Battery Metals

July 2022

HATCH

Battery Metals

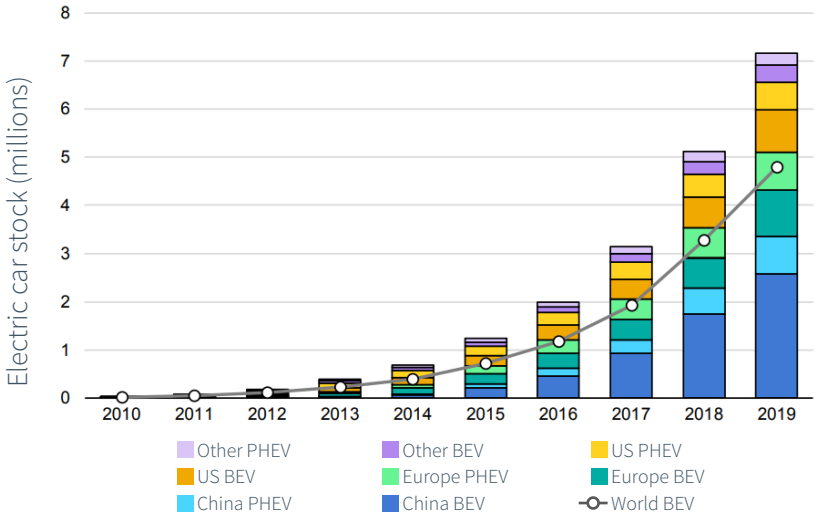
Hatch Advisory Group: Providing business advisory services to our clients in the metals, energy and infrastructure space.

- Investors continue to have growing interest in battery metals and the key commodities surrounding this trend:
  - Lithium, as battery grade (BG) lithium hydroxide monohydrate (LHM, $LiOH.H_2O$)
  - Nickel, as Nickel sulphate hexahydrate ($NiSO4.6H_2O$)
  - Cobalt, as Cobalt suphate heptahydrate ($CoSO4.7H_2O$)
- Hatch has been involved in numerous projects for these three metals, and our Advisory group is able to leverage our internal industry experts to assist our clients in transaction advisory services, including M&A, investing or lending
- This discussion provides an overview of the battery metals trends and the key challenges of executing lithium, cobalt, and nickel projects

Battery Electric Vehicle Industry Trends

Global trends are pushing adoption and development of battery electric vehicle (BEV) technologies worldwide.

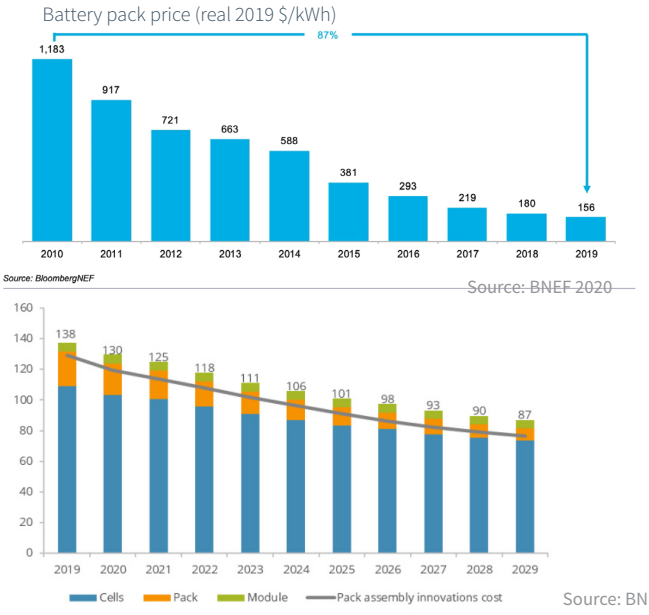
- Recent advances in battery technology have gradually improved performance and reduced cost, and BEVs are expected to be competitive with internal combustion engines (ICEs) in the near future
- Climate change and pollution concerns continue to push governments to reduce domestic fossil fuel consumption via subsidies and regulation for green energy
- China seeks to be a world leader in BEV production by aggressively incentivizing domestic BEV adoption and securing global battery metal supplies
- Energy storage is a growing industry as green energy and electric vehicle needs are increasing



Global electric car stock 2010-2019
(PHEV = plug-in hybrid electric vehicle; BEV = battery electric vehicle)

Battery technologies are central to the BEV trend.

- Material costs account for about 60% of lithium ion battery (LIB) cost
- Battery manufacturers seek to secure raw material supplies of critical raw metals for battery cathodes:
  - Lithium, as battery grade (BG) lithium hydroxide monohydrate (LHM, $LiOH.H_2O$)
  - Nickel, as Nickel sulphate hexahydrate ($NiSO4.6H_2O$)
  - Cobalt, as Cobalt suphate heptahydrate ($CoSO4.7H_2O$)
- Research and development in battery technologies is driven by the desire to reduce cost and improve battery performance through substitution of cheaper cathode materials

