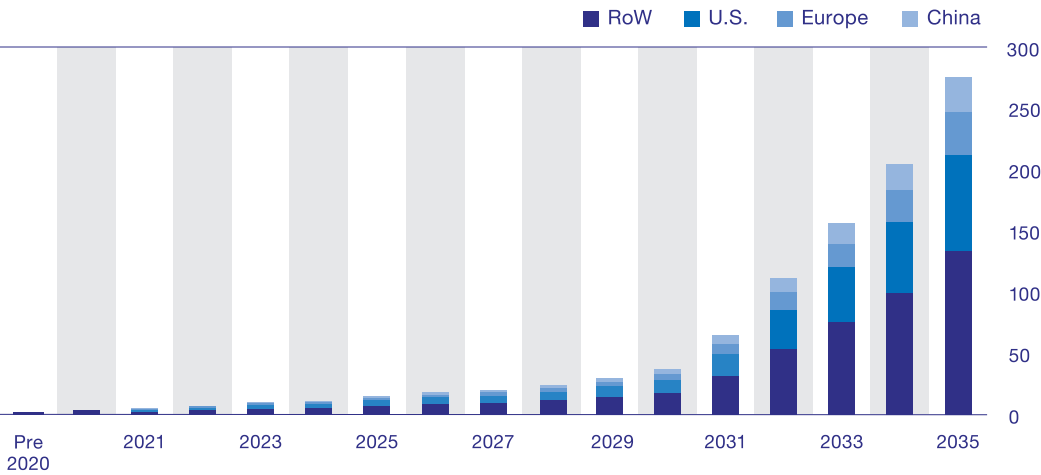
Can end-of-life batteries also be a resource?

In Europe, the United States, and China, the waves drive changes; they take the plunge into investment, development of policy and criteria for end-of-life batteries, fueling green business and boosting economy. Bloomberg NEF, a global market research firm, predicted that there will be more than 110GWh reusable end-of-life batteries in the global market by 2032. The batteries are equivalent to the electrical consumptions of as many as 11 million pure EVs that travel 50km per day on average. This means if you utilize end-of-life batteries well, you can reuse energy that can charge 11 million pure EVs. In 2020, EU Battery Regulation initially proposed mandatory minimum levels of recycled raw materials in manufacturing batteries sold in Europe by 2030 and also suggested that the collection rates of end-of-life batteries shall be increased to improve the recycling rates.

In line with this trend, LG Energy Solution has established a Closed-Loop system that covers the entire value chain from production of battery raw materials to consumption and disposal, and is working with local companies to reuse and recycle the used batteries and to recycle the scraps generated during the production process, which meet global environmental standards. We are also building a sustainable battery value chain through reusing the recovered battery based on the battery life cycle and decomposing the battery to extract rare metals such as lithium, cobalt, nickel and manganese for recycled usage. To lead the future end-of-life battery market and further environmental-friendly manufacturing, LG Energy Solution keeps up with investment and sharp the state-of-the-art technologies in ESS (Energy Storage System), which is our long-time asset.



GWh, Residual Capacity
Source Second-Life Batteries by Bloomberg NEF 2021



How does the battery reuse work?

End-of-life EV batteries still have a remained residual capacity of about 70-80% of the original ones. Even though the EV battery has completed its lifespan, it could be reused depending on its residual capacity and state of health (SoH). LG Energy Solution is establishing and executing a process to utilized end-of-life batteries as valuable energy resources.

01 Collection of End-of-life Batteries

It is a process in which batteries, which can no longer be utilized for EVs due to the vehicle reaching the end of its life or car accidents, are recovered through the regional collection system. Through initial diagnosis, batteries that can be reused and recycled are transported and stored separately.

02 Diagnosis and Commercialization

In the reconditioning process, we select reusable batteries through detailed test and diagnosis, including the appearance of reusable batteries, electrical inspection, diagnosis and prediction of residual capacity, and rate them according to their conditions and purposes of use. Batteries that do not meet the criteria for reuse are recycled.

