ASX ANNOUNCEMENT

21 November 2019

Lithium ferro phosphate (LFP) as a future energy storage technology

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ASX: LIT

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Lithium Australia presents at the WA Clean Energy Forum 2019.

HIGHLIGHTS

- **Lithium Australia presents its view on the future of LFP in energy storage.**
- **LFP powders have been extensively evaluated by Japanese and Chinese battery producers.**
- **LFP batteries provide superior safety, performance and longevity.**

WA Clean Energy Forum 2019

On 20 November 2019, the Clean Energy Council will host the WA Clean Energy Forum 2019 at the Perth (Western Australia) Convention Centre. The forum will have a strong focus on energy storage, and Lithium Australia, as a consequence of its experience in lithium ferro phosphate (LFP) batteries will be presenting its view on the future of this medium in the energy storage sector.

Lithium Australia (ASX:LIT), through its' wholly owned subsidiary, VSPC Ltd, has been producing LFP cathode powders in its pilot plant in Brisbane. These powders have been extensively evaluated by Chinese and Japanese battery producers.

Lithium Australia has also developed metal extraction technologies to recover lithium from mine waste, and a phosphate, for direct feed into the production of LFP cathode powders, similarly it has achieved the re-birthing of cathode powders from lithium phosphate recovered from spent lithium ion batteries.

The achievements are significant as they provide a strong foundation for ethical and sustainable supply into the energy storage industry where LFP batteries provide superior safety, performance and longevity.

The content of the address is included in this ASX release and the abstract is provided at Annexure A.

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About Lithium Australia NL

Lithium Australia aims to ensure an ethical and sustainable supply of energy metals to the battery industry (enhancing energy security in the process) by creating a circular battery economy. The recycling of old lithium-ion batteries to new is intrinsic to this plan. While rationalising its portfolio of lithium projects/alliances, the Company continues with R&D on its proprietary extraction processes for the conversion of *all* lithium silicates (including mine waste), and of unused fines from spodumene processing, to lithium chemicals. From those chemicals, Lithium Australia plans to produce advanced components for the battery industry globally, and for stationary energy storage systems within Australia. By uniting resources and innovation, the Company seeks to vertically integrate lithium recycling, extraction and processing.

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Lithium ferro phosphate (LFP) as a future energy storage technology

Raw materials
Li chemicals
Batteries
Recycling

Lithium Australia NL

ASX: LIT

Adrian Griffin

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COMPETENT PERSON'S STATEMENT

The information in this report that relates to reporting of Exploration Results is based on and fairly represents information and supporting documentation prepared by Adrian Griffin, a member of the Australasian Institute of Mining and Metallurgy. Mr Griffin is a shareholder in, and managing director of, LIT and has sufficient experience relevant to the style of mineralisation and type of deposit under consideration. He is qualified as a Competent Person as defined in the 2012 edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. *Mr Griffin consents to the inclusion in this report of the matters based on information in the form and context in which it appears.*

More lithium to waste than enters the supply chain

Lepidolite concentrates recovered from a petalite mine in WA.


Concentrator that will reject fine and contaminated spodumene.


Lepidolite stockpiled during pegmatite mining in WA.

The dominant sources of lithium, for the production of lithium chemicals are spodumene concentrates, derived from pegmatite mining (mainly in Western Australia) and lithium brines recovered from salars and underlying aquifers in South America. Spodumene concentrators generally recover only 50-70% of the lithium, as much is discharged as fine or contaminated material, unsuitable for processing in the conventional “converters”. Those converters roast and leach the spodumene as part of the process to produce lithium chemicals (usually lithium hydroxide, or lithium carbonate). The recovery of lithium from brines is also poor, with losses resulting from leakage in evaporation ponds, and lithium solutions entrained in salts that are discarded during the evaporation/crystallization process leading to the production of lithium carbonate. These factors alone see around 40% of lithium available for processing being discharged rather than being available to produce lithium chemicals.