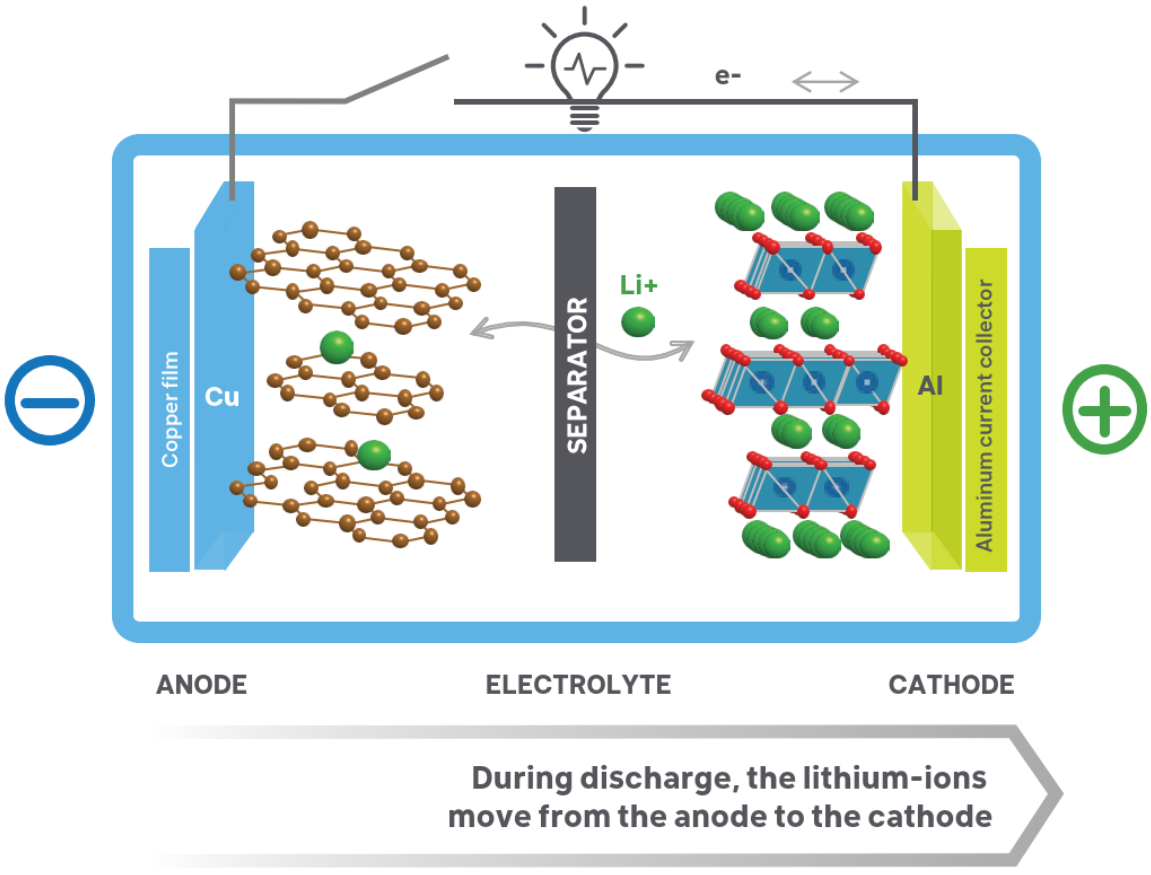


Source: BNEF 2020

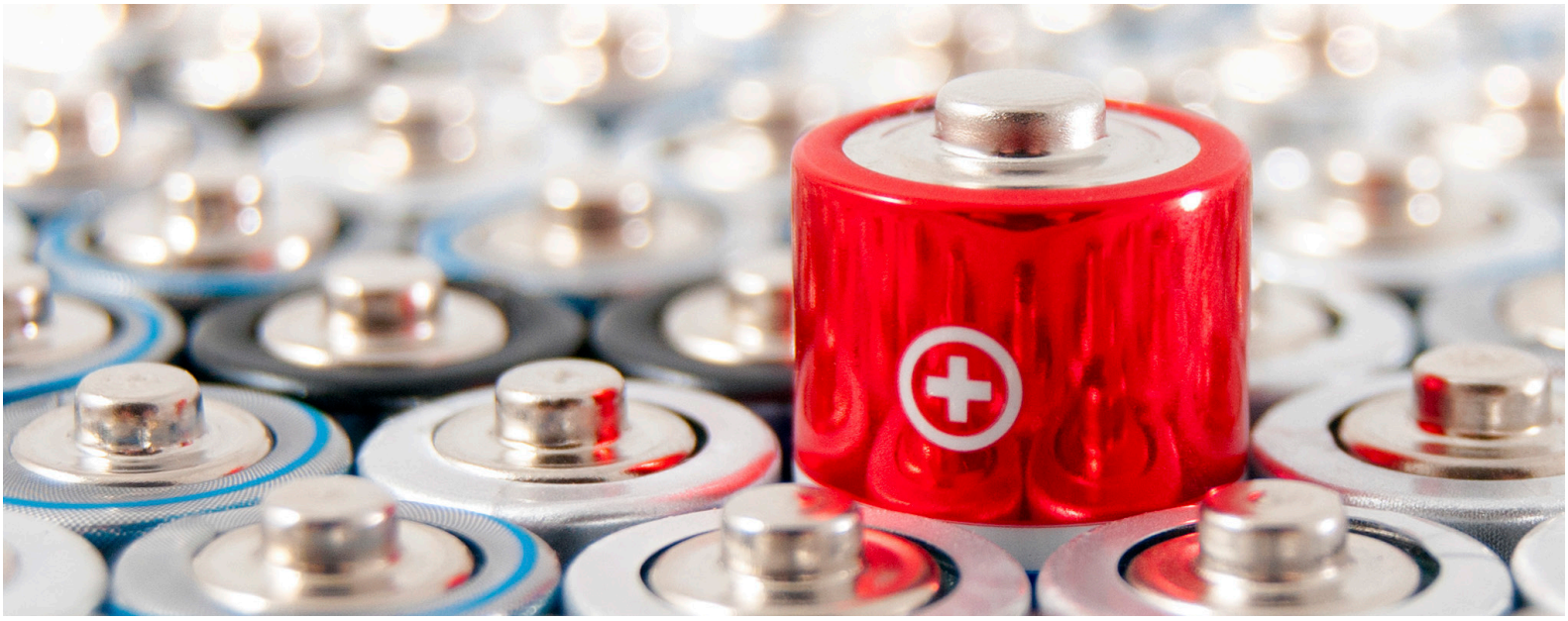
Lithium Ion Battery Chemistries

For BEVs to be competitive, their batteries need to have long range, fast charging times, high safety and a low cost.

- Traditionally, battery manufacturers achieve these characteristics by altering cathode chemistry in the battery
- All batteries have a cathode, anode, and electrolyte component
- Upon battery discharge, ions flow from the anode to the cathode via the electrolyte (conductor), while charging reverses this flow
- Cathodes are comprised of many metals, such as lithium, cobalt, nickel, manganese, and aluminum



Source: Report Development of the Li-ion Battery sector in Quebec, April 2019, Propulsion Quebec



There are five prevalent lithium ion battery cathode chemistries.

LCO – Lithium Cobalt Oxide	LMO – Lithium Manganese Oxide	LFP – Lithium Iron Phosphate	NCA - Lithium Nickel Cobalt Aluminum Oxide	NMC – Lithium Nickel Manganese Cobalt Oxide	NMCA – Lithium Nickel Manganese Cobalt Aluminum Oxide	Ni-rich Cobalt free - Lithium Nickel Manganese Oxide
(1991)	(1996)	(1996)	(1999)	(2008)		
• High specific energy makes it popular for mobile devices • Limited specific power and high cobalt content (cost), and lower relative safety make it unsuitable for EVs	• Higher specific power than LCO, but lower specific energy • Pure LMO batteries now uncommon, superseded by lithium manganese batteries with other metals added (see NMC)	• Very high specific power, can be used in place of lead acid starter battery • High safety rating • Low specific energy makes it unsuitable for EVs on its own	• A good option for EVs • High specific energy, good specific power, good safety • Safety and cost are inferior to NMC batteries, but safety can be improved with proper battery design	• The preferred battery for EVs due to recent improvements in specific energy and cost • High specific energy, good specific power, good safety • Battery chemistry can be tailored to improve energy or power		

Specific energy = how much energy a battery can store
Specific power = how fast energy can be taken from the battery

Source: Hatch

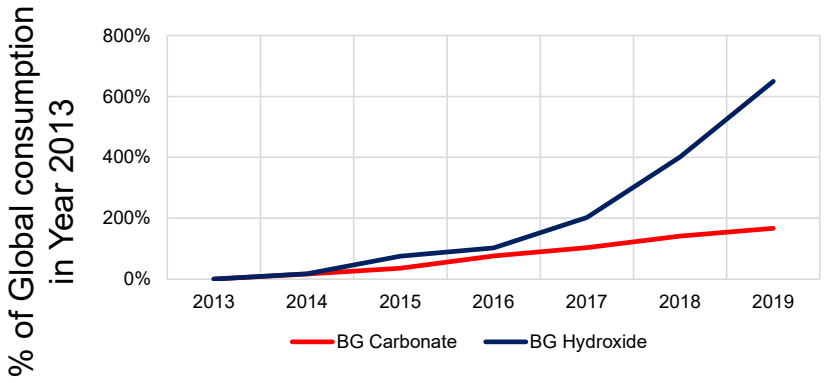
Feed Material Production for BEVs

Lithium

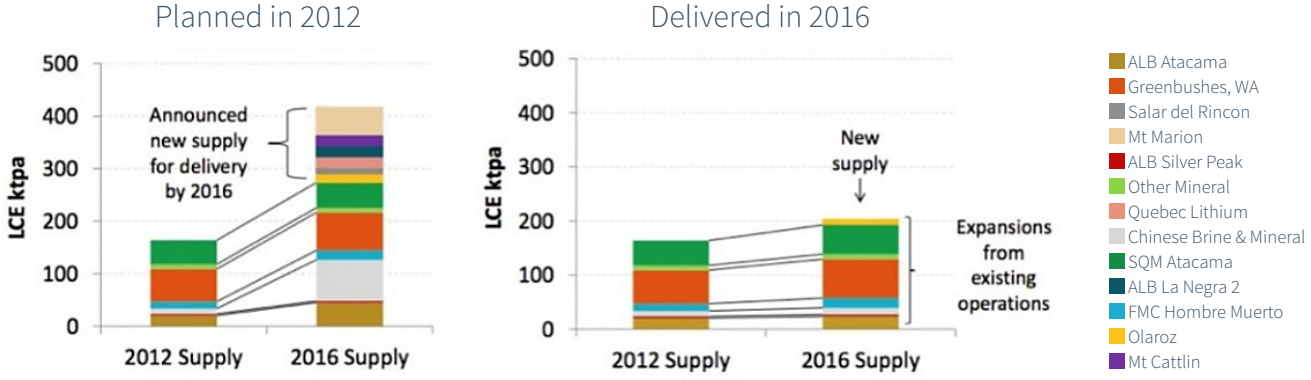
Lithium is a critical ingredient to lithium-ion batteries, and good alternatives are not yet available.

