Product Offering

Se-cure Waste Management Pte Ltd

Recycling & Processing Facility of SWM

Internationally accredited facility for compliance to Environmental, Health & Safety Standards

R2v3 – The Sustainable Electronics Reuse & Recycling (R2) Standard v3
ISO9000 – International Standards for Quality Management System
ISO14001 – International Standards for Environmental Management System
ISO45001- International Standards for Health & Safety at Work

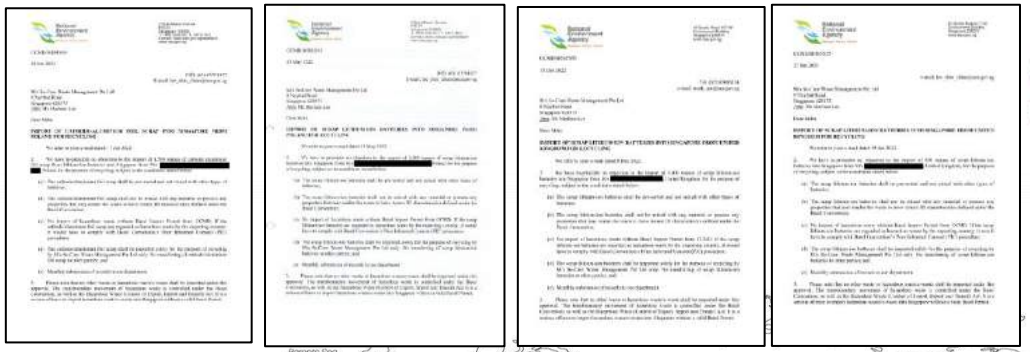
Locally compliant facility to Singapore legislations by National Environmental Agency (NEA)

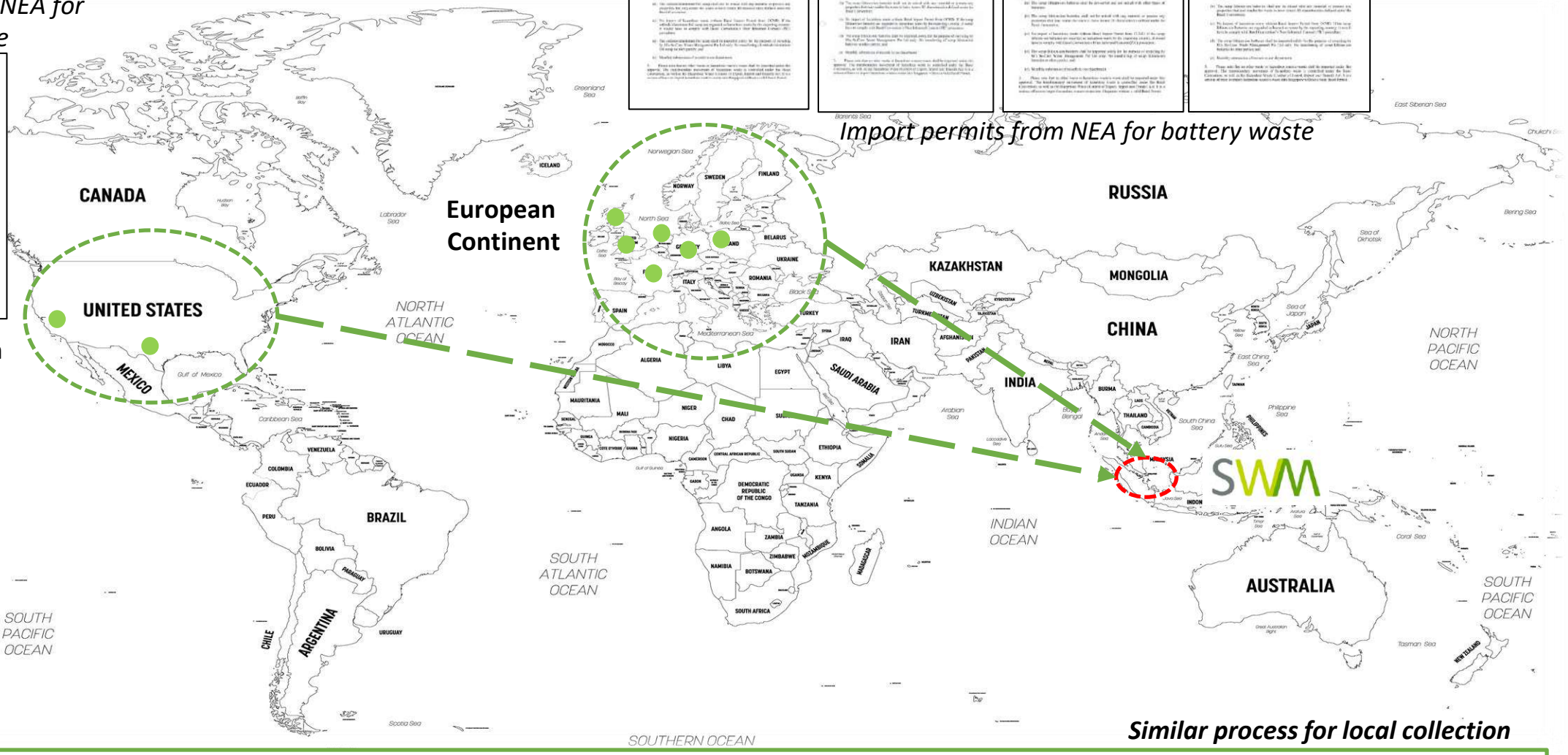
GWDF – Approved Waste Disposal Facility for Lithium-ion Batteries
GWC – Approved Waste Collector for Lithium-ion Batteries
BizSAFE – Approved by Workplace Safety & Health Council to operate