Tantalum and tin production often produces lepidolite as a waste product. Lepidolite is a lithium mica, not currently processed for lithium commercially, but discharged in large volumes during the exploitation of other minerals. Some kaolin producers too discharge large quantities of lithium mica. **The reason for the poor recoveries in hard rock operations is simple – it is the lack of appropriate processing technology to maximise recoveries. But there are solutions to that problem!**

Lithium chemical production

Lithium Australia has developed a suite of processing technologies for the recovery of lithium, and other battery metals, from waste materials, including fine and contaminated spodumene, lithium micas and spent lithium ion batteries (LIBs).

LieNA® is a caustic conversion process that derives much of its process philosophy from the alumina industry. The process is ideally suited to the material discarded by the spodumene concentrators, being fine or contaminated material unsuitable for conventional "converters". LieNA ® can produce a range of lithium chemicals including phosphate, sulphate, hydroxide or carbonate. Flexibility of design allows this to be achieved in a single plant. The commercial application of this process may revolutionize the industry by having the capability of dealing with the largest waste stream generated by the lithium industry – fine and contaminated spodumene that is regularly discharged to tailings streams.

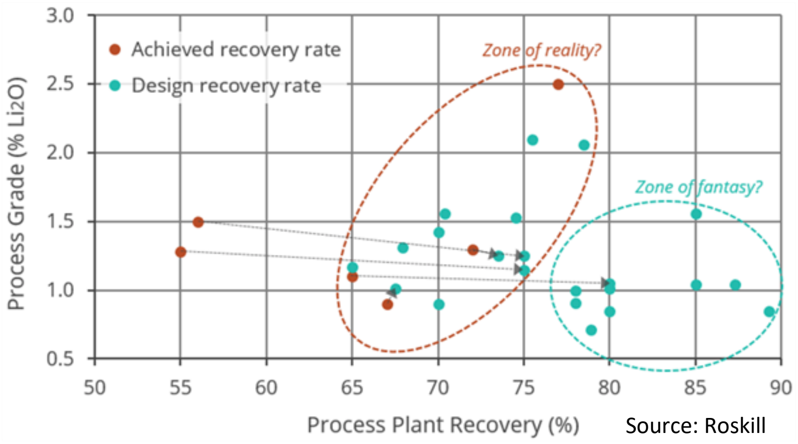
SiLeach® is designed to recover lithium, as a phosphate, from unconventional sources such as the lithium micas.

Metals from spent batteries – Lithium Australia has partnered with Envirostream Australia to recover all metals from spent batteries, including the lithium as a phosphate.

Direct to cathodes without lithium hydroxide of carbonate. The processes developed by Lithium Australia have a common thread – lithium phosphate. The lithium phosphate produced from waste materials can be readily refined using a proprietary Lithium Australia process that produces very high purity lithium phosphate. This can be used as direct feed for the production of lithium ferro phosphate (LFP) cathode powders, providing the advantage of adding lithium and phosphorous in a single reagent. This unique attribute results in lithium phosphate commanding a significant premium to other lithium chemicals in the battery industry.

The wasteful miners

The recovery of spodumene from ore to concentrate is impeded by the fundamental physical properties of the mineral, and the downstream processing used to recover the lithium from the concentrate.



Source: Roskill

Firstly, spodumene has 2 perfect “cleavages” i.e. it readily breaks apart on two planes that are at angles to each other. This characteristic results in spodumene producing abundant fines and slimes during grinding, the first physical process in liberating the mineral to produce a concentrate.

Lithium Australia has developed the LieNA® process to combat the low recovery rates currently achieved by spodumene concentrators. This loss is one of the largest untapped lithium inventories available, which already has an embedded mining cost and comminution cost, but has been relegated to tailings storage as a consequence of a number of factors. LieNA® is designed to thrive in the environments within which conventional processes fail.

Secondly, the conventional “conversion” process used to generate lithium chemicals from spodumene concentrates commences with roasting in a rotary kiln, a process sensitive to particle size, in particular the inability to roast very fine material.

