BRIEFING NOTE

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TECHNOLOGY LANDSCAPE REPORT AND BUSINESS CASE FOR THE RECYCLING OF LI-ION BATTERIES IN SOUTH AFRICA

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KEY FINDINGS

A study was conducted to determine if there is a business case for the establishment of a Li-ion battery (LIB) recycling facility in South Africa. The results indicated that very low volumes (between 6 - 10 tonnes per year) of LIB waste are currently collected in South Africa. A desktop techno-economic study, comparing generic flowsheets for a pyrometallurgical, hydrometallurgical and physical process (producing black mass), showed that the most profitable recycling option would be the production and sale of black mass, followed by the hydrometallurgical and pyrometallurgical routes. In all cases, recycling only becomes economical at a LIB feed rate of round 500 tpa for high-value batteries. At the current low collection rates, there is not a business case for establishing a commercially viable recycling plant in South Africa. The biggest driver for the establishment of such a facility would be the anticipated growth in the local EV market.

INTRODUCTION

A sharp increase in global consumption of lithium-ion batteries (LIBs) has been observed in recent years, mainly due to the growing market for electric vehicles (EVs). The anticipated large amount of spent LIBs joining the waste stream in the next decade, is currently driving the global establishment of new recycling facilities.

There is currently no LIB recycling facility in South Africa. Although studies have previously been conducted on the LIB value chain, no study has been undertaken to assess the business case for establishing a LIB processing plant in South Africa. From a business perspective such a study is a critical first step that will inform decisions made on technology selection as well as the economic viability of the chosen technology, while from a policy perspective it is critical in determining the interventions required to unlock potential business opportunities in the LIB sector.

METHODOLOGY

- The objectives of this study were three-fold:
- To provide an overview of the current state of the LIB recycling industry in South Africa.
- To assess commercial recycling technologies that are currently available and evaluate whether these technologies are suitable for local application.
- To conduct a techno-economic study to investigate the business case for the establishment of a LIB recycling plant in South Africa.

To achieve these goals, a desktop review was performed to establish the broad trends and dynamics impacting the LIB industry locally and globally, the scope of LIB recycling in various parts of the world, end user markets for LIB fractions and the nature and availability of technologies used in the recycling of LIBs. In addition, interviews were conducted with various stakeholders to gain an understanding of the sources, flows, intermediate and final markets for LIB fractions and determine the quantities of the waste LIB material that are potentially available for recycling in South Africa. Based on the collected information, a techno-economic study was performed.

MAIN RESULTS

Currently, China, Japan and South Korea collectively account for around 80% of global LIB production. A large portion of international LIB recycling takes place in close proximity to these LIB manufacturing facilities, since closed-loop systems with recycling at the end-of-life provide a source of recycled battery materials used by manufacturers for the production of new batteries.

The anticipated large quantities of spent LIBs joining the waste stream from the EV sector, are currently driving the global establishment of new recycling facilities, especially in the Northern hemisphere.

Very low volumes of waste LIB (between 6-10 tonnes per year), mainly from consumer electronics and ICT equipment, are currently collected locally. The estimated current installed LIB capacity in South Africa is around 5 000 t, with around 1 200 tpa available for recycling. The low volumes collected (estimated at around 1% of the available waste) are not sufficient to support a local recycling facility and as a result the current LIB waste in South Africa is either stockpiled, landfilled or shipped to recycling facilities around the globe.

Currently there are three recycling process options available for the processing of waste LIBs; pyrometallurgy, hydrometallurgy and direct recycling. Pyro- and hydrometallurgical technologies have been commercialised, whereas direct recycling is still in the research stage. These different processes can be combined in different flowsheet configurations, depending on factors such as quantity and characteristics of the material available and quantity and value of the materials that can be recovered. The hydrometallurgical route is favoured for new installations, specifically in China, the United States and Northern Europe.

Three generic flowsheets, pyrometallurgical, hydrometallurgical and physical processing to produce a black mass, were used to perform a techno-economic analysis. Based on the analysis, the most profitable recycling route is the production and sale of black mass, followed by the hydrometallurgical and pyrometallurgical routes. The analysis shows that recycling only becomes economical at a LIB feed rate of round 500 tpa for high-value batteries. For lower value batteries, the process only becomes economical at much larger capacities. Profitability is very sensitive to the feed composition, specifically the Co, Ni and Cu content.

CONCLUSIONS AND THE WAY FORWARD

At the current low collection rates, there is not a business case for establishing a commercially viable LIB recycling plant in South Africa. The biggest driver for the establishment of such a facility would be the anticipated growth in the EV market. It is recommended that:

- Strategies to increase the collection of LIBs be implemented.
- Government encourages the uptake of EVs in South Africa through acceleration of the implementation of South Africa's Green Transport Strategy, implementation of fiscal incentives to make EVs more cost-competitive and stimulate market penetration, and addressing issues related to the availability of charging stations, reliable electricity supply and possibly setting manufacturing and sales targets as is being done elsewhere.

Until such time as local volumes increase sufficiently to merit a local recycling facility, it is recommended that processes be implemented to treat LIBs to a stable state, after which it can be exported to international recycling facilities. Longer-term recommendations include:

- Installation of a small-scale mechanical plant for the pre-processing of the LIB waste to produce black mass, once collection rates around 500 tpa are reached. The black mass can be treated locally or exported to international refineries for metal recovery.
- A hydrometallurgical plant for the treatment of LIBs to produce either metal precipitates or high purity battery materials should be considered once the collection and availability of a reliable supply of large enough LIB waste volumes can be guaranteed.

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