

Lithium-ion Battery Direct Cathode Recycling and Battery Cell Manufacturing

Principal Investigator (PI): Leandre Berwa, MSc, CEO & Head of Research at SLS Energy

Tel: +250 788 69 8888, e-mails: leandre@slsenergy.io and lberwa@andrew.cmu.edu

Co-PIs: Aristide Gumyusenge, Ph.D., Massachusetts Institute of Technology; Rebekah Shirley, Ph.D., Kigali Collaborative Research Center

Specific Aims

In 2020, Rwanda generated 12,432 tonnes of wastes from electrical and electronic equipment (WEEE) (Twagirayezu et al., 2021). This is expected to grow annually at a rate of 5.95%, accelerated by the target of 100% electrification rate by 2024 (Access, n.d.) and the ongoing adoption of electric vehicles for motorcycle taxis (*Rwanda Is Going Electric: Government To Eliminate Gas Motorcycles*, n.d.). Batteries, most specifically lithium-ion batteries (LIBs), have a considerable share of the total waste generated by small electronics such as cellphones, tablets, and laptops to larger equipment such as electric motorcycles, cars, and buses (Stan et al., 2014). Although there is a local e-waste dismantling and recycling facility, there is no capacity to recycle LIBs and those are exported to recyclers in Europe and/or Asia. The need to recycle locally is, therefore, an open opportunity.

This project will be a collaborative effort of partners from **SLS Energy**; the **Department of Materials Science and Engineering (DMSE) at Massachusetts Institute of Technology (MIT)**; and the **Kigali Collaborative Research Center (KCRC)**. The industry partner and researchers will contribute expertise in battery technology, materials science, and energy systems modeling.

Despite an obvious need for LIB recycling and manufacturing capacity, there are questions that need clarification to make the research project implementation economically and technically viable. These include: i) What is the generated quantity of lithium-ion batteries in the e-waste stream? How will this waste grow over time? ii) How do techniques and trends applied in LIB recycling compare to each other? iii) What is the cost to acquire materials, install and run the LIB recycling and new battery cell manufacturing facility? iv) How could these costs be optimized for cost competitiveness and relevance of produced batteries in the growing battery market? **The overall project aim** is to pioneer battery direct recycling in Rwanda and demonstrate the first of its kind, fully recycled and made-in-Rwanda battery cells. **The specific objectives** are:

- i. To demonstrate direct recovery of electrode materials, especially precious metals,
- ii. To develop an effective lithiation protocol to regenerate high-performance electrode materials,
- iii. To reassemble new batteries from the recycled electrode and electrolyte materials, and
- iv. To understand cost structures and competitiveness of new batteries considering resource availability and energy storage market needs.

The approach of this work will be to utilize a hydrothermal recycling approach to ensure the retention of structural integrity. To avoid any structure disintegration, we will i) carefully stripe the battery cells, ii) systematically clean the electrode materials through a chemical wash-and-decant process, and iii) demonstrate a thermally driven re-lithiation to regenerate functional electrodes. Market and policy trends in the regional energy storage market will also be mapped and analyzed. The outcomes of the project will be the **recovery of electrode materials** and the **demonstration of assembled cells from fully recycled materials**. There will also be a market analysis to understand the **cost competitiveness of these processes and product in regards with market needs**. While the initial research phase will consult and/or employ local stakeholders and global experts in e-waste management and battery recycling, **the expected impacts** at a later stage will be to further socio-economic, environmental, and financial gains through the creation of jobs, environment protection, and economic growth. The project will be carried out over **a period of 18 months** on a budget of RWF 89,916,427.

Additional information

Investigators/Institutions

Aristide Gumyusenge, Ph.D., Merton C. Flemings Assistant Professor, Massachusetts Institute of Technology, expert in materials science.

Rebekah Shirley, Ph.D., Research Fellow, Kigali Collaborative Research Center, expert in energy and power systems modeling.

Logos



Reference

Access. (n.d.). Retrieved April 24, 2020, from <http://www.reg.rw/what-we-do/access/>

Rwanda Is Going Electric: Government To Eliminate Gas Motorcycles. (n.d.). Retrieved May 27, 2020, from <https://weetracker.com/2019/08/28/rwanda-electric-government-plans-outlaw-gas-motorcycle/>

Stan, A. I., Swierczynski, M., Stroe, D. I., Teodorescu, R., & Andreasen, S. J. (2014). Lithium ion battery chemistries from renewable energy storage to automotive and back-up power applications - An overview. *2014 International Conference on Optimization of Electrical and Electronic Equipment, OPTIM 2014, December 2015*,

Twagirayezu, G., Irumva, O., Uwimana, A., Nizeyimana, J. C., & Nkundabose, J. P. (2021). Current Status of E-waste and Future Perspective in Developing Countries: Benchmark Rwanda. *Energy and Environmental Engineering*, 8(1), 1–12. <https://doi.org/10.13189/eee.2021.080101>