- Demand has increased significantly in recent years due to the forecast growth in EV adoption
- Other battery technologies that are free of lithium are still 10-20 years away from challenging lithium ion battery dominance in the market
- This growth has spurred on several projects for new and expanded capacity
- Lithium projects can take 5-10 years to begin production due to difficulty in raising funds as investors remain hesitant

Global Consumption of Battery Grade Lithium Carbonate and Battery Grade Lithium Hydroxide



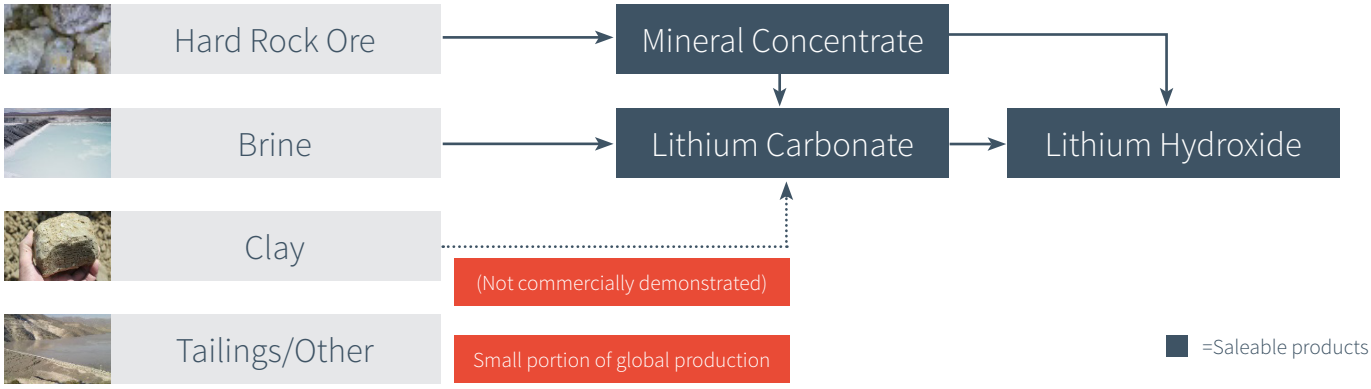
Source: Hatch Analysis, Roskill 2020



LCE = Lithium Carbonate Equivalent

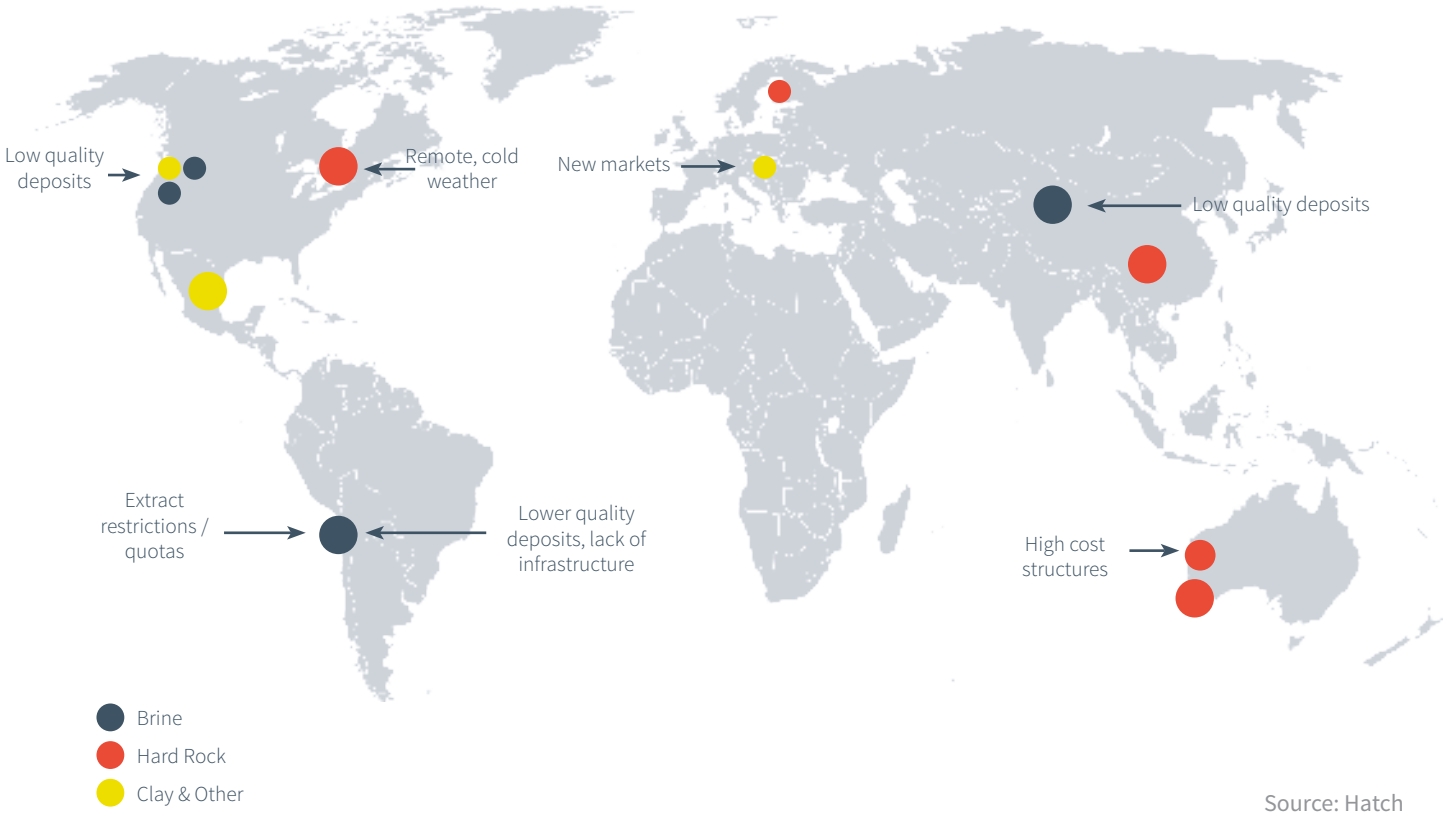
Source: Mining.com 2018

The key lithium chemicals used in battery production are lithium carbonate (Li_2CO_3) and lithium hydroxide ($LiOH.H_2O$), which can be produced from various sources.



Source: Hatch

Each key lithium jurisdiction has challenges associated with the production and sale of lithium chemicals.



