

# NEOMETALS COMMENCES LITHIUM BATTERY RECYCLING PILOT PLANT

## Highlights

- SGS Lakefield awarded contract to construct and operate Neometals' battery recycling pilot in Canada
- Neometals' battery shredding plant successfully commissioned and approximately 2 tonnes of used batteries prepared for leaching stage
- SGS has purpose-built facilities and world-class hydrometallurgical processing expertise
- Pilot will produce samples of high purity battery materials for market qualification testing
- Pilot operation to provide showcase for customers and precedes front-end engineering studies

Neometals Ltd (ASX: NMT) ("Neometals" or "the Company") is pleased to announce the successful commissioning of stage 1 of its lithium-ion battery ("LIB") recycling pilot plant ("Pilot") in Canada. SGS Canada Inc. ("SGS") was awarded the contracts to construct and operate the Pilot in its fully accredited Lakefield facility. The SGS Lakefield facility is recognised worldwide for housing pre-eminent expertise in the development, optimisation and piloting of mineral processing and chemical extraction processes.

SGS has been engaged by Neometals to undertake Pilot front-end feed preparation (shredding, removal of metal casings and plastics) ("Stage 1") and the subsequent hydrometallurgical processing and refining stage to deliver high-purity battery materials for market qualification ("Stage 2").

The Pilot is intended to demonstrate and showcase Neometals' mixed feed flowsheet which can accommodate a variety of LIB types from multiple sources including consumer electronics, electric vehicle batteries and the emerging stationary storage sector. The Pilot aims to verify assumptions made at bench scale, it will generate marketing samples of products and will also provide essential data required for a front-end engineering design study ("FEED"). The proposed FEED study will support a subsequent feasibility study and enable consideration of an investment decision on a commercial plant ("FID").

Neometals Managing Director Chris Reed said:

*"We are delighted to see our battery recycling project back on track. The commissioning of the Pilot represents a significant milestone and marks the culmination of extensive research and development into a flowsheet to process multiple battery chemistries, from consumer electronics to electric vehicle applications."*

*"With ever increasing volumes of commercial LIBs reaching their end of life, we are focussed on proving at scale, then qualifying our scale-able and modular recycling solution with industry as early as possible. The Pilot will serve as a showcase facility for potential partners as well as provide strong independent data for future engineering and financial studies".*

## BACKGROUND

Despite regions like the European Union (“EU”) being heavily regulated under battery recycling compliance schemes, it is estimated that only approximately 5% of LIBs are currently recycled globally. Worldwide regulation is however tightening at a very fast pace. Regulations coupled with corporate requirements for ethical sourcing and disposal of LIBs has created a considerable opportunity for Neometals to recover critical / non-renewable resources while reducing environmental impacts associated with battery disposal.

Neometals has developed a process flowsheet to recover >90% of all battery materials (plus recycle water and minimise plastic and graphite waste) from targeted end of life LIBs that could otherwise find their way to land fill or inefficient base metal recovery circuits. Neometals’ process flowsheet targets the recovery of cobalt from consumer electronic batteries (devices with lithium cobalt oxide cathodes (“LCO”) as well as nickel-rich EV and stationary storage battery chemistries (lithium-nickel-manganese-cobalt (“NMC”) cathodes). This mixed feed flowsheet is the subject of the Pilot.

## PILOT PROGRAM

SGS has been awarded the following programs of work:

1. Feed preparation of two tonnes of spent LIBs via physical processes including shredding, screening and rejecting steel casings and plastic wrappers to produce a concentrate referred to as, black powder (“Black Powder”);
2. Bench optimisation of the refining process on the Black Powder including leaching, product recovery and full water recycle; and
3. Construction and operation of the recovery and refining stage.

### Feed Preparation – Stage 1

The feed preparation aspect to the Pilot has now been successfully commissioned using two tonnes of spent LIB feed. Neometals has developed the know-how to safely and efficiently shred spent, but still charged, LIBs at a commercial scale and commissioned its modular primary shredding system for temporary installation at SGS.



Figure 1 – Front end shredding plant at the SGS Lakefield facility.