Recycling Process Overview

Import permit from NEA for battery waste

Import permits from NEA for battery waste



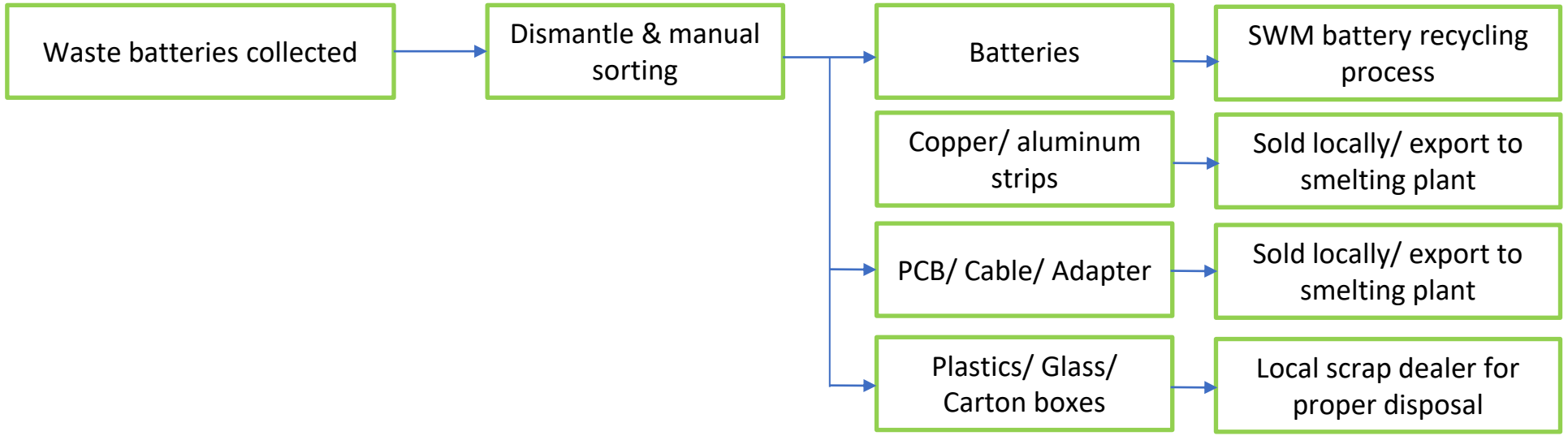


Similar process for local collection

Battery waste from European and North American continents → Import permits from NEA allows battery waste to enter Singapore → SWM → Segregation, Discharging, Evaluation, QC Check, Potential Fire Hazard Assessment, Processing, Packaging → Sends to approved downstream vendor for continued processing

