

## Battery recycling as a business

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### Why Subsidies are needed



Lithium-ion batteries are expensive to manufacture and this is mainly due to the high raw material cost and complex preparation processes. The most costly metal of most Li-ion is cobalt, a hard lustrous gray material that's also used to manufacture magnets and high-strength alloys.

The first commercial Li-ion battery of the early 1990s was lithium iron cobalt. The high specific energy made this battery popular for mobile phones, laptops and digital cameras. Other lithium-ion systems soon emerged, in part to substitute cobalt with the lower-cost manganese and nickel, as well as to gain better load capability, improve safety and prolong service life. Then came lithium iron phosphate, a lithium-based battery that uses no cobalt.

This system delivers excellent load capability and offers high stability, but comes at the cost of lower specific energy. Table 1 lists the material value per ton of lithium-ion batteries. The table also includes lead acid, the easiest and most profitable battery to recycle.

Battery Chemistry	Metal value (per ton)
Lithium cobalt oxide	\$25,000
Lithium iron phosphate	\$400
Lead acid	\$1,500

**Table 1: Metal value per ton of battery**

**Lead acid remains the most suitable battery to recycle; 70% of its weight contains reusable lead.**

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Knowing that billions of Li-ion batteries are discarded every year, and given the high cost of cobalt, one wonders why so few companies recycle these batteries. The reason becomes clear when examining the complexity and low yield. The retrieved raw material barely pays for labor, which includes collection, transport, sorting into batteries chemistries, shredding, separation of metallic and non-metallic materials, neutralizing hazardous substances, smelting, and purifying the recovered metals.

Consumers return 20–40 percent of spent household batteries for recycling. Many are faded laptop batteries, their life is known to be short, but one of the highest numbers comes from mobile phones. Since the battery is the only replaceable part of most mobile phones, service providers replace them as a way to solve an apparent phone problem. Most times, the fault lies elsewhere and examining the returned batteries reveal that 90 percent of these returned packs are good or can be restored with a simple service.

Ingenious entrepreneurs have discovered a business opportunity to test and recirculate batteries that have collected in overflowing boxes under the counters of mobile phone stores. Battery service centers have sprung up in the USA, UK and Israel. They purchase surplus batteries by the ton and check them with Cadex battery analyzers. This is made possible with QuickSort, a technology that assesses the battery state-of-health in 30 seconds. Some service centers handle as many as 400,000 batteries per month. Customers receiving restored B-Class batteries offer the same performance as new packs with no increased returns. Figure 2 shows a box of unwanted mobile phone batteries for testing and recirculation. Restoring discarded batteries offers a profitable and clean alternative to recycling.



**Figure 2: Discarded mobile phone batteries for service and redistribution**  
**90% of warranty returns can be serviced. Modern battery rapid-test technologies make rapid sorting possible.**  
**Courtesy of Cadex.**

Larger batteries can also be tested and reused. Several companies, including AAB, are studying the redeployment of reclaimed batteries from electric vehicles. EV batteries have a longer life than packs used in mobile phones and laptops. EV manufacturers estimate up to 70 percent remaining capacity after 10 years of service when the car may be worn out. This presents sufficient reserve performance for less demanding applications such as residential and commercial energy storage systems. An effective rapid-test method to check these larger batteries does not yet exist and would help the business case.

Lead acid are the most widely recycled batteries and the automotive industry receives credit for making this possible early on. Recycling programs are believed to have started soon after Cadillac introduced the cranking motor in 1912. There are over 100 million e-bikes on Chinese roads mostly powered by lead acid, and these batteries are responsible for 20 percent of China's 3.7 tons of lead refining. In the USA, recycled batteries provide over 50 percent of the lead supply, and lead-acid battery manufacturers, such as Johnson Controls and Exide Technologies run profitable recycling operations. The process is simple and up to 70 percent of the battery's weight yields reusable lead.

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Recycling can be dirty and the EPA (Environmental Protection Agency) has imposed strict guidelines to store cycle lead acid batteries. The plants must be sealed and the smoke stacks fitted with scrubbers. To check for possible lead escape, the perimeters must be surrounded by lead-monitoring devices.

However, people find loopholes. Lead is gold and many batteries end up in Mexico and other developing countries with lax regulations. This puts workers and residents at risk of lead poisoning. Lead is toxic and can enter the body by inhalation of lead dust or ingestion when touching the mouth with contaminated hands. If leaked onto the ground, the acid and lead particulates contaminate the soil and become airborne when dry.

Children and fetuses of pregnant women are most vulnerable to lead exposure because their bodies are developing. Excessive levels of lead can affect a child's growth, cause brain damage, harm kidneys, impair hearing and induce behavioral problems. In adults, lead can cause memory loss and lower the ability to concentrate, as well as harm the reproductive system. Lead is also known to cause high blood pressure, nerve disorders, and muscle and joint pain. Researchers believe that Ludwig van Beethoven became ill and died from lead poisoning.

Nickel-based batteries can also be recycled and the retrieved materials are iron and nickel, materials used in stainless steel production. Nickel-metal-hydride (NiMH) yields the highest return in nickel and with enough supply, the recycling process is said to make money. The lower demand for cadmium has a reduced profitability for NiCd batteries. Furthermore, the difficulty to retrieve precious metals from Li-ion makes this battery less attractive and a financial breakeven may not be possible. Although alkaline and carbon zinc amount to over 90 percent of batteries consumed in the United States, the precious metals content is low, so is the toxicity. Nevertheless, organizations are seeking ways to recycle them also. Table 3 lists the typical metals content of commonly recycled batteries.