In conjunction with Primero Group Pty Ltd and SGS, the primary shredding system has been incorporated by Neometals into a feed preparation flowsheet that effectively removes the waste plastic wrapping and steel casings whilst upgrading the high value cobalt, nickel and lithium powders contained within LIBs into a feed material for Stage 2 processing.

The Black Powder is a mixture of high value cobalt, nickel and lithium compounds as well as shredded copper and aluminium foil which is suitable for Stage 2 hydrometallurgy recovery and refining.

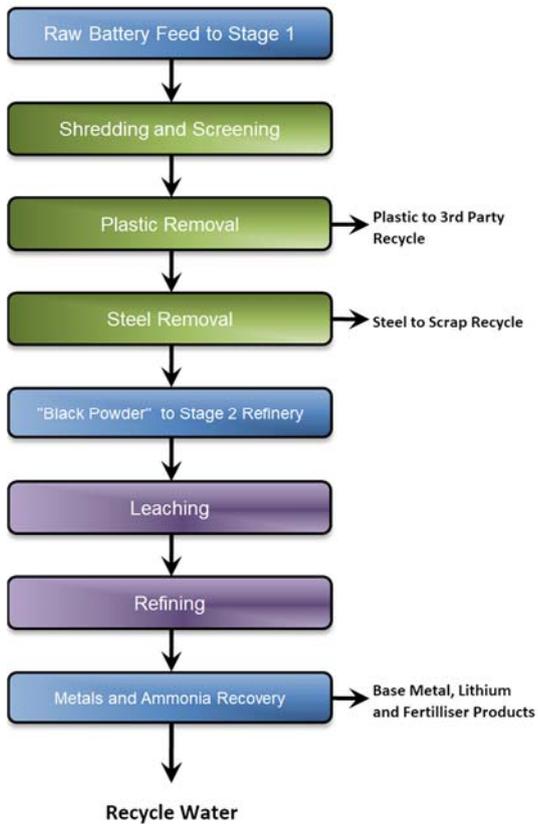


Figure 2 – Simplified Block Flow Diagram



Figure 3 – Black Powder and 1"8650" lithium ion battery

### Hydrometallurgical Recovery and Refining – Stage 2

During 2018, Neometals undertook significant test-work in Perth to develop a new novel hydrometallurgical flowsheet. A provisional patent application was filed against the flowsheet which met the following criteria:

1. Robust enough to accommodate all known LIB battery chemistries;
2. Maximises recovery of the high value cobalt and nickel content resulting in high purity battery grade products suitable for LIB manufacturers; and
3. Minimises solid waste streams with total metal recovery from the leached Black Powder.

SGS will soon commence independent verification and optimisation of this flowsheet using a homogenous sample of Black Powder from Stage 1 shredding. This will provide data for the operation of the Stage 2 recovery and refining aspect to the Pilot which is currently being constructed.

### NEXT STEPS

A FEED study is planned to follow the Pilot and precede an economic feasibility study to give Neometals a commercial handle on approximately 80% of costs at an early development stage. Having commercially relevant data to commence commercial discussions is seen as the most prudent approach with potential partners.

