Circular Economy for Battery Industry in Indonesia and Its Prospect for Korean Companies

Muhammad Hilmy Alfaruqi, PhD

The Indonesian Researcher Association in South Korea (APIK)

Abstract

Batteries play an important role as energy storage systems to support the implementation of renewable energy resources, emergency power-backup, and electric vehicles. Specifically, batteries directly avoid 0.4GtCO_2 emissions in transport and contribute to enable renewables as a reliable source of energy to displace carbon-based energy production, which will avoid 2.2 GtCO_2 emissions. Battery market is expected to keep growing at an estimated 25% annual rate to reach a volume of 2,600 GWh in 2030. However, limited material resources such as nickel, cobalt, and manganese will become huge concern for battery industries supply chain. To anticipate this issue, circular economy for battery should be enabled. This article highlights the current condition in Indonesia toward implementation of circular economy of batteries as well as provides insight for Korean companies to involve in this business.

Introduction

Greenhouse gases emissions have increased significantly in the past decades. Notably, high fossil fuel consumption, that has been the main source of energy in the transport sector, is linked to global warming and significantly contributes to air pollution. Lithium-ion batteries (LIBs) have taken a vital place to overcome these issues. Specifically, LIB is a key driver and prominent solution in energy transition by its ability to power electric vehicles (EVs) and support grid decarbonisation via renewable energy (RE) sources. LIBs dominates the EV market due to their high energy and power density as well as long cycle life. The global LIB market was recorded over $20 billion at the cell level in 2016. It will continue to grow and by 2025 it is projected to reach ~$40 billion.[1] Although today's EV numbers are relatively low compared to other countries (Figure 1), based on Indonesia's electrification strategy, the Indonesian government has announced EVs production roadmap where 400,000 EVs will be produced in 2025, 600,000 in 2020, and 1 million in 2035.[2] Furthermore, the Indonesian Government established the Indonesia Battery Corporation (IBC) in March 2021 with equal shares from four state-owned enterprises, i.e. PT MIND ID, PT Aneka Tambang, PT Pertamina, and PT PLN that operate in aluminum smelting, mining, oil and gas, and electricity, respectively. IBC has signed a memorandum of understanding (MoU) with Korean companies, i.e. Hyundai Motor Group and LG Energy Solution to establish an EV battery cell manufactures.[3] Indonesia also aim to be new hubs for EVs in the Association of Southeast Asian Nation (ASEAN) region.

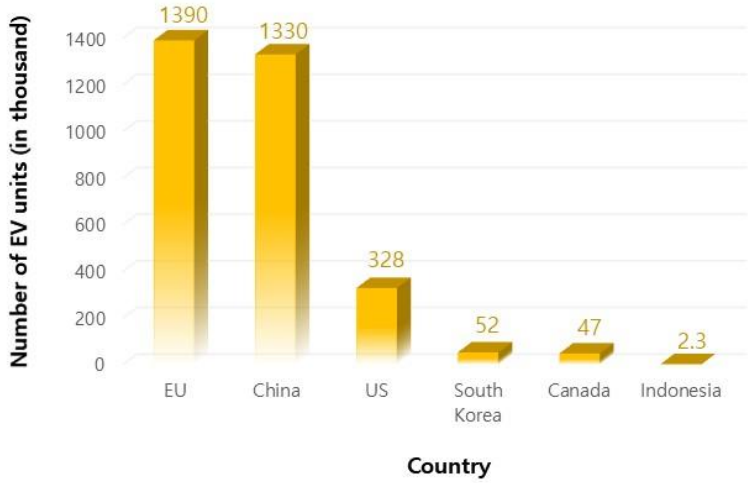

Figure 1. Number of EV units in various countries in 2020.

It is worth considering that based on typical 8 to 10 years EV batteries life span (~20% degradation rate), it is now can be accumulated about 1 million EVs have reached their optimum utilizations.[4] Furthermore, the numbers will continue to grow significantly in conjunction with the internal combustion engine (ICE) vehicles ban regulations in many countries. This can be translate into huge numbers of spent batteries in the near future, i.e. 1.6 million tons of end-of-life batteries will be expected in 2030. Moreover, spent batteries from vast numbers portable electronic applications are also expected in accordance to the Central Bureau of Statistics (BPS); i.e. the use of LIB in power bank other household electrical appliances reached more than 15 million units per year.[5] This particular issue should be foreseen since the used batteries contain environmentally hazardous chemicals and harmful to human health.