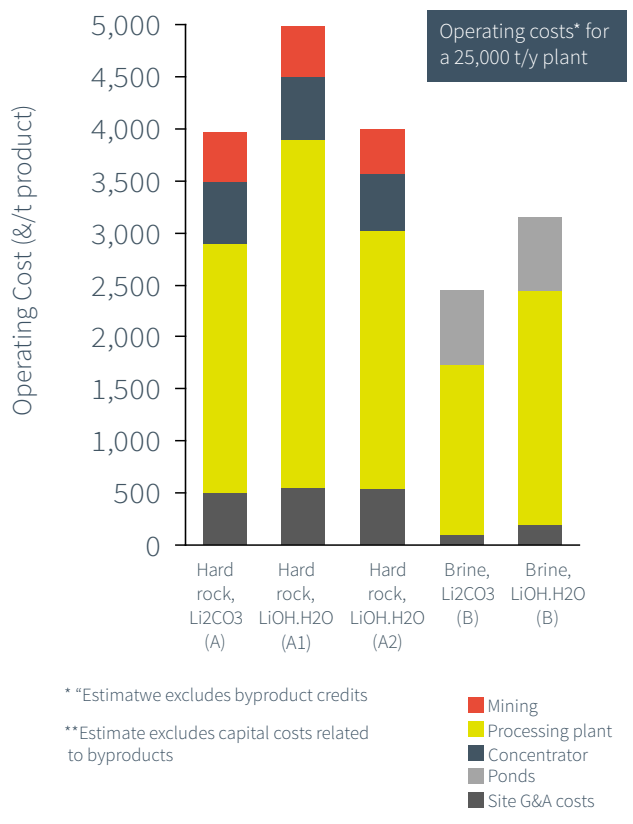
Source: Hatch

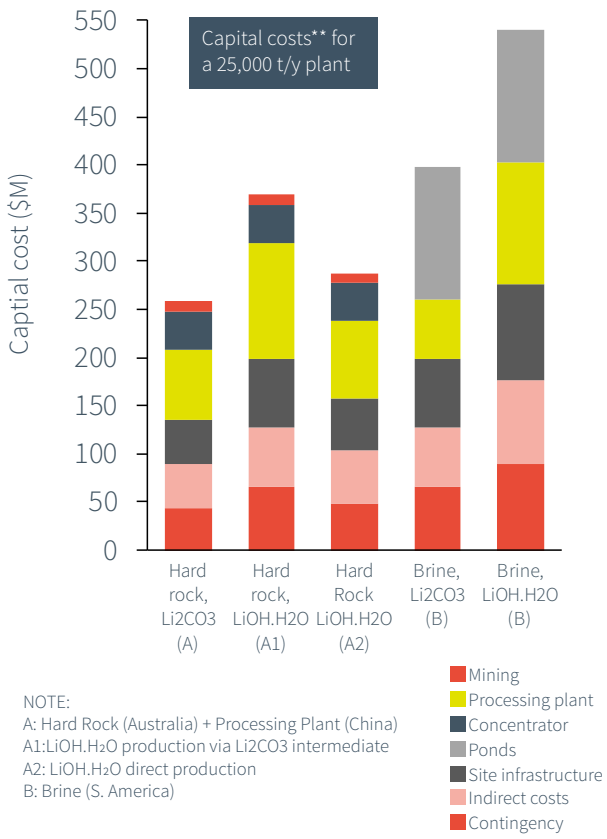
Most of the world's lithium carbonate and lithium hydroxide production currently comes from either hard rock or brine deposits.

Current processing technologies:

Hard Rock	Brines	Clay/Other
High opex, fast ramp-up • Concentrator plant to produce mineral concentrate, followed by • Chemical plant to produce Li_2CO_3 from concentrate using acid roast leach process, or • Chemical plant to produce LiOH.H_2O directly from concentrate via the lime or causticization process	**Low opex, slow ramp-up** • Fresh brine to Li_2CO_3 using evaporation ponds and chemical purification, followed by • Li_2CO_3 to LiOH.H_2O using either the lime or causticization process	**No plants currently exist, but projects plan to:** • Process clay to Li_2CO_3 • Process hard rock sources via electrolysis processes

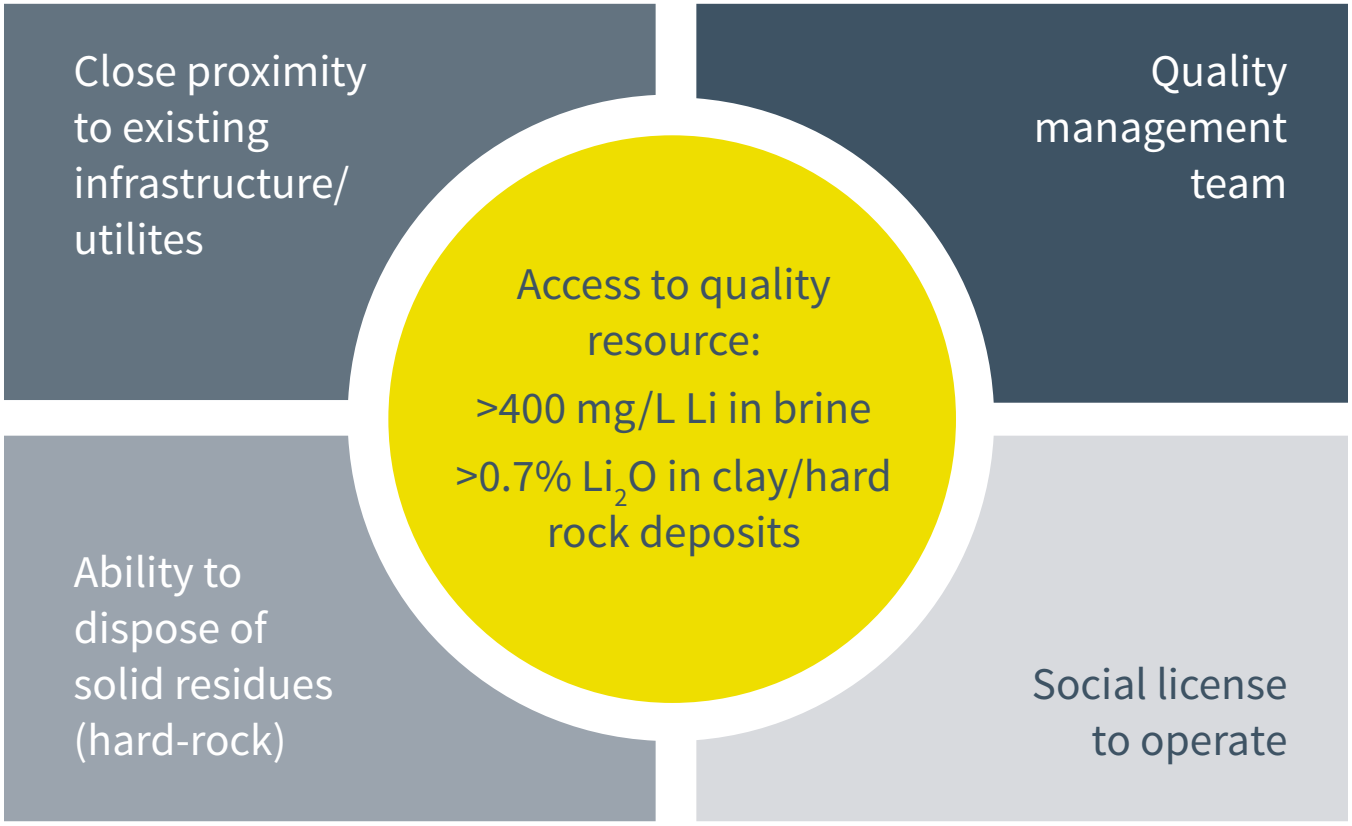
Operating costs are dominated by reagents and labour, while major capital cost contributors are the ponds (brine) and the purification / processing plant (hard rock and brine).