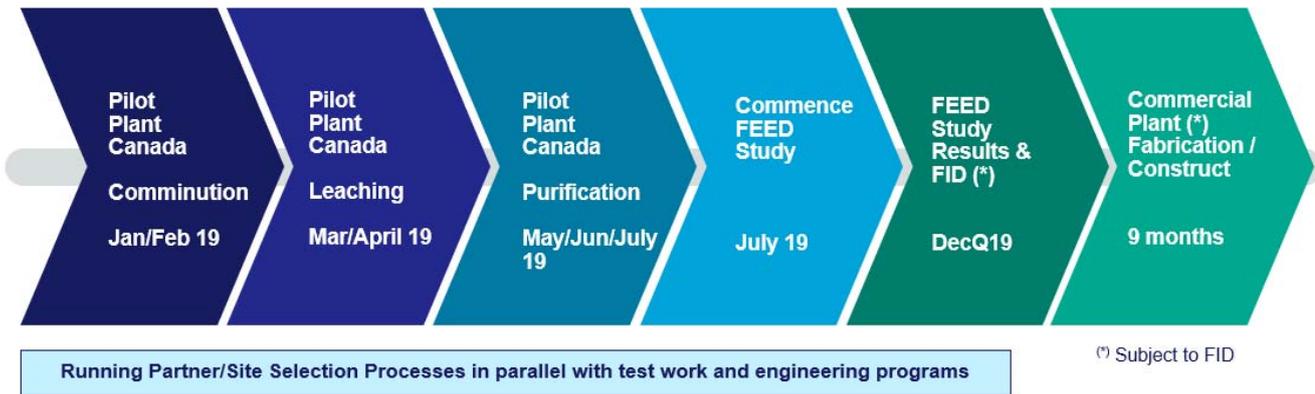


Figure 4 - Indicative timeline for the Neometals LIB recycling program

### NEOMETALS LIB RECYCLING BUSINESS MODEL

The growing need for a universal LIB recycling solution allows Neometals to participate at several levels in the market. The Company's flowsheet differs from pyrometallurgy-only routes and offers a true modular closed-loop recycling solution that borrows from Neometals experience in the lithium-ion battery supply chain.

A key point of differentiation for Neometals is that it does not rely on Stage 1 and Stage 2 processing being located together. This supports a 'hub and spoke' approach where modular and transportable Stage 1 feed preparation units can produce a non-hazardous Black Powder (predominantly cathode material) which can be transported safely to centralised Stage 2 hydrometallurgical facilities. This allows feed sourcing from companies receiving / collecting end of life LIBs at multiple locations and across borders.

The revenue model for Neometals includes potential earnings from the following value chain participants:

1. **Parties seeking a disposal/recycling service.** This could include electric vehicle and consumer electronic makers or their battery manufacturers who need to acquit for end of life LIBs or recycle off spec and warranty claim cells;
2. **LIB collectors or aggregators** in battery product stewardship programs that do not have the means to process or transport LIBs. This could include a range of transfer stations and scrap merchants who are responsible for collecting, sorting and overseeing LIB logistics for reprocessing; and
3. **LIB recycling proponents** who licence the technology in jurisdictions where Neometals is better placed relying on the local knowledge of partners.

Neometals General Manager of Product Development and Marketing, Paul Wallwork, commented on the market for LIB recycling:

*"There is little argument from analysts and industry participants that LIB demand is expected to grow very strongly as we see the following unfold:*

1. *sticker price parity for electric and ICE vehicles;*
2. *capacity expansions for the production of refined chemicals used in battery electrodes;*
3. *commissioning of the next wave of planned LIB mega-factories; and*
4. *the arrival of deadlines set by countries and vehicle manufacturers to phase out ICE vehicles.*

*We believe that Neometals will have a unique offering with a business model that is as important as the proprietary technology itself. Having the flexibility to locate in proximity to manufacturers who have products with consistent chemistry allows ready access to defective batteries, production scrap and end of life cells. We don't believe scale is the key to profitability".*

## ENDS

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## About Neometals Ltd

Neometals Ltd ("Neometals" - ASX:NMT) is a developer of industrial mineral and advanced materials projects. Neometals has two key divisions – an integrated Lithium business and a Vanadium-Titanium resource development business. Both are supported by proprietary technologies that assist downstream integration through revenue enhancement and cost efficiencies.

Neometals owns a 13.8% stake in the Mt Marion lithium mine near Kalgoorlie (subject to sale), which operates one of the world's biggest lithium concentrators. Neometals holds an offtake option, which forms the backbone to its fully-integrated lithium business aspirations which include a Lithium Hydroxide Refinery and Lithium-ion Battery Recycling process. The 100%-owned Barrambie Titanium-Vanadium Project in WA's Mid-West is one of the world's highest-grade hard-rock titanium-vanadium deposits.

Neometals' strategy focuses on de-risking and developing long life projects with strong partners and integrating down the value chain to increase margins. The company aims to leverage its cashflows to grow opportunities that provide sustainable mineral and material solutions to customers and to return value to shareholders.

**APPENDIX 1**

**MARKET FOR END OF LIFE LIB**

Analyst consensus shows clear trends highlighting material expansion to LIB demand due to growing electric vehicle and home energy storage sales penetration together with greater consumption of consumer electronics.