The chemicals in spent batteries are valuable if they are recovered using proper technology. As one of the main components in LIB, cathode active material (CAM) determines the majority of cell performance. Nickel-cobalt-manganese (NCM)-based compound is widely used for CAM. Recycling CAM will make sense from economic as well an ecological standpoint. Moreover, material costs have been fluctuating significantly in the last few years. This where circular economy of batteries (CEB) comes into play. The demand for NCM-based CAM is estimated to increase by factors of 18–20, 17–19, and 28–31 for lithium, cobalt, nickel, respectively, from 2020 to 2050, and thus a drastic growth of material supply chains is needed.[6]

CEB framework also allows the possibility of utilizing spent batteries for second-life applications, for example to support RE grid as stationary energy storage devices with an extra 10 years before being recycled. As a response to this situation, although Indonesia has the largest nickel reserve in the world and possesses 21 million, 1.2 billion, 43 million, and 51 million tons of nickel, aluminum, manganese, and copper, respectively, the Indonesian government also pays strong attention for treating the waste batteries. In this regard, for example, the government founded PT Nasional Hijau Lestari (NHL) owned

by PT MIND ID, PT Aneka Tambang, PT Bukit Asam, and PT Timah with equal shares. PT NHL involves in transporting, collection, storing, recycling, and final disposal. In addition, China also invested a USD 4 billion in one of Indonesia's largest nickel smelters in Morowali Industrial Park. The investment was made not only for the construction of a lithium battery factory but also for a used battery recycling factory. In Morowali Industrial Park and Weda Bay Industrial Park, other foreign companies also invested in battery production and recycling, including CATL, LG, Panasonic, Volkswagen, Mercedes Benz, and GEM Co. Ltd., a prominent battery recycling company. In the light of above discussion, this article highlights the CEB related condition particularly on the battery recycling progress and provides insight into the prospects for Korean companies for entering CEB in Indonesia.

Circular Economy of Batteries and Battery Recycling in Indonesia

The Indonesian Government has set an ambitious target as the biggest battery player in the world. The target covers all battery supply chain, i.e. involves in all activities throughout CEB. Figure 1 illustrates a typical CEB workflow. After the first application usage, depend on their state of health (SOH), batteries can be subjected for second-life applications or recycling. In the case of second-life applications, after disassembling from packs, used batteries should be further tested to determine their reusability before reconfiguration and reassembly.

The second scenario, i.e. recycling, the waste batteries will be further processed using various methods such as direct recycling, pyrometallurgy and/or hydrometallurgy. In pyrometallurgical recycling method, high-temperature thermal treatments are used, which can remove flammable electrolytes, decompose organics components the separator layer; however, high energy consumption and the emission of hazardous gases are the main concerns. Besides, hydrometallurgical recycling method offers several advantages, including lower energy consumption and potentially smaller environmental footprint.

Collaborative works through academic innovations and industrial demonstrations of the battery recycling processes are constantly evolving and attempting to make a practical impact. However, to date, none of the existing battery recycling technologies is perfect. It can be inferred that waste battery recycling technologies are challenging and undergo rigorous development to obtain highly efficient recycling process in many countries including Indonesia. It is understood that implementing both options to treat waste batteries, i.e. use for second-life applications and recycle, require sufficient knowledge and technologies.

Compare to Korea, China, or EU countries that have more establishment on the battery recycling technologies and regulations, Indonesia is still in the early stage of development for treating waste batteries although some significant progresses have been achieved. There are also some institutions that work intensively on battery recycling for example National Research and Innovation Agency (BRIN) and Gajah Mada University (UGM). At UGM, researchers founded Center of Battery Recycling. In addition, PT Indonesia Puqing Recycling Technology in Morowali also exhibits proper battery recycling technology and ready to produce new batteries from the waste batteries.[5] However, the company faced

a hurdle related to the licensing from the Indonesian government for processing Toxic and Hazardous Material (B3) waste. It is worth mentioning that there is no sufficient regulation for treating LIB waste and currently the government's work on the corresponding regulations is under progress. While, for the early stage on recycling process, i.e. waste battery collection, Center for Green Industry (Pusat Industri Hijau) under the Ministry of Industry has also deployed electronic and battery waste collection points in some major cities.

Opportunities for Korean Companies

Establishing green and environmentally friendly industry, in this regard the battery industry, is in line to the UN Sustainable Development Goals (SGDs). Therefore, Ministry of Industry supports and encourage the improvement of added value on waste processing through recycling industry, particularly on battery EV industry. The Indonesian Government has also started the works on regulation to support CEB in order to accelerate the battery and EV ecosystem development. In addition, with the establishment of battery recycling activities, new job opportunities can be created, economic activities and the domestic component level (TKDN) can be improved. Furthermore, the research and development of energy storage system is included in the National Research Priorities (PRN) 2020-2024 and thus more skilled workers are required. The Indonesian Government also facilitates more incentives for business sectors that focus on the battery recycling for energy sustainability in Indonesia. These conditions open the opportunities for foreign companies, including Korean companies that are well-known for their technology reputations.