	<b>Fe</b> Iron	<b>MnMang</b> an-ese	<b>Ni</b> Nickel	<b>Zn</b> Zinc	<b>Li</b> Lithium	<b>Cd</b> Cadmium	<b>Co</b> Cobalt	<b>Al</b> Aluminum	<b>Pb</b> Lead
Lead acid									65
NiCd	35		22			15			
NiMH	20	1	35	1			4		
Li-ion	22				3		18	5	
Alkaline	24	22		15					

**Table 3: Metals in commonly recycled batteries as a percentage of the overall content. The metal content may vary according to battery type.**

Battery recycling is energy-intensive and it takes 6-10 times more energy to reclaim metals from recycled batteries than through other sources, including

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mining. Efficient logistics to get batteries is important, and recyclers claim that the business could be profitable if a steady stream of batteries, sorted by chemistry, were available at no charge.

### **Recycling Lithium**

Some lobby groups warn about an imminent lithium shortage; they compare lithium to fossil oil as the future commodity of high demand. The need for Li-ion batteries is indeed increasing, and finding sufficient lithium as a raw material could be a challenge for the mining industry. A compact EV battery (Nissan Leaf) uses about 4kg (9lb) of lithium. If every man, woman and teenager were to drive an electric car, a lithium shortage could indeed develop.

Lithium is named after the Greek word "lithos" meaning "stone." About 70 percent of the world's supply comes from brine (salt lakes); the remainder is derived from hard rock. Scientists are developing technology to draw lithium from seawater. China is the largest consumer of lithium; they believe that future cars will run on Li-ion batteries and an unbridled supply of lithium is important to them. The total demand for lithium in 2009 reached almost 92,000 metric tons, of which batteries consumed 26 percent. Figure 4 illustrates uses of lithium that also include lubricants, glass, ceramics, pharmaceuticals and refrigeration.



**Figure 2: Discarded mobile phone batteries for service and redistribution**  
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Most of the known lithium sources are in Bolivia, Argentina, Chile, Australia and China. The supply is ample and concerns of global shortages are speculative. It takes 750 tons of brine, the base of lithium, and 24 months of preparation to get one ton of lithium in Latin America. Lithium can also be recycled an unlimited number of times; 20 tons of spent Li-ion batteries yield one ton of lithium, but recycling could be more expensive than harvesting new supply through mining. The recycled lithium is contaminated and has a quality similar to raw material that needs much processing.

Lithium is inexpensive. The raw material costs a fraction of one cent per watt, or less than 0.1 percent of the battery cost. A \$10,000 battery for a plug-in hybrid contains less than \$100 worth of lithium. Rather than worrying about a lack of lithium, graphite, the anode material, could be in short supply. A large EV battery uses about 25kg (55lb) of anode material. The process to make anode-grade graphite with 99.99 percent purity is expensive and produces much waste.

There is also a concern about shortages of rare earth materials for permanent magnets. Electric motors with permanent magnets are among the most energy efficient and they are found in many EV powertrains. China controls about 95

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percent of the global market for rare earth metals and they expect to use most of these resources for its own production. High prices of these metals may encourage more recycling in the future but current methods are difficult because the material tends to oxidize. Returning these elements to their pure metallic state requires special procedures that may not be economical with current technologies.

### Summary

Batteries are made for good performance and long life at a low price. Recycling is an afterthought and manufacturers invest little to simplify the retrieving of precious metals. The recycling business is small compared to the vast battery industry, and to this day only lead acid can be recycled profitably. Nickel-based batteries might make money with good logistics, but Li-ion and most other chemistries yield too little in precious metals to make recycling a viable business without subsidies. The true cost to manufacture a modern battery is not only the raw materials but preparation, purification and processing into micro- and nano-structures. Recycling brings the metal to ground zero from which the preparations must start anew.

To make the recycling business feasible, subsidies are needed by adding a tax to each cell sold. Perhaps more importantly than earning a profit is preventing toxic batteries from entering landfills. Soil contamination can be harmful to health and is difficult to reverse. The key to reduce the battery wasteland is in respecting batteries by treating them well and only discard them when no salvage remedy exists. Better charge methods, modern battery monitoring systems (BMS) and advanced battery test devices help get the full life out of a battery. Too many batteries are replaced as a way to troubleshoot an apparent problem. Advanced diagnostic devices help in eliminating trial-by-error so that only faded batteries and those with valid deficiencies are replaced.

### Reference

Green Economy: Why Advanced Lithium Ion Batteries Won't Be Recycled, <http://uk.ibtimes.com/articles/20110516/why-advanced-lithium-ion-batteries-wont-be-recycled.htm> [1]

Batteries International Fall 2011: Recycling compliance and ever-changing, ambiguous, environment, Timothy Ellis, Ph.D in Metallurgy; Can foreign EV makers prosper in China, editor Michael Halls.

Lead From Old U.S. Batteries Sent to Mexico Raises Risks; Andrew W. Lehren contributed reporting from New York, and Karla Zabudovsky from Mexico City. David Agren contributed research from Guadalajara, Mexico. [http://www.nytimes.com/2011/12/09/science/earth/recycled-battery-lead-puts-mexicans-in-danger.html?\\_r=1&pagewanted=all](http://www.nytimes.com/2011/12/09/science/earth/recycled-battery-lead-puts-mexicans-in-danger.html?_r=1&pagewanted=all)

Wikipedia: Battery recycling, [http://en.wikipedia.org/wiki/Battery\\_recycling](http://en.wikipedia.org/wiki/Battery_recycling) [2]

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