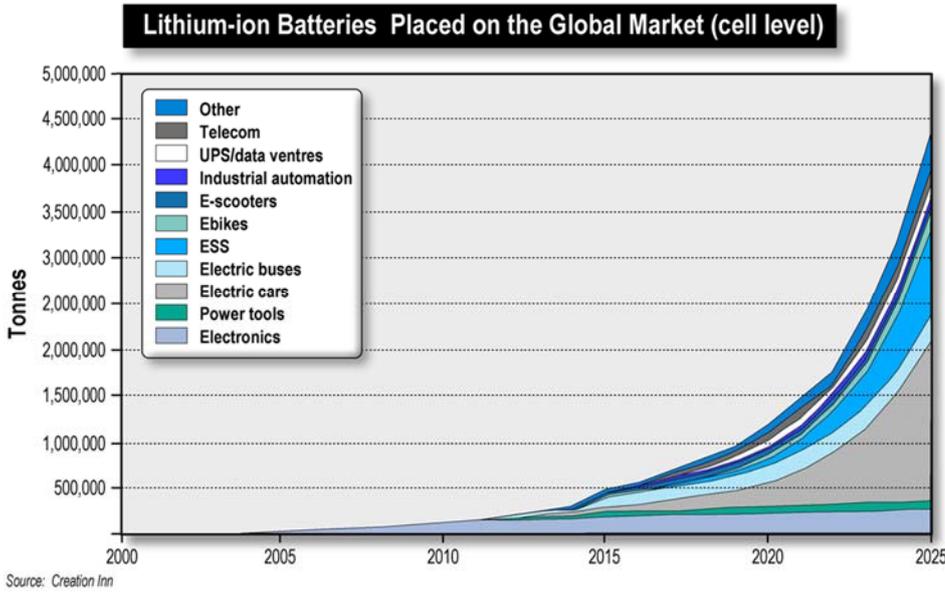


Figure 5 - graph showing an approximate four-fold increase in LIBs placed on the market between now and 2025

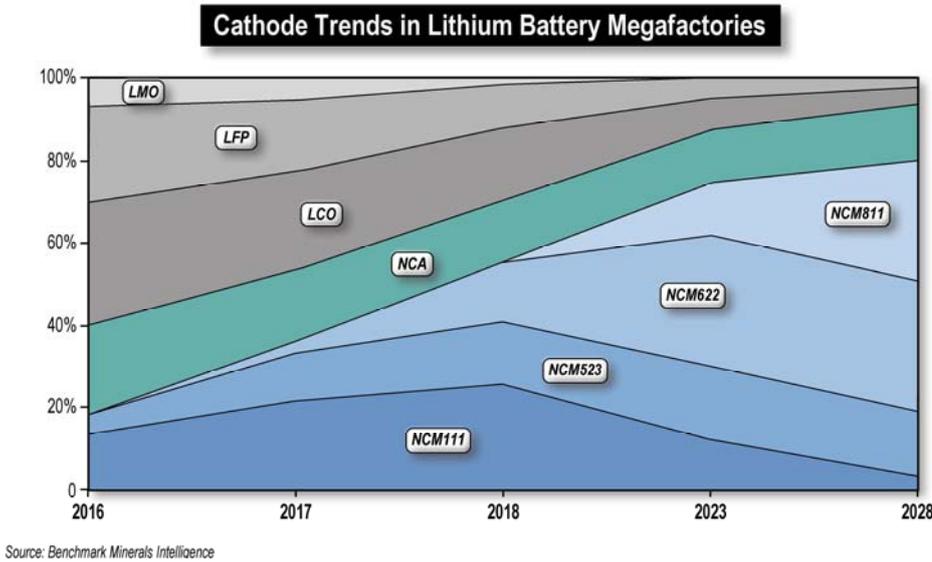


Figure 6 - graph showing the forecast LIB cathode production trend towards nickel rich cathode chemistry (NMC) in its varying formats