In the refurbishing process, we develop solutions that meet system performance, quality level, and requirements for certification in each purpose of reuse, and ensure the cost competitiveness by having optimal design of necessary parts with verified safety as a top priority and efficiency of manufacturing procedures.

03 Sales and Marketing of Reusable Products

We preemptively secure applications that can maximize battery value to sell products that have a competitive edge and are economically viable for each purpose, and design a recovery system that can induce reuse after the sales and usage of the products.

LG Energy Solution is speeding up the pace of actualizing future opportunities through sufficient review, performance, and early verification of each process.

What is LG Energy Solution's battery reuse strategy?

To strengthen its capabilities as a battery manufacturer, LG Energy Solution has secured the core infrastructure technology of the battery reuse business and is establishing an optimized business model. The advancement of the safety/remaining battery life evaluation algorithm based on the diagnostic database and the securement of the safe and verified system solution are key technologies for business continuity, and we are in the process of creating a suitable business model and discovering the core usages that can minimize the end-of-life batteries' limitations and increase their competitiveness.

As part of this, we plan to secure verified technology and know-how early, through various attempts and improvements such as installation of EV charging stations using end-of-life batteries (Ochang, Chungcheongbuk-do) and establishment of ESS linked to renewable power (Jeju-do). We also actively participate in regional regulation and policy improvements and cooperate with major OEMs and related companies.

When the recovery of the used batteries for EVs is in full swing, LG Energy Solution is performing and preparing various tasks to preemptively propose diversified business models to the market and provide verified solutions. If used batteries cannot be used anymore, we are also preparing a plan to establish a virtuous cycle system, in which metals necessary for battery manufacturing are extracted through battery decomposition, refining, and smelting.



The Convergence EV Charging Station in Jeju. (Left Aewol Susan-ri Turning Place / Right World Cup Stadium)

ESG by Me

We asked Jinu Seong of the Reuse Business Team



What is the most important and difficult part of LG Energy Solution's end-of-life battery reuse business?

LG Energy Solution's end-of-life battery reuse business is not just for creating profits. Our goal is to build a healthy industrial ecosystem by collecting and reusing batteries in terms of sustainability and through a virtuous global cycle of resources system that includes recycling. We believe that our technological advance in reconditioning and refurbishing, and potential market size are the keys to achieve the goal. However, the institutional arrangements for revitalization are still insufficient, so continuous supplementation is needed. We participate in policy development by having a dialogue with the government for better outcome and swifter improvement.

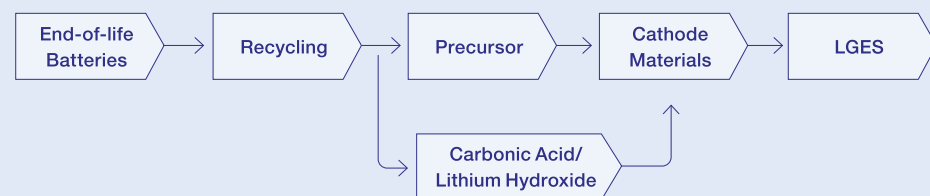
What kind of demonstration project is being carried out by the Reuse Team, and how is the battery demonstration project carried out?

As criteria for certification and inspection are still in establishing in Korea, we go on with each of the domestic projects with approval of regulatory sandboxes. It will take more time for the system to be finalized. Still, institutional restrictions, such as limitations on transportation of hazardous goods, BMS data sharing, and performance test criteria of reused batteries in pack units, are expected to be gradually relieved. Starting with the "ESS Demonstration of Reused Battery with Fast Recharge," which will be installed and operated in Ochang Plant in 2021, we are preparing demonstration projects for various purposes like UPS and power reserve. We are planning to continue to expand and promote them.

How does battery recycling work?