Our Services & Offerings

E-waste solutioning, with lithium-ion batteries focus



Buy/ Sell (Trading) of ferrous and non-ferrous metals

Standard Procedure for Collection

Step 1:	Completion of collection/assessment form by clients and SWM
Step 2:	Joint site inspection by clients and SWM (where required)
Step 3:	Quotation and advisory on types of scrap by SWM
Step 4:	Collection and incoming checks by SWM
Step 5:	Dismantling, segregation and/ or recycling by SWM
Step 6:	Certificate of destruction issued by SWM to clients
Step 7:	Audit and compliance checks by clients

Can be customized to suit unique needs of clients/ stakeholders

Story of my life…

Raw Mat'l Extraction

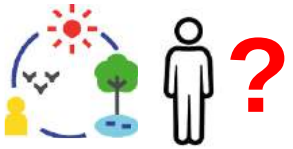
Supply

Manufacture New Batteries

Sale/ Transaction

Utilization

Landfill



Collection/ Disposal

Repurpose

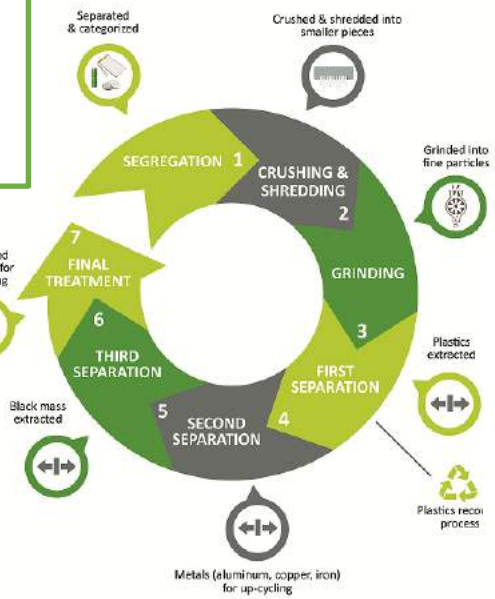
Utilization – 2nd life

Recycle

Recover

SWM EVALUATION

SWM



SWM Proprietary Mechanical Process

Final Extraction

Battery grade metal salts

SWM *rategic partners*

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Proprietary Organic Hydrometallurgy Process

NEU BATTERY MATERIALS

Proprietary Electrochemical Process

Our Mechanical Flowsheet

Lithium-ion batteries compose of metals including cobalt, nickel, lithium and manganese. At the end of life, the battery goes through the recycling process. This processed material is known as ***"black mass"***, consisting of amounts of cobalt, nickel, lithium, and manganese. These precious metals can be extracted from the black mass and upcycled for new battery production.

START

Batteries segregated; EV batteries dismantled

1. Segregate

Batteries are crushed (same types) and shredded into smaller pieces

2. Shred & Crush

Batteries are further grinded into fine particles

3. Grind & Mill

Plastics extracted (~2-5%)

4. First Separation

certified downstream plastic recyclers

Metals (iron, aluminum & copper) are extracted

5. Second Separation

Metal traders and/ or refineries

Black mass extracted

6. Third Separation

Authorized dealers

END

Overall yield between 85% - 98%, highly dependent on the nature, content and condition of batteries

Strategic Partners

- Collaborating strategic partners to offer solution(s) beyond black mass
- Promoting local innovation, providing opportunities for test/ lab effort to commercialization