Source: Hatch

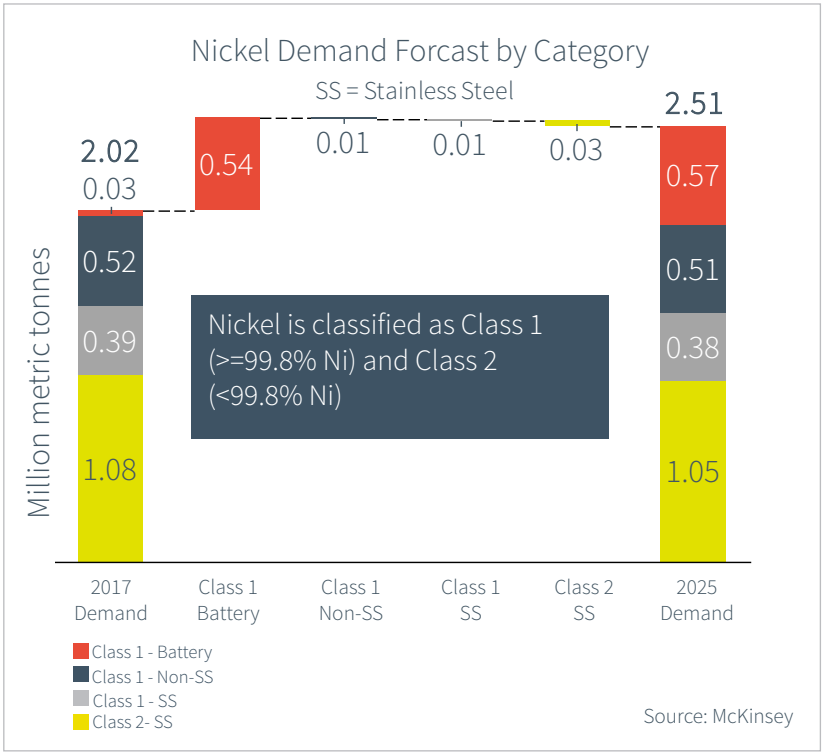
Key success factors for lithium projects:



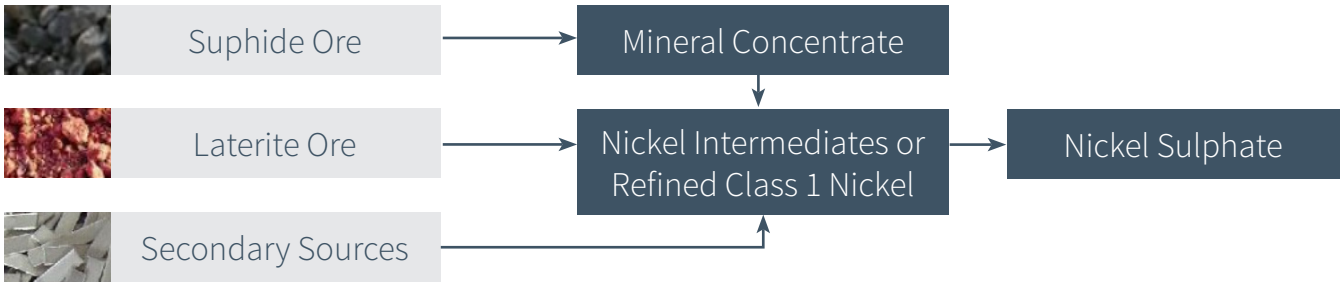
Nickel

Nickel is used in lithium-ion batteries to improve battery performance, and battery production requires Class 1 nickel.

- The majority of global nickel consumption is in the steel industry, which uses both Class 1 and Class 2 nickel
- Class 1 nickel consumption is expected to grow significantly, and nickel pricing may be split into two products
- There is consensus that EVs will replace ICE vehicles and that nickel-rich lithium ion battery chemistries will dominate. This is estimated to result in an increase in nickel demand for batteries from ~154kt in 2020 to ~570Mt by 2025.
- Nickel sulphide deposits may offer the best economics for production of nickel sulphate, but few major new high grade discoveries have been made
- Future demand will likely have to be met by increased nickel sulphate production from laterite deposits

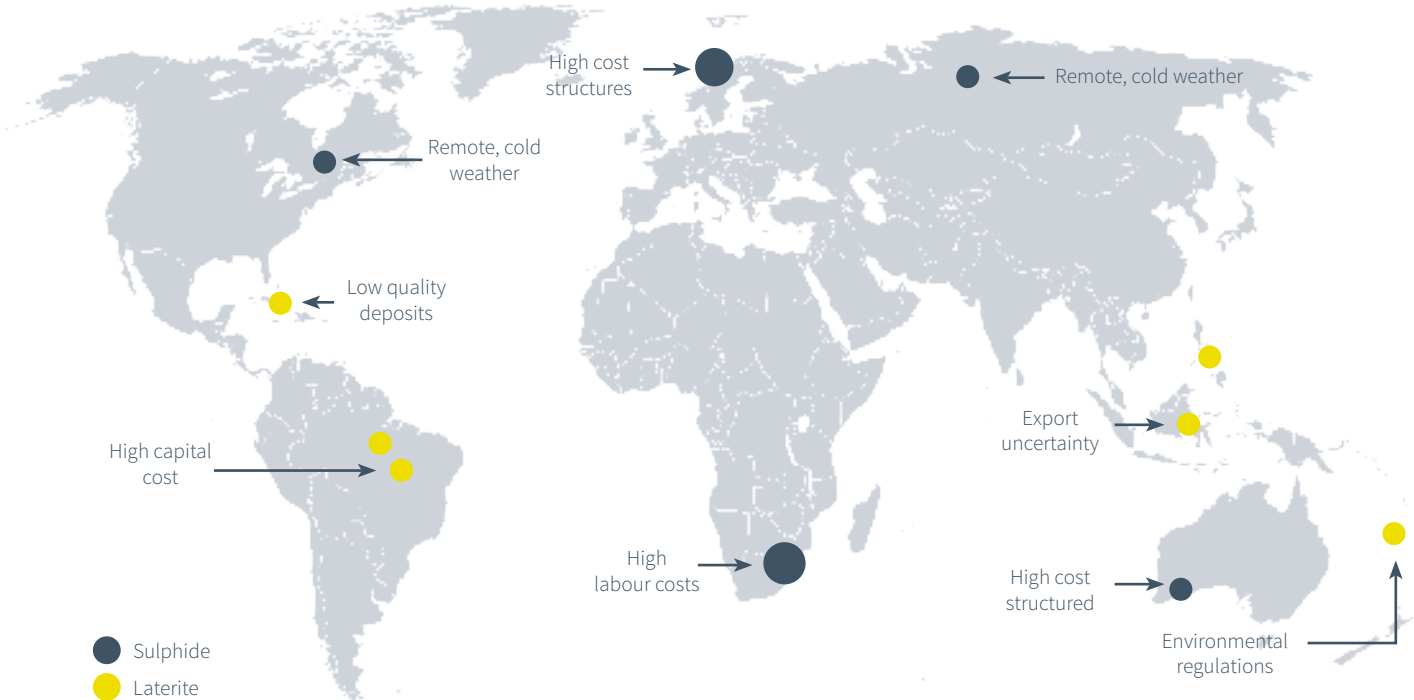


The main nickel chemical for battery production is nickel sulphate hexahydrate (NiSO4.6H2O), which can be produced in multiple ways.