The combination of these two factors results in fine spodumene passing to tailings. This “lost” product presents a significant recovery challenge for the spodumene producer, a challenge that can be met with LieNA® - a process specifically developed to process fine and/or contaminated spodumene.

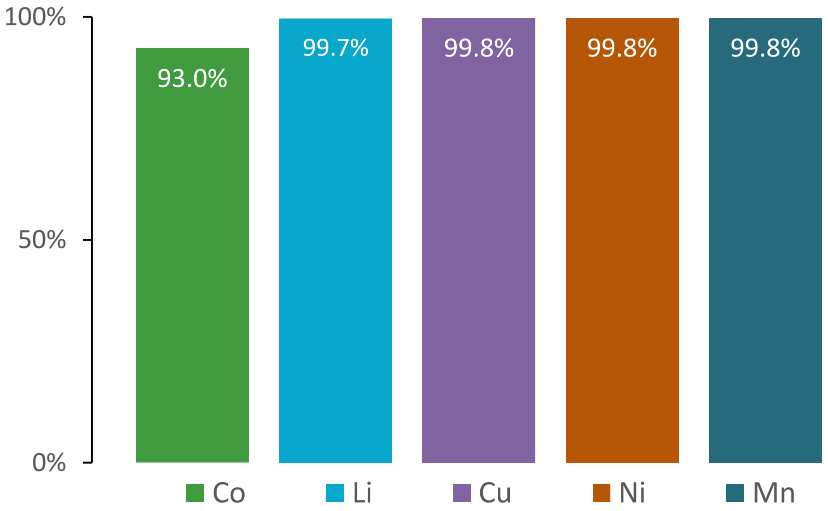
Recycling – removing the labour pains from cathode re-birthing

There are many predictions as to the market penetration of LIBs, particularly in the EV sector. Regardless it is likely that the availability of spent batteries will rise to more than 7 million tonnes annually over the next 20 years

At present global recycling rates are only 9% with China dominating the practice and skewing statistics. In Australia, on the other hand, recycles less than 3%. This situation provides an unprecedented opportunity to apply advanced processing technologies to an industry that is becoming an environmental problem.

Few recyclers recover lithium from LIBs, but as it is a critical raw material, greater emphasis should be given to its recycling and sustainability

Lithium Australia can recover ***ALL*** metals from the spent LIBs. The technologies developed by Lithium Australia can produce a superior lithium product which commands a significant premium for direct input into LFP cathode powders.



Laboratory metal recoveries from spent lithium-ion batteries.

Lithium phosphate – the common thread

Lithium Australia's processing technologies have been developed around the recovery of lithium as a phosphate. This provides:

- the ability to recover lithium from solutions with low lithium concentrations
- superior water balance
- reduction or removal of evaporation processes in the production of lithium chemicals
- a direct route to the production of LFP cathode powders

These processes may also have an application in the direct precipitation of lithium from brines, a process which otherwise relies on years' of residence time and solar evaporation.

Lithium Australia, through its wholly owned subsidiary, VSPC Ltd, has proprietary cathode powder production technology that has used waste materials (lithium phosphate recovered from mine waste, lepidolite and spent batteries) to generate cathode powders, and subsequently LFP cells for test purposes. VSPC cathode powders have been extensively tested by Chinese and Japanese battery producers and the veracity of the product demonstrated by the production and testing of commercial format 18650 cells.

The ability to recover lithium and other battery metals from waste material closes the loop on the circular battery economy. It provides better ethical, sustainability and environmental options than the sourcing of new materials. In the future these recycled materials may provide a cheaper alternative than using newly mined materials. Regardless of the cost and benefits, there is no doubt that the more these materials are recycled, the less the environmental impact of the battery industry will be.