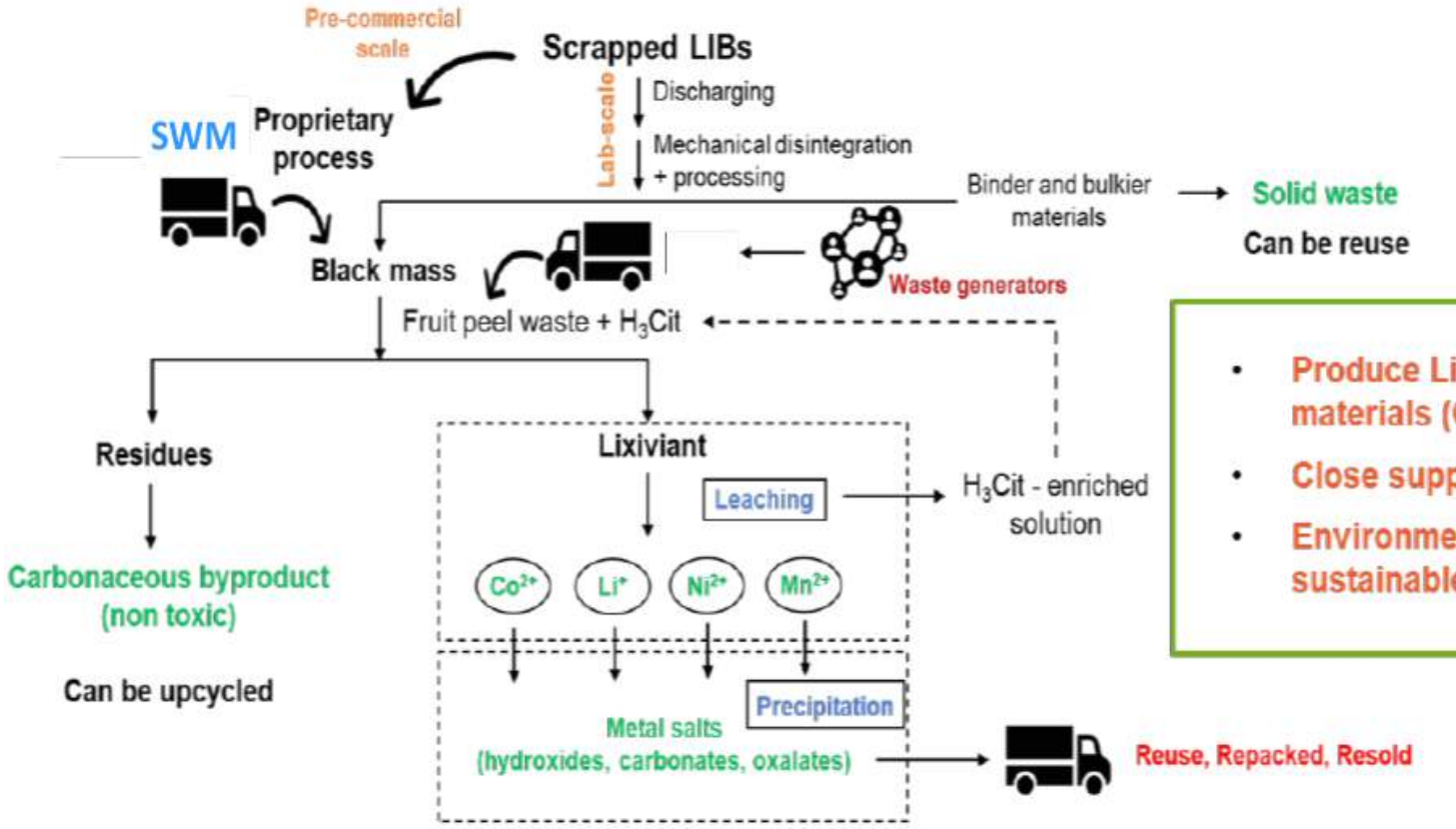
NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

- Part of NTU Scarce team's initiatives & Toxicity Studies Core Team
- Developed an organic process with orange peels using hydrometallurgy
- Development process is currently on-going, expanding beyond orange peels and exploring other food waste options
- Pilot line is located at SWM's physical site; commercial evaluation on-going

- A spin-off from NUS enterprise; a startup organization
- Focuses on the recycling of lithium-ion phosphate batteries
- Uses electrochemical process to extract battery grade lithium hydroxide that can be supplied to battery manufacturers
- Pilot line is located at SWM's physical site; commercial evaluation on-going