Source: Hatch

Each key nickel jurisdiction has challenges associated with the production and sale of nickel chemicals.



Source: Hatch

Most of the world's current nickel sulphate production comes from either nickel sulphide or laterite ores, both of which may be processed via multiple different technologies.

Current processing technologies:

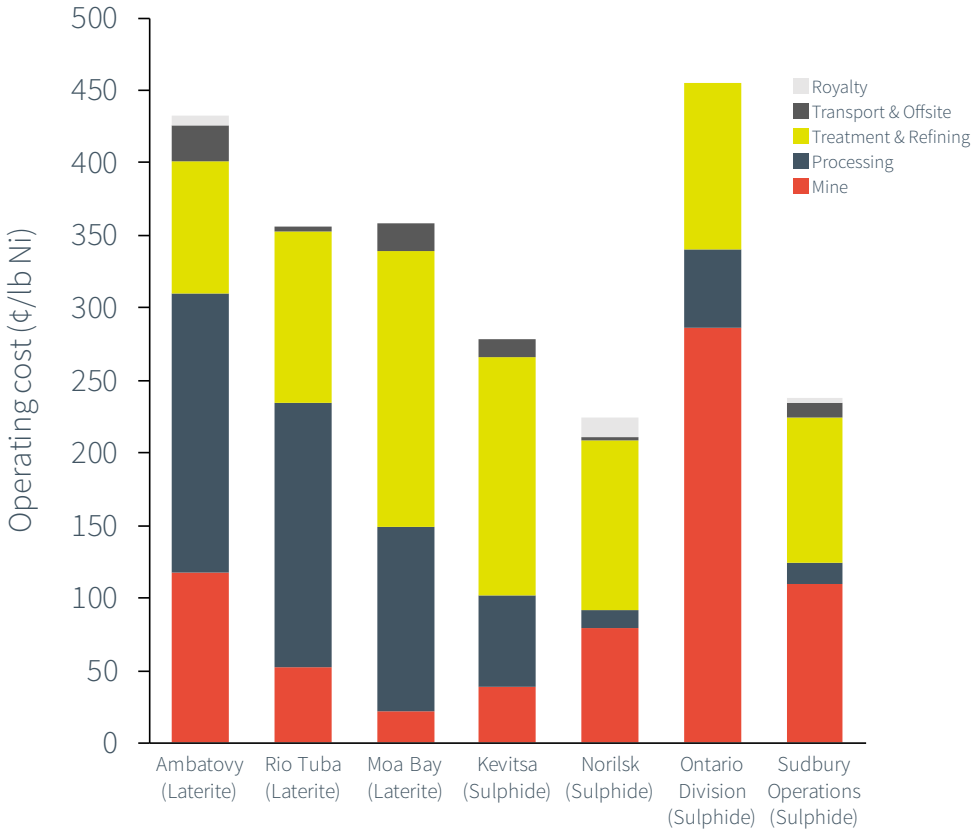
Laterite Ores	Sulphide Ores
High opex	**Low opex, few new discoveries**
• Upgrading to produce higher grade ore, followed by • High pressure acid leach (HPAL) to produce nickel intermediates, or • Smelter with sulphur addition to produce nickel matte, followed by • Refinery to produce nickel sulphate	• Concentrator plant to produce mineral concentrate, followed by • Smelter to produce nickel intermediates, or • Acid leach to produce nickel intermediates, followed by • Refinery to produce nickel sulphate

Nickel sulphate can be produced from many different feedstocks, including but not limited to nickel hydroxide, nickel or mixed sulphide, nickel matte, nickel metal, and nickel carbonate

Operating costs for nickel laterite ores are dominated by processing and refining

The processing costs of laterite ore projects are often higher than those for sulphide ore projects

Many of the first quartile producers on the nickel cost curve are sulphide ores



Source: Hatch

Cobalt

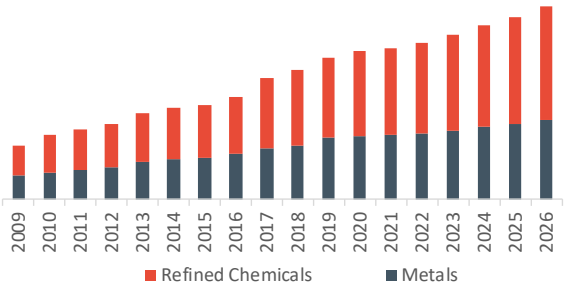
Cobalt is a critical ingredient for EV batteries, where it is used in the form of cobalt chemicals.

- Battery manufacturers continue to push for lower cobalt content to reduce battery cost, and will use lower and lower cobalt over the next decade, aiming to zero-cobalt cathode materials by 2030.
- Approximately 97% of the world's cobalt is produced as a by-product of nickel or copper, and supply of cobalt is strongly governed by nickel and copper prices
- China has been making significant moves to secure a dominant position in the cobalt market
  - Ability to invest in cobalt projects on western-based exchanges are therefore limited
  - The majority of Chinese-owned cobalt assets are in the Democratic Republic of the Congo

The majority of world cobalt reserves and resources are located in the Democratic Republic of the Congo (63%), followed by Australia (10%), Tonga (9%), and Canada (5%)

Refined chemicals are expected to represent over two thirds of total cobalt demand by 2026

Forecast of Global Cobalt Chemicals Demand



Source: CRU 2017

The key cobalt chemicals used in battery production are cobalt oxide and cobalt sulphate, which can be produced from various sources.

Current common processing technologies for cobalt-containing ores:

Cobalt-Copper Ores	Cobalt-Copper-Nickel Ores
• Cobalt-copper ores in DRC and Zambia are typically processed to produce a mineral concentrate. • This is treated to produce a separate cobalt-rich concentrate for treatment in a cobalt circuit. • Cobalt concentrates are then treated further via pyrometallurgical or hydrometallurgical processes, followed by electrolysis to recover cobalt.	• In pyrometallurgical processes, cobalt is oxidized to smelter slag along with iron. The slag is typically treated in a furnace to recover the cobalt to a metal alloy. • In hydrometallurgical processes, nickel cobalt is recovered from solution by reduction with hydrogen under pressure. • Cobalt is refined from crude processing by-products via electrowinning.

Cobalt found in laterite ores that are processed to Class 2 nickel products such as ferronickel and nickel pig iron is typically not recovered.

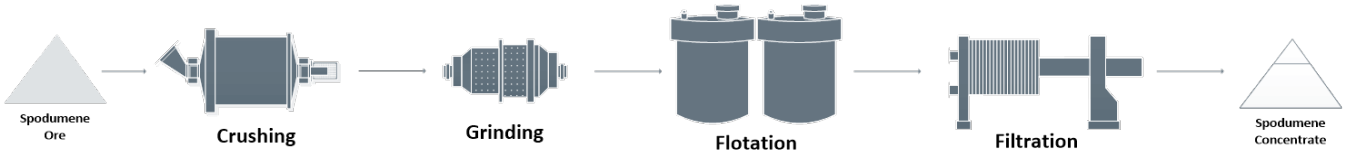
Conclusions

Demand for electric vehicles and battery energy storage is expected to continue growing in the short and mid-term.

