savannah resources plc

AN INTRODUCTION TO LITHIUM

Lithium: what is it?

- Lithium is a soft silvery-white metal which is highly reactive and does not occur in nature in its elemental form
- In nature it occurs as compounds within hard rock deposits and salt brines
- Lithium and its chemical compounds have a wide range of industrial applications resulting in numerous **chemical** and **technical** uses
- Lithium also has the highest electrochemical potential of all metals
- These properties provide very high energy and power densities for batteries, for long useful life in small and comparatively lightweight packages, that is also driving growth in demand

Lithium ingots with a thin layer of black nitride tarnish

Where does lithium come from?

- Lithium has two major sources: hard rock and brines. Savannah's projects are hard rock in origin so only that source is described
- In the case of hard rock lithium, it is primarily sourced from pegmatites, which are essentially granite-like rocks that are distinguished from other granite rocks by their extremely coarse but variable grain size
- Lithium bearing pegmatites are a subset of granitic pegmatites that are associated with certain granites
- Pegmatites consist mostly of quartz, potassium feldspar, albite, and muscovite and the major lithium ore minerals are spodumene, petalite, and lepidolite

Spodumene is the primary lithium mineral present at Savannah's Portugal Lithium projects

Lithium uses

- Lithium and its chemical compounds exhibit a broad range of beneficial properties including:
  - The highest electrochemical potential of all metals
  - An extremely high co-efficient of thermal expansion
  - Fluxing and catalytic characteristics
  - Acting as a viscosity modifier in glass melts
  - Low density
  - Low atomic mass

- As a result, lithium is used in numerous applications which can be divided into two broad categories:

CHEMICAL APPLICATIONS

TECHNICAL APPLICATIONS

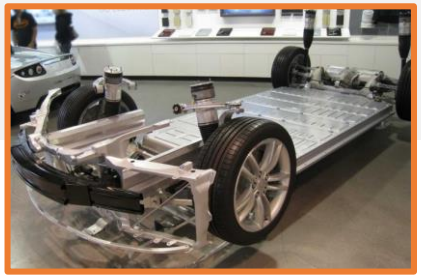
Lithium uses: technical and chemical

TECHNICAL APPLICATIONS
ESTABLISHED USES

Lithium products are used directly in some technical applications, when they are concentrated to around 5% and sold directly, mostly for use in glass and ceramics, the current largest global market for lithium. These products generally require lithium with low iron concentration to meet end-user requirements

CHEMICAL APPLICATIONS
THE FASTEST GROWING MARKET

From concentrates, lithium can then be processed further to form a variety of chemicals, including lithium carbonate, lithium bromide, lithium chloride, butyl lithium and lithium hydroxide. The fastest growing (and second-largest) market for lithium globally is for use in batteries