Battery recycling is becoming more significant in the circular economy as a means to reduce green-house gas emissions generated during the production of raw materials, to prevent resource depletion, and to decrease environmental destruction problems by recycling. Batteries can be recycled by utilizing no longer reusable batteries and scraps generated during the production process. Raw materials of the battery can be extracted by grinding and dissolving them, and by establishing the resource circulation system where they are re-injected into the production stage of cathode materials, the proportion of recycling can be increased. LG Energy Solution strives to establish a virtuous cycle of resources system that encompasses the overall value chain from production of raw materials to consumption and disposal, in order to minimize the environmental impact in the battery production process and to respond to investor and government regulations regarding the execution of circular economy. In order to do this, LG Energy Solution has signed a contract with Li-Cycle, the largest battery recycling company in North America, to provide scraps and to be supplied with 20,000 tons of nickel for 10 years. This is an amount that can produce 300,000 batteries, considering the standard of high-performance EV with battery capacity of 80kWh. Recently, in order to prepare for the expansion of the battery recycling market, we have sold the scraps generated during the production process to the recycling companies, and have established a system in which nickel, cobalt, lithium, etc. that are produced can be used as the recycled materials to make cathode materials. We have completed the implementation of recycling system at our Chinese business site in 2022 and will apply it to all production facilities of the business sites around the world, including Korea, Europe, and the United States, by 2025.

The Schematic Diagram of End-of-life Battery Recycling Value Chain



How to manage the waste generated at the business sites?

As the world gradually faces on problems in securing natural resources and managing wastes, so in the recent ESG management, it has become more essential to set plans for a resource circulation system so as to increase the rate of reuse and recycle, which can lead to saving natural resources. LG Energy Solution is rapidly promoting conversion to the resource circulation system by minimizing incinerated and dumped waste and recycling waste discharged from business sites.

Reduction of Landfill Wastes

LG Energy Solution is achieving zero waste to landfill by proactively recycling wastes discarded from the business sites. China's Nanjing Plant won the highest platinum rating in recognition of a 100% resource circulation rate from the global certification agency, UL (Underwriters Laboratories). The US LGESMI Company has been certified as Landfill Zero for five consecutive years since 2018, recognized as having less than 1% of the overall landfill rate—waste sent to landfill as a proportion of the waste generated—from the NSF (National Sanitation Foundation).

Reduction of Incinerated Wastes

The Nanjing Plant developed its self-disposing technology for wastewater treatment that is generated during the production of cathode materials for the battery manufacturing process, to improve the operating conditions of its wastewater disposal plant (cohesion adjustment, etc.) and to reduce the amount of incinerated wastes by effectively removing graphite from the cathode wastewater.

Reduction of Hazardous Wastes

To prepare for the increase in hazardous waste generation due to the growth of the business, the Nanjing Plant developed a new technology to recycle NMP solvent waste (N-Methyl-2-pyrrolidone), which accounts for about 85% of the hazardous waste. The effectiveness of thin-film evaporation technology was verified through Lab Scale Test, and the original NMP recycling rate of 80% was increased to 97%. This helped streamline the processes' operations and reduce hazardous waste emissions and the risk of waste transportation.

ESG by Me

We asked Yue Tao from the Corporate/Environmental Safety Team of LG Energy Solution Nanjing (LGESNJ)



What is the "Landfill Zero" certification, and how is the Nanjing LGESNJ Plant disposing of waste?

"Zero Waste Landfill" certification means that it meets the standard of UL ECVP 2799, Environmental Claim Validation Procedure for Zero Waste to Landfill. In other words, this means achieving a 100% waste conversion rate through reduction, reuse, and recycling without the disposal of solid and hazardous waste. In 2018, the Nanjing Plant was the first to acquire "Landfill Zero" certification from UL and was certified with a platinum rating in 2022.

What are the policies for waste disposal in the future?

We will continue to do our best to classify and dispose of waste and, at the same time, reduce the emission of waste to lessen the environmental impact and reduce waste disposal costs. We also hope to have better understanding of waste disposal and take control of the risk through in-depth monitoring to keep safety rules in work.