NEU BATTERY MATERIALS

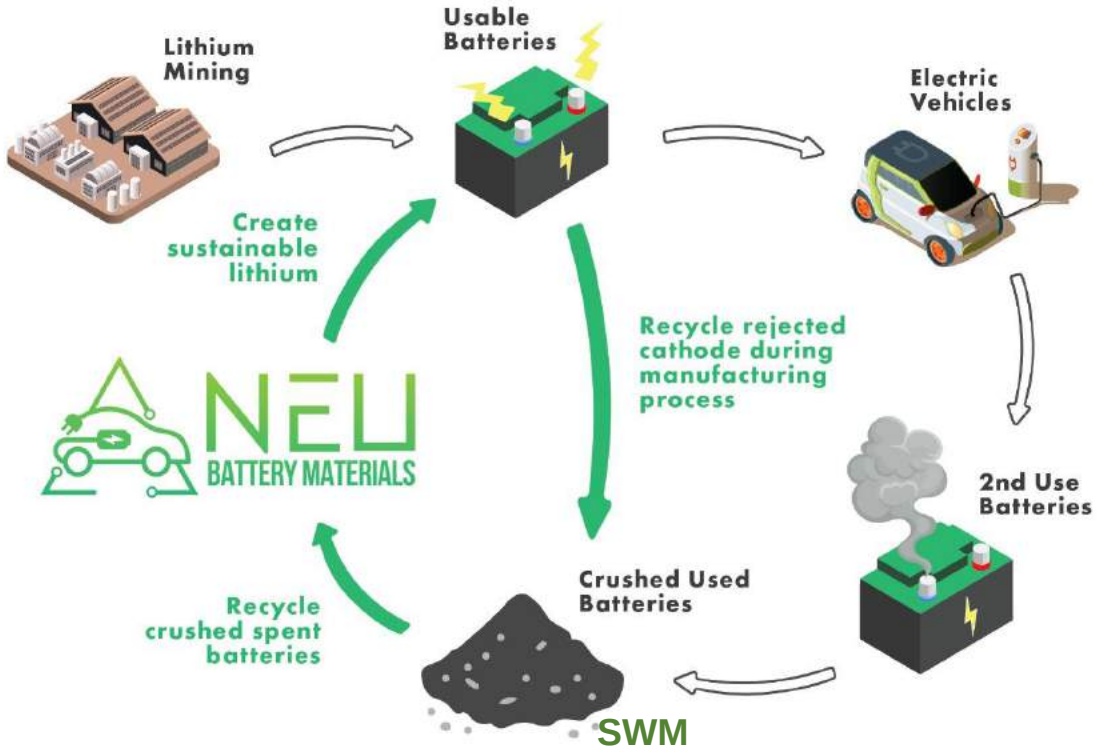
Exploring Beyond Black Mass: Organic Hydrometallurgy



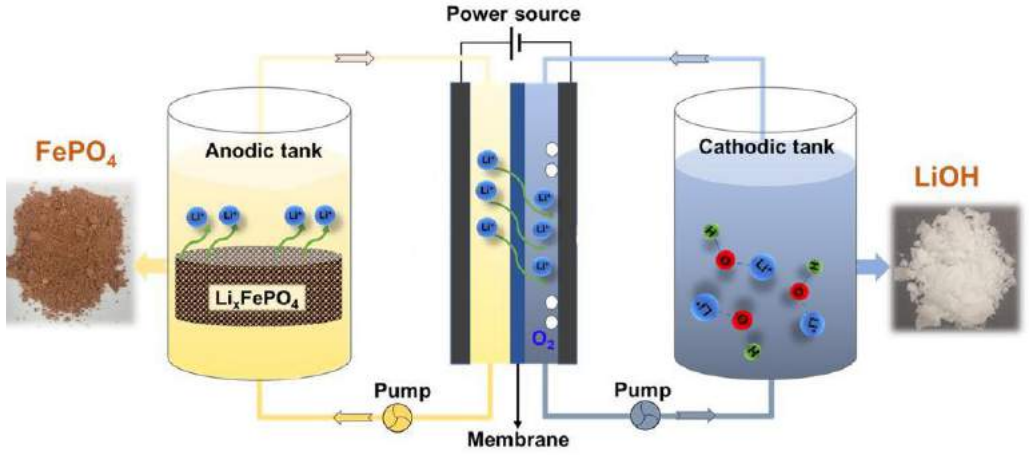
- Produce Li ion battery grade materials (Cathode + Anode)
- Close supply chain loop
- Environmental and economic sustainable approach

Source: NTU CESG2022 Poster & Environmental Science & Technology 2020, 54, 15, 1681-9692

Exploring Beyond Black Mass: Electrochemical Process



- Extracts lithium from black mass, producing lithium hydroxide, using electricity
- Further dried to produce battery-grade lithium hydroxide which can be supplied back to battery manufacturers
- Sustainable lithium is key to support the growth of electric vehicles as lithium acts as the key component for batteries



Source: https://www.neumaterials.com/ & CESG2022 Poster

Se-cure Waste Management Pte Ltd

Thank you

www.se-curewaste.com