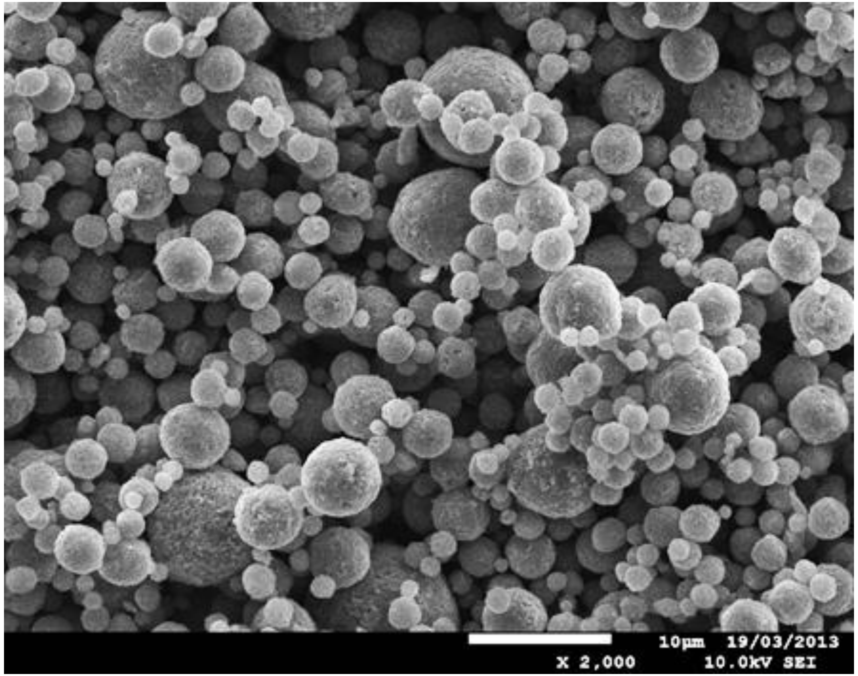
VSPC cathode materials

VSPC Ltd, a wholly owned subsidiary of Lithium Australia, has been developing nano powders for over 16 years. It has developed the most advanced process for manufacturing LFP powders. Although the techniques are largely chemistry agnostic, and capable of being applied to NMC and other compositions, LFP retains a high priority because of its superior attributes in energy storage applications.

VSPC cathode powder production has the following attributes:

- simple nanotechnology for superior battery cathodes,
- precise control of composition and particle size,
- unparalleled quality control, and
- low-cost production.

LFP is ideally suited to the energy storage market and other applications where energy density is less critical. VSPC plans to manufacture LFP cathode powders and batteries in China with a view of marketing the products in Australia.



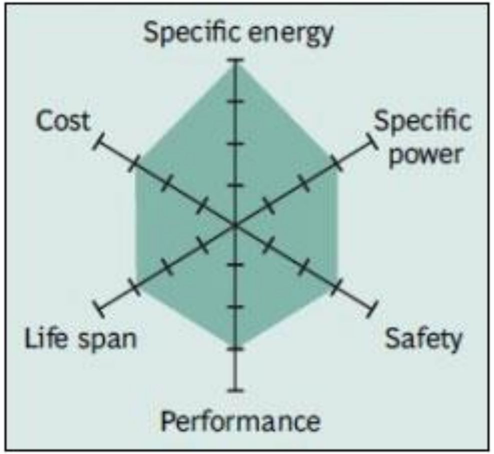
LFP – the rugged Li-ion battery

LFP should be the battery of choice for Australian energy storage applications now and the benefits are likely to become even more compelling into the future.

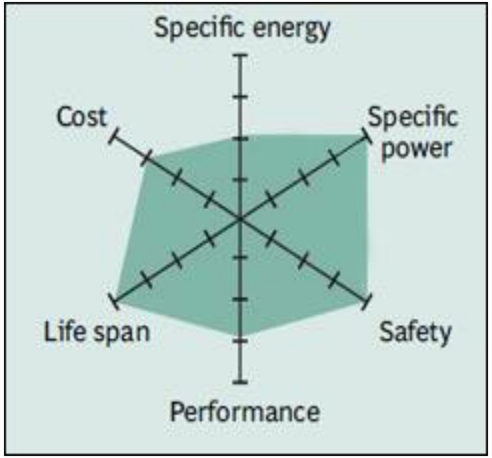
LFP attributes that make it the ideal chemistry for energy storage include:

- deep discharge,
- high recharge rates,
- high power delivery,
- long service life,
- low-cost,
- operation without battery management systems,
- wide operational temperature range,
- no thermal runaway,
- very safe, and
- applicable to transport and energy storage applications.