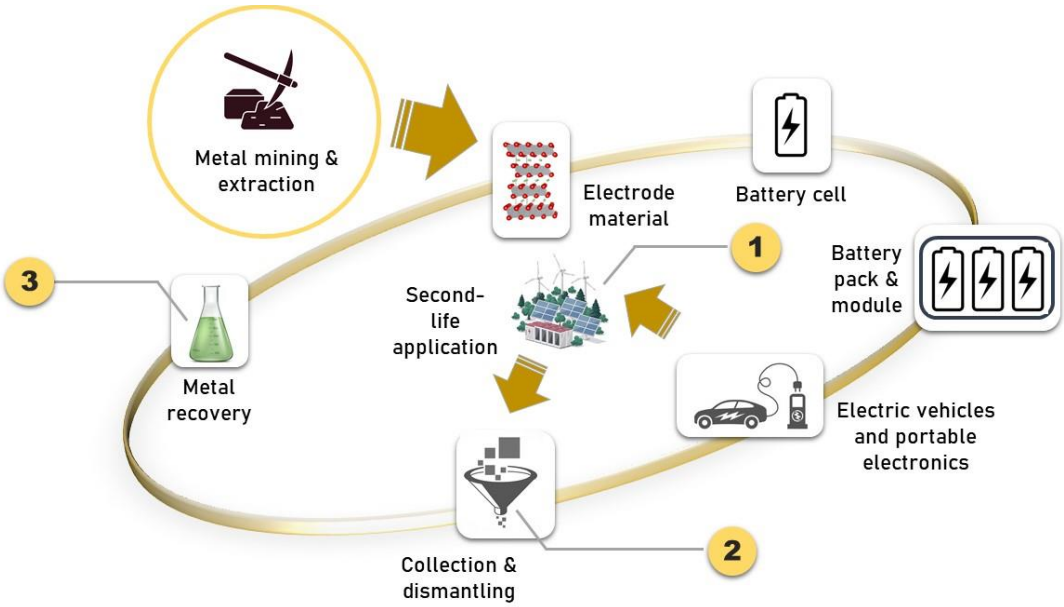

Figure 2. Illustration of CEB workflow.

The typical workflow for CEB is illustrated in Figure 2. The numbers indicate where Korean companies can enter the market on CEB, particularly at the recycling stage; although there are already many Korean companies joined the battery manufacturing business. For second-life application of waste batteries, huge opportunities for companies that have the ability to identify the battery health condition and able to facilitate the installation of grid using renewable energy resource such as solar panels and wind turbines and stationary energy storage systems. As Indonesia also aims to be a battery hub in ASEAN, more resources will be needed for the collection and dismantling stage since the waste battery may originates not only from inside Indonesia but also from neighboring countries. In the last stage of CEB, i.e. metal recovery, companies with proper technology could also involve in this business. These opportunities are widely open for companies that comply as green companies. It is also worth mentioning that not only technology-focused companies that have these opportunities, but also transport company to distribute waste battery as well as companies that focus on providing sustainable development education.

Concluding Remarks

Although Indonesia is still in the early stage on the development of battery ecosystem and its circular economy, it shows huge potential for the next decades and this moment is the right moment to enter the business. For the battery industry in Indonesia, battery recycling process will play a significant role from both ecologic and economic points of view. Enabling this CEB will require huge resources from research institutions and companies and this is great opportunities for Korean companies. Many collaborative schemes are available from the Indonesian Government to realize battery ecosystem in Indonesia.

References

1. Heelan, J., Gratz, E., Zheng, Z., Wang, Q., Chen, M., Apelian, D., & Wang, Y. (2016). Current and prospective Li-ion battery recycling and recovery processes. *JOM*, *68*(10), 2632-2638.
2. Mahalana, A., Yang, Z., & Posada, F. (2021). Indonesia transport electrification strategy (No. 2021-36).
3. Konewka, T., Bednarz, J., & Czuba, T. (2021). Building a competitive advantage for Indonesia in the development of the regional EV battery chain. *Energies*, *14*(21), 7332.
4. Chen, M., Ma, X., Chen, B., Arsenault, R., Karlson, P., Simon, N., & Wang, Y. (2019). Recycling end-of-life electric vehicle lithium-ion batteries. *Joule*, *3*(11), 2622-2646.
5. Puspita, A. N. G., Haryanto, I., & Salsabila, A. M. (2021). Peluang pertumbuhan dan prospek pasar daur ulang baterai di asia pasifik. *Jurnal Rekayasa Pertambangan*, *1*(1).
6. Xu, C., Dai, Q., Gaines, L., Hu, M., Tukker, A., & Steubing, B. (2020). Future material demand for automotive lithium-based batteries. *Communications materials*, *1*(1), 1-10.