Lithium uses

CURENT APPLICATIONS

CHEMICAL

Batteries

Lubricants

Air Treatment

Aluminium smelting

Pharmaceuticals

TECHNICAL

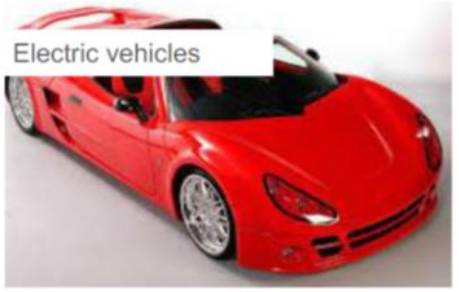
Glass

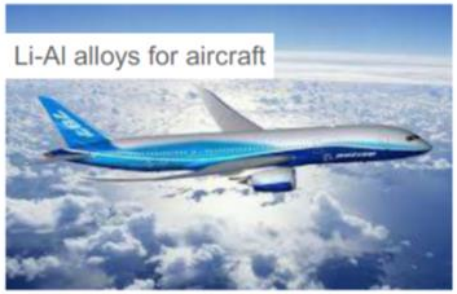
Ceramics

Aerospace

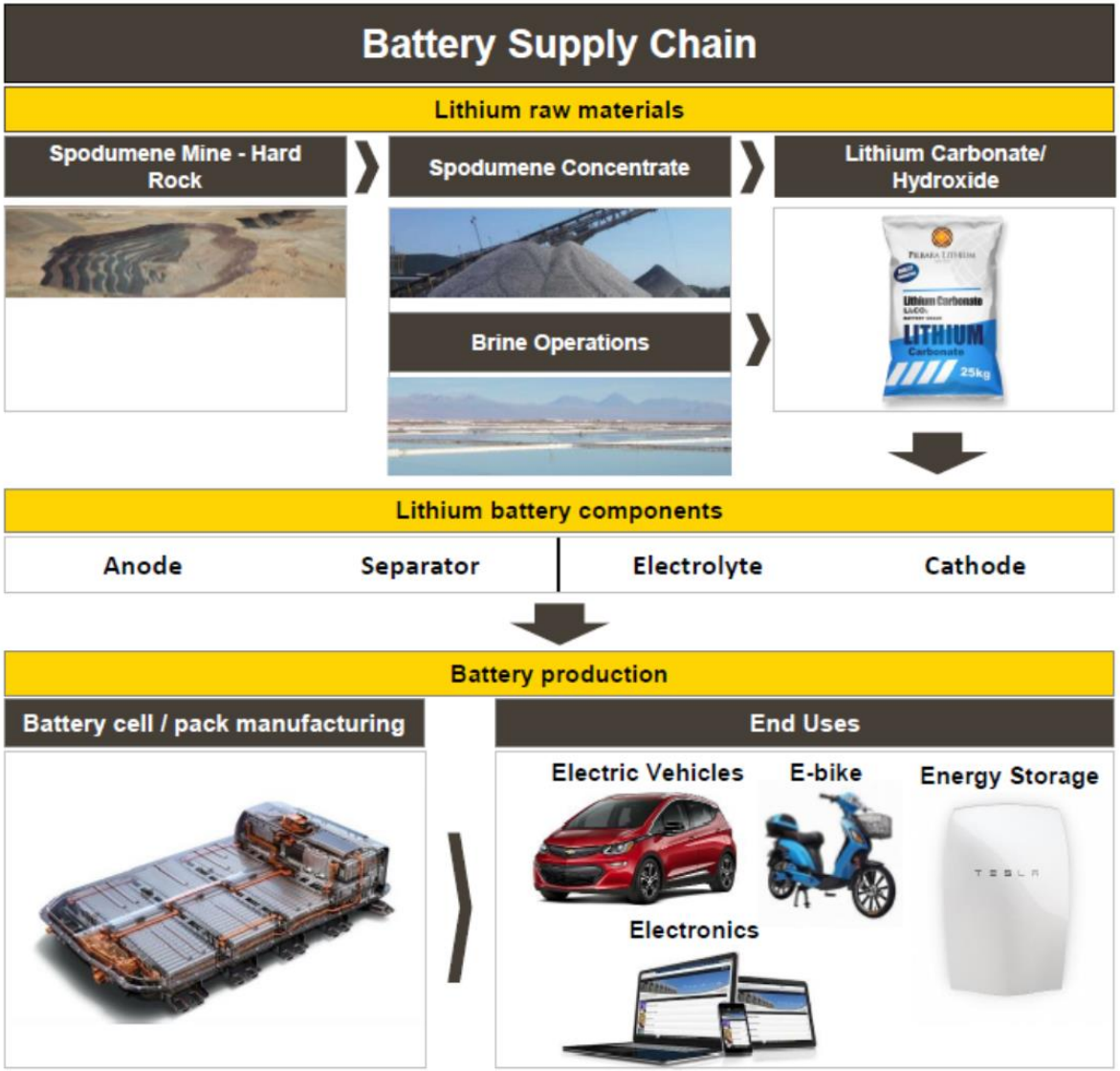
Steel and Iron castings

NEW MARKETS





Lithium batteries



Lithium quantities used in various industries

Increased lithium use driven by EV battery requirements:

e-Buses

~200kg

PHEV & BEV

40-80kg

HEV

~5kg

e-motorcycles

0.5kg+

Powerwall

10kg

Power Tools

40-60g

Notebooks / Tablets Tools

20-45g

Smartphones

3-5g

Why lithium is so important

- Scientists have concluded that most of the observed global warming is very likely due to the burning of coal, oil, and gas – in order to tackle the issue of global warming we must quickly move away from the use of hydrocarbons and use cleaner sources of energy in an effort to reduce our carbon footprint
- Fossil fuels like oil are running out, governments and consumers are demanding cleaner and new sources of energy and new sources of power like batteries are now coming into play
- Michael Gove, the UK Environment Secretary, has warned that Britain "can't carry on" with petrol and diesel cars because of the damage that they are doing to people's health and the planet: "There is no alternative to embracing new technology," he said
- Britain is to ban all new petrol and diesel cars and vans from 2040 amid fears that rising levels of nitrogen oxide pose a major risk to public health

…and so demand on lithium is expected to rise:

- Analysts predict that rechargeable lithium-ion batteries have the highest potential for future energy storage systems
- Lithium-ion batteries are being used in the electric cars and hybrid cars of the future
- Lithium converts chemical energy into electrical energy very efficiently, and lithium-ion batteries are lighter than previous battery technology and hold a charge a lot longer

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