LFP – longevity, power, price



(lithium) nickel manganese cobalt
NMC



Lithium iron phosphate
LFP

Source: https://batteryuniversity.com

Waste ➡ lithium phosphate ➡ VSPC ➡ recycle

Lithium Australia (ASX:LIT) is the only company with the technology to transition from mine waste to LIB cathode materials. Similarly the same can be achieved by recycling of spent LIBs.

LIT can generate lithium chemicals from waste materials and regenerate batteries from the lithium chemicals.

LIT can restart the cycle, adding sustainability to the industry and conserving critical metals that may be in short supply.

Conclusions

- The application of technologies developed by Lithium Australia provides improved sustainability, reduced carbon footprint, and reduced reliance on conflict metals.
- Lithium phosphate – the ideal feed for the production of LFP cathode powders – can be derived from mine waste and recycled lithium ion batteries. Significantly it can be refined to a very high-purity product by the application of refining technology developed by Lithium Australia.
- LFP cathode powders can be directly generated from waste using SiLeach®, LieNA® Envirostream and VSPC technologies. This has already been accomplished with lithium recovered from mine dumps, and also lithium recovered from spent batteries.
- LFP chemistry is ideally suited to energy storage system (ESS) applications, having superior longevity, wide operating temperature range and exceptional safety.
- The use of LFP chemistry **eliminates the reliance on nickel and cobalt** providing ESS and supply chain security. This can also reduce reliance on battery metal sources afflicted by child labour, military conflict, or adverse environmental impacts.

ANNEXURE A

WA Clean Energy Forum 2019

ABSTRACT

Lithium ferro phosphate (LFP) batteries as a future energy storage technology

Adrian Griffin
Managing Director
Lithium Australia NL

To create clean energy, all aspects of the supply chain must have a minimal non-renewable energy footprint. Minimising the environmental impact requires a holistic approach starting with exploration, resource assessment, mining, mineral processing, battery manufacture, and end-of-life recycling to optimise sustainability of the ESS sector. Supply efficiencies are particularly important where the disparate processes required to produce the final product interface with each other e.g. the transition from lithium concentrates to lithium ion battery precursors.
The lithium industry is characterised by very poor extraction efficiencies. In some cases these are less than 50%. At present the efficiencies are low due to the inability to provide an appropriate interface between mining/concentration and downstream processing.

Lithium Australia ('LIT') has designed and developed a suite of technologies to improve resource sustainability in the lithium-ion battery (‘LIB’) industry while reducing costs and carbon footprints. To date, LIT is the only company that has successfully generated battery cathodes and lithium-ion batteries from mine waste. Similarly, LIT has used spent batteries as a feed source for the re-birthing of battery cathodes. With Envirostream Australia, LIT is developing the infrastructure to recycle spent batteries in Australia.

Significantly, the extraction and recovery technologies LIT employs have a common thread: the production of lithium phosphate ('LP'). The use of LP (rather than lithium hydroxide or carbonate) in the production of lithium-ferro-phosphate ('LFP') batteries reduces the number of process steps required.

LIT’s suite of processing technologies improves the efficiency of each production step (i) mining/concentrating, (ii) lithium chemical production, and (iii) production of LFP cathode powders The characteristics LFP batteries make them well suited for ESS applications, particularly in more extreme environments where safety, longevity and minimal maintenance are of paramount importance.

LIT, which is currently commercialising its battery materials for ESS applications and aims to generate much of the feed required from recycled materials to improve sustainability, reduce cost, and decrease the energy footprint involved in delivering ESS to consumers
Together with DLG Batteries (a major Chinese battery producer), LIT will market energy storage solutions for domestic, fringe-of-grid and off-grid applications in Australia. LIT will focus on LFP as it remains the chemistry of choice for rugged applications.