- While development of new supply is attracting investor attention for lithium, investors are still hesitant how expansion projects of existing producers will affect supply and how long new projects will take to bring online
- Battery production is a growing source of Class 1 nickel consumption, bringing opportunity to Class 1 nickel producers. Some existing nickel producers are also developing nickel sulphate plants to take advantage of the growing demand for this material
- Cobalt supply is closely tied to copper and nickel, resulting in a recent surge in cobalt pricing. Investors and buyers are hesitant about the social impact of supply from the world's largest producer, the DRC, in which some small producers use manual labour with low safety standards
- Hatch has extensive experience in engineering and execution of mining and metals processing projects in the lithium, nickel, cobalt, copper, graphite, aluminium, manganese industries. Hatch also developed expertise in engineering and execution of battery-grade materials, as well as precursor of Cathode Active Material (pCAM) and CAM manufacturing. We have worked with many major lithium and nickel producers over the past few decades supporting both greenfield and brownfield projects, including supply of our Hatch technologies. We are excited to leverage this experience to assist your pursuits in the battery metals space

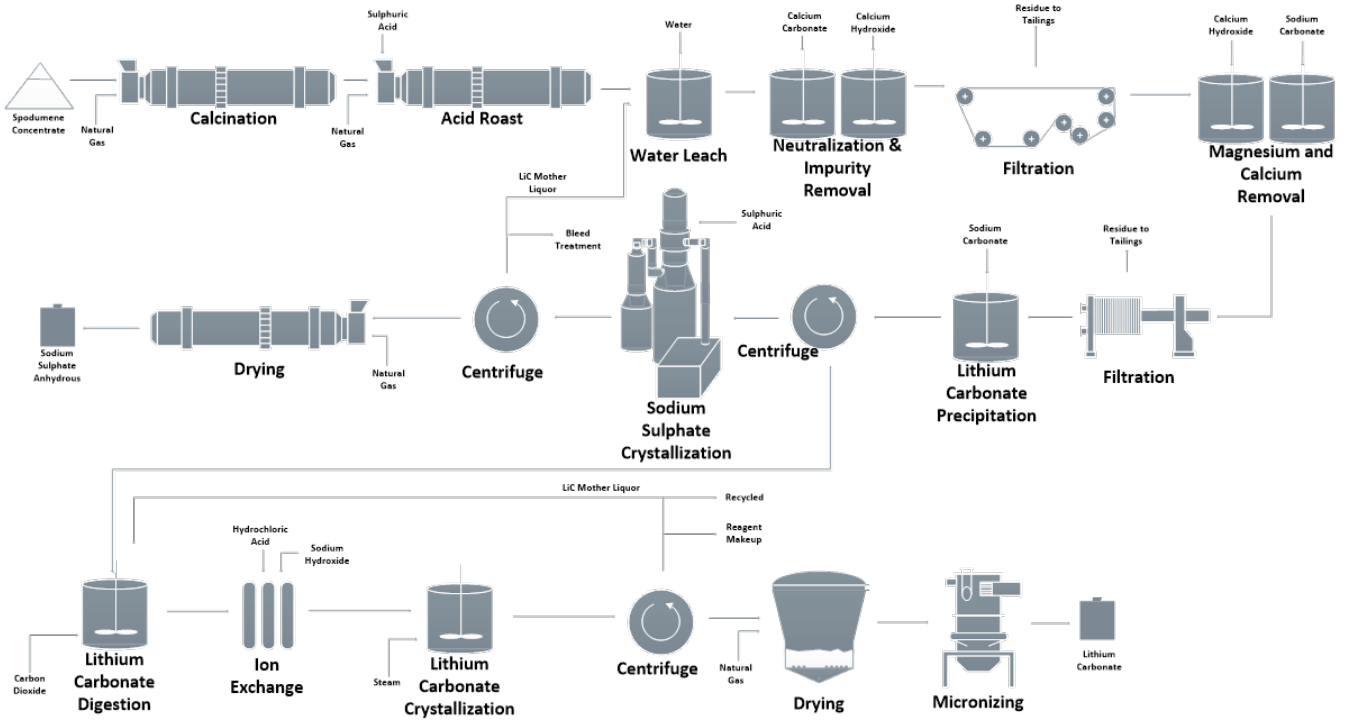
Appendix A: Lithium Process Flow Diagrams

Hard rock deposit owners can focus on concentrate production, for sale to China (or other low cost country) where it can be processed at lower cost



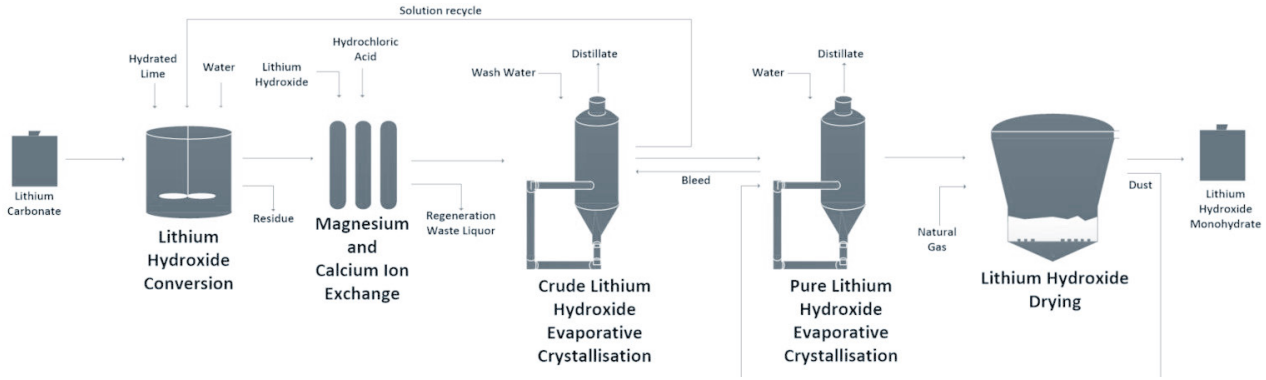
Source: Hatch

Spodumene concentrate is calcined, roasted, and leached prior to chemical purification and Li_2CO_3 production



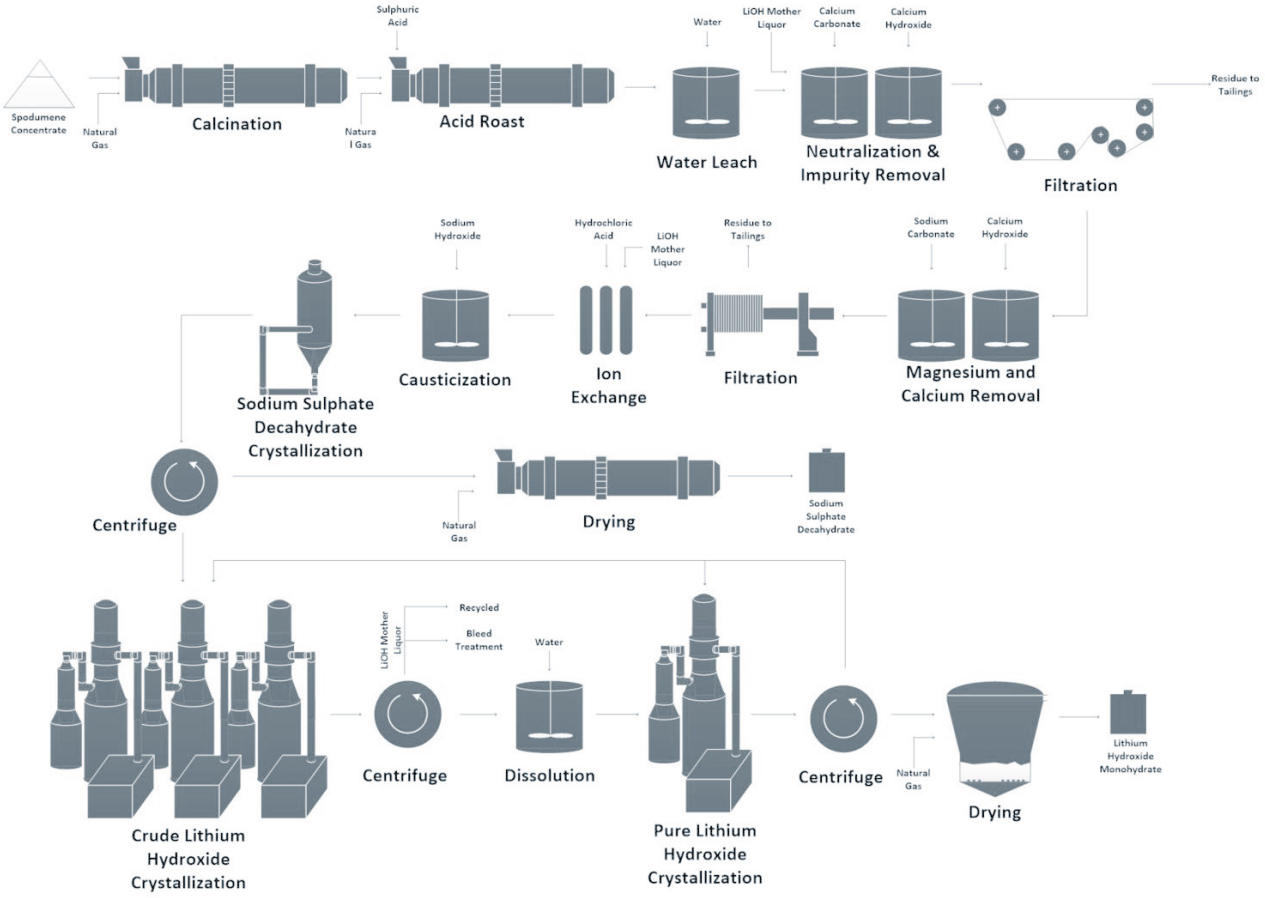
Source: Hatch

Li_2CO_3 is reacted in solution with hydrated lime followed by ion exchange before crystallizing and drying the $LiOH.H_2O$



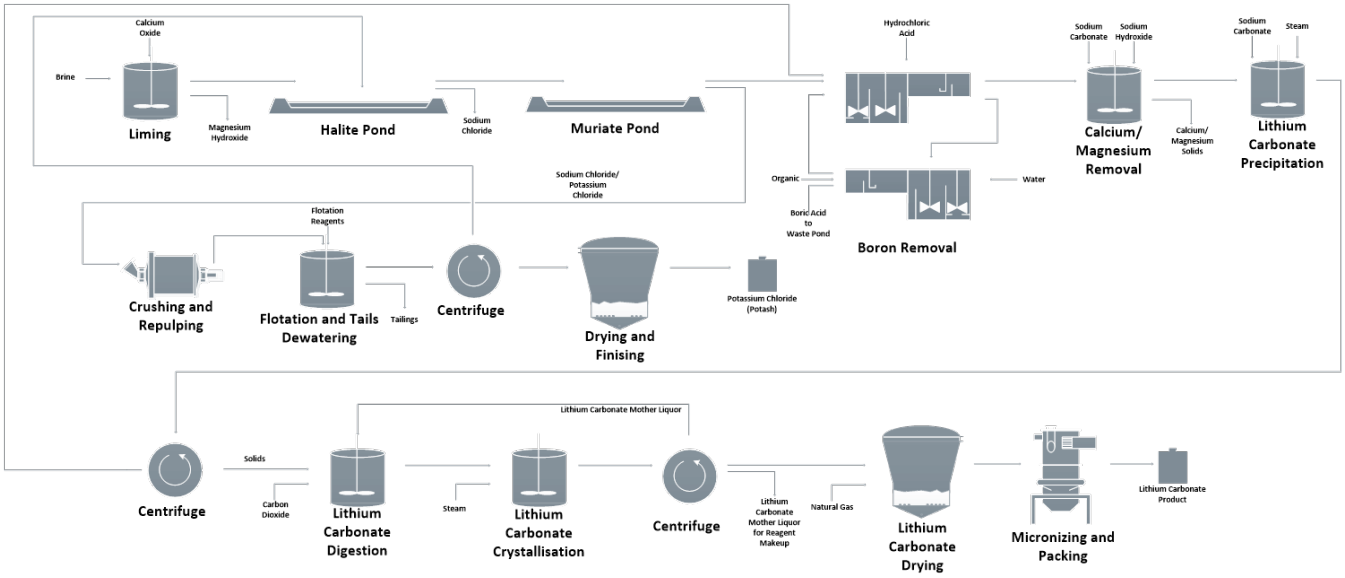
Source: Hatch

$LiOH.H_2O$ can be produced directly from spodumene concentrate via a causticization process



Source: Hatch

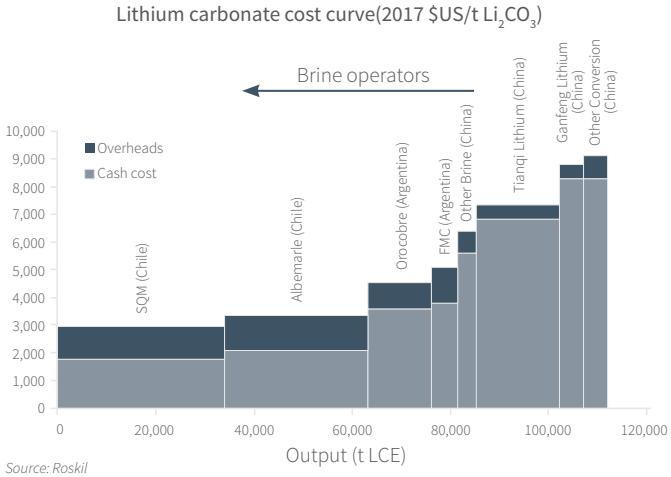
Lithium rich brines utilize large solar evaporation ponds, prior to on-site chemical purification and conversion to Li_2CO_3



Source: Hatch

Appendix B: Lithium Cost Curve

The bottom half of the lithium carbonate cost curve is dominated by brine production facilities



Source: Roskil

Notes: Battery and technical grades; Includes direct carbonate production from raw materials (brine and minerals); SQM & Rockwood costs assume potash cost share methodology; Tianqi mineral conversion assumes US$560/t spodumene concentrate price; Other China and Ganfeng assumes US$750/t spodumene concentrate price

Appendix C: Project Experience

Project experience lists, as follows:

1. Battery Material

Battery Materials

Representative experience

Note: The projects listed here are the ones specifically dedicated to the Li-ion battery industry; BG = Battery grade.

Project	Client	Location	Project scope	Hatch scope	Metal	Date
Lithium metal production	Lyten	California	Scoping Study for a customized process to make battery grade lithium metal. The process includes Hatch Equipment Technology, for instance molten salt electrolytic cells and a refining furnace.	Scoping Study (FEL1)	Li	2022
Electra Phase III and IV Scoping Study	Electra Battery Materials	TBD	Feed option study (Black mass and various nickel feeds) and pCAM manufacturing	Scoping Study (FEL1)	Battery recycling, pCAM	2022
Confidential	Confidential	Confidential	Pilot plant for a cathode manufacturing LFP plant.	Scoping Study (FEL1)	Cathode Material	2022
CAM process cost comparison	Nano One Materials Corp.	North America	Cost comparison of conventional pCAