

Decommissioned Power Battery Recycling and An Analysis of Relevant Urban Minerals Extensibility in China

Wang Weiping^{1*} and LV Zhishan²

¹Department of Science and Technology, China Minmetals Corporation, Beijing, China

²China-ASEAN Mineral Resources, Beijing, China

Abstract

It is recommended that decommissioned power batteries be categorized as scrap batteries for recycling or batteries with remaining capacity for use in cascade utilization. Leadership from the public sector combined with the power of social participation should see China taking the opportunity to develop the related extensibility research and work on urban minerals, encouraging upstream and downstream enterprises as well as terminal users to implement decommissioned power battery utilization.

Keywords: Decommissioned power battery; Cascade utilization; Recycling; Urban minerals

Introduction

Rapid development of the power battery material industry and related equipment has been driven by the huge demand for new energy vehicles. For example, in 2015 and 2016, China's lithium-ion power battery production reached 17.0 GWh and 30.5 GWh, respectively, an increase of 188% and 79.4%. China has now developed into the world's largest power battery producer. Consequently, the year 2020 will witness a peak of scrapping power battery as 120–170 thousand tons in China [1].

China's power battery recycling system and related technologies are still not perfect, damaging the economic performance of the industry as a result of high costs for testing and repurposing of used batteries, as well as high ex-factory prices for cascade energy storage. However, with the improvement of government support policies, the promotion of the uses of recycled batteries to pre-recycling users, and the guidance of related companies to gradually establish a sound recycling system, the orderly and sound development of power battery utilization is being encouraged. At the same time, the implementation of key technologies to continuously upgrade the cascade utilization of power batteries will inevitably reduce their economic costs.

Waste batteries that are not properly treated will cause heavy metal, LiPF₆ or PVDF contamination. In the power battery recycling process, hazardous power batteries that have experienced water ingress, overheating, and physical damage need to be disposed of safely. When a power battery is retired from an electric vehicle, the residual voltage is high, and then the power battery unit is at risk of burning and explosion in an unsafe disassembled way. The main risks and hazards of dismantling waste batteries include soil, water, and air pollution caused by leakage of heavy metal in the electrode materials and various acidic or alkaline electrolytes. Some waste batteries are especially prone to burning and explosion due to short circuiting and overcharging. The dismantling of used batteries results in metal parts, plastic parts and electronic control parts, each with particular requirements for recycling.

Decommissioned Battery Recycling Legal Policy

Countries with relatively mature processes for power battery decommissioning and recovery have taken Germany as an example. Germany has established a relatively complete legal system for recycling. Battery manufacturers and importers must register with the government, and dealers must organize and implement mechanisms

to assist manufacturers in introducing where to recycle used batteries to consumers, that where free recycling of batteries exists, users are obliged to return used batteries to the designated agency.

In China, the first national standard on recycling power batteries, "Recycling Of Traction Battery Used In Electric Vehicle-dismantling Specification (GB/T 33598-2017)", has been formulated in 2017. But at present, China has not established a recycling system for the collection, transportation, storage, and recycling of waste power batteries, and lacks an effective management system, legal system and uniform certification standards [2-4].

Utilizing Decommissioned Power Battery Remaining Capacity and Recycling Waste Materials

Currently, the main research area for the application of decommissioned power battery cascade utilization is in the energy storage and capacity optimization field [5-7]. The power battery is used as an energy storage system of distributed generation to improve the stability of power supplies and reduce the cost of power generation. Battery decommissioning applies to power batteries that have been reduced to 70% to 80% of their capacity and cannot meet the applicable standards for use in electric vehicles [8]. However, these batteries with remaining capacity can still be used in energy storage and other fields after recovery, screening, and refurbishment, thereby extending the usable life of power batteries. This generates value as well as easing the pressure on recyclers of retiring power batteries.

Cobalt, lithium, nickel, copper, aluminum and such valuable non-ferrous metal elements, existing in power batteries widely, are mainly refined through hydrometallurgy and pyrometallurgy in the industry [9,10]. In terms of recycling waste materials of scrap power batteries, an environmental quality cost has been considered [11,12].

***Corresponding author:** Wang Weiping, Department of Science and Technology, China Minmetals Corporation, Beijing, China, E-mail: bruceminerals@hotmail.com

Received March 26, 2018; **Accepted** April 16, 2018; **Published** April 23, 2018

Citation: Weiping W, Zhishan LV (2018) Decommissioned Power Battery Recycling and An Analysis of Relevant Urban Minerals Extensibility in China: A Short Review. Int J Waste Resour 8: 334. doi: [10.4172/2252-5211.1000334](https://doi.org/10.4172/2252-5211.1000334)

Copyright: © 2018 Weiping W, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Decommissioned Power Battery Recycling Supply Chain Management Proximate Analysis

The power batteries that enter a battery recycling station are generally decommissioned batteries derived from maintenance and replacement practices by specific auto repair factories or 4S shops. The collected power batteries will be parked and stored for a short period of time after entering the recycling station. During this period, technical processes such as discharge processing will be required. After a certain number of batteries are collected, they will then be transported to the next processing plant. China has promoted the establishment of a coding system and a traceability system for power battery products. This means that in the future, power batteries will bear the same types of identification marks as traditional car engines.

In developed countries, a heavy metal combined smelter is a terminal processor of complex electronic wastes that include complex components and rare metals. For example, Umicore, Pollidan, and Aurubis are EU companies that deal with sorting electrical and electronic waste products, circuit boards and mobile phone waste to recover copper and rare metals. These companies have successfully built industrial chain of urban mineral resources from waste metals to strategic materials by developing the resource recycling businesses in the transformation and upgrading of traditional metal smelting.

Umweltbundesamt, UBA, as Germany's main environmental protection agency has set two demonstration projects LiBri and LithoRec for decommissioned power battery recycling, respectfully applying pyrometallurgical and hydrometallurgical process to deal with scrap power batteries [13-15].

Urban Minerals Work Scalability for Decommissioned Power Battery Recycling

"Urban minerals" refers to the recyclable material that is generated and contained in used electrical and mechanical equipment, wire and cable, communication tools, automobiles, home appliances, electronic products, metal and plastic packaging, and scrap. Urban minerals especially waste electrical and electronic products, scrapped cars and power batteries, all contain significant amounts of precious metals. The recycling and utilization of urban minerals, and the transformation, upgrading and development of large-scale integrated smelting enterprises are major issues facing China's resource, environment and non-ferrous metal sector in the next 10-20 years. In May 2010, China's National Development and Reform Commission and the Ministry of Finance jointly issued the "Notice on the Construction of Urban Minerals Demonstrative Bases". The "urban minerals" demonstration base includes advanced technology, environmental protection standards, modern management practices, and the use of scale and integration with other industries. A large quantity of nonferrous metals within scrap power batteries could supply the metallurgical materials for urban mineral demonstrative bases. The process of urban minerals work scalability for power battery returning and recycling is highly advanced

from a technological standpoint, that knowledge and technology transfer instruments should be supported in policy channel.

Conclusion

Currently, issues facing decommissioned power battery recycling work such as information isolated island, lacking of systematic standards and system closures remain widespread. Relevant industries should base themselves on the concept of a green circular economy, reliant on big data and cloud computing technology. Establishing a big data platform covering "Big data + Entity Companies + End Users" and supporting industrial layouts with the platform will help address market shortages and overcapacity as well as supply chain fluctuations. The use of cloud computing, IoT, and decommissioned battery recycling expertise will create highly networked, collaborative, and distributed services for maximizing the utility of relevant urban minerals.

References

1. Li Y (2012) Effective use and improvement of vehicle power battery recycling system in China. *Low Carbon World* 3: 30-31.
2. Guo X (2015) Study on the legal issues of power battery recycling. Master's Thesis, Beijing Institute of Technology.
3. Liu W, Gao H (2017) The urgency and countermeasures of power lithium battery recycling in China. *Industrial Economy Review* 6: 26-31.
4. Cui Y, Fu Q, Pan W, Li J (2016) Research on the construction of standards system for full life cycle of Li-ion battery used in electrical vehicle. *Standard Sci* 12: 23-29.
5. Wang Y, Yang J, Zhang C, Wang J (2017) Analysis and suggestion on the echelon use of retired lithium iron phosphate power battery. *Recyc Resour Cir Economy* 4: 23-27.
6. Li Z, Dong H (2016) Feasibility study of secondary utilization of retired power lithium-ion battery. *Chinese J Power Sources* 8: 1582-1584.
7. Liu N, Tang X, Duan S, Zhang J (2013) Capacity optimization method for PV-based battery swapping stations considering second-use of electric vehicle batteries. *Proceedings of the CSEE* 4: 34-44.
8. Zhu G, Liu S, Hai B, Chen X (2015) Research status of power battery recycling and echelon utilization. *Chinese J Power Sources* 7: 1564-1566.
9. Li J, Xu Z, Ji Z, Sun Q, Huang X (2017) An overview on the current technologies of recycling spent lithium-ion batteries. *Chinese J Rare Metals* 21: 1-11.
10. Li X, Wang N, Guo S, Li X (2017) Research progress in recycling of spent power Li-ion battery. *Battery Bimonthly* 1: 52-55.
11. You J, Duan C, Huang Z, Zhong Z (2014) Environmental quality cost control modeling based on power battery recycling. *J Tongji University* 6: 969-975.
12. Xie Y, Yu H, Ou Y, Li C (2015) Environmental impact assessment of recycling waste traction battery. *Inorganic Chemicals Industry* 4: 43-46.
13. UBA (2014) Electric bikes get things rolling-The environmental impact of pedelecs and their potential.
14. Wegener K, Andrew S, Raatz A, Dröder K, Herrmann C (2014) Disassembly of electric vehicle batteries using the example of the Audi Q5 hybrid system. *Procedia CIRP* 23: 155-160.
15. Natkunarajah N, Scharf M, Scharf P (2015) Scenarios for the return of lithium-ion batteries out of electric cars for recycling. *Procedia CIRP* 29: 740-745.