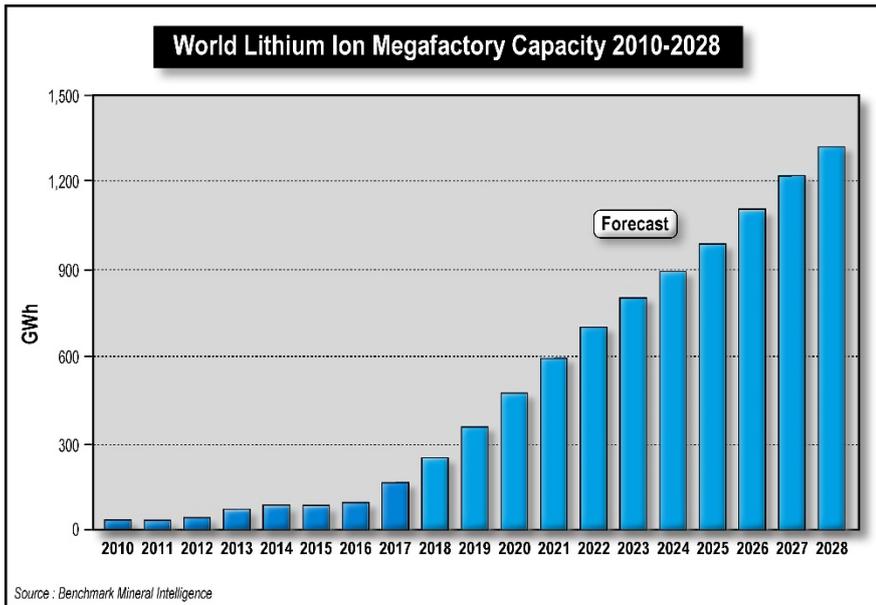


Figure 7 - forecast installed capacity response to future LIB demand by battery manufacturers

According to Circular Energy Storage (2018), the value of the end-of-life market for LIBs is expected to exceed USD\$1.3 billion in 2018, of which USD\$1.1 billion will come from recovery of materials and around USD\$0.2 billion from repair, refurbishment and preparations for reuse of industrial batteries (as distinct from portable batteries). In 2025 the market for LIB recycling is expected to grow to USD\$3.5 billion and the market for second life batteries to USD\$4.2 billion.

The LIB end of life market, currently dominated by China (70%) and South Korea (16%), is driven by the following key players in the value chain:

- Electric vehicle manufacturers with regulatory and/or corporate commitments to recycle spent LIBs in vehicles they sold (locally and internationally). These companies have a focus on ethical sourcing and disposing of materials as well as demand for the materials recovered from recycling processes;
- Companies that refine mined and recycled materials to chemical products, prepare anodes, cathodes and electrolytes for batteries and battery companies that do some or all of this in house; and
- The energy storage market which uses industrial batteries to provide different services to secure the quality of the grid or provide backup power and energy efficiency to households, industrial or commercial buildings and operations.

The current Chinese and Taiwanese dominance in battery recycling relates partly to the volume of LIBs exported to China as part of electronic device refurbishment (where batteries are embedded) and the sheer volume of electrode material being manufactured in Asia (and hence recycled in the same market). Going forward, it is expected that volumes of industrial LIBs (vehicles and stationary storage) will dwarf that from portable electronics and the locations where LIBs reach end of life will reduce Asia's market share given regulations making waste transport, particularly hazardous waste, increasingly difficult and expensive.

Although LIBs contain toxic substances they are not considered hazardous when declared as waste, but rather, they fall into that category by piggybacking legislation for other hazardous batteries such as nickel cadmium and lead-acid. As a result, LIBs are banned from both landfilling and incineration in Europe, Canada, Japan, and in a few states in the US.

For industrial batteries in the EU, recycling responsibility stays with the producer (i.e. vehicle manufacturers) to arrange for take-back of spent batteries at no cost for the end-user (i.e. vehicle owner). As such, the collection target is 100% given prohibition on landfilling and incineration of industrial batteries. All industrial batteries must be taken back and recycled. In the US, the recycling responsibility stays with the owner of the battery (who may have to pay a waste sorting company to take the battery when its spent), but in states where landfill and incineration are prohibited, the effect on recycling is similar to the EU. Like the EU, Chinese producers that placed the batteries on the market face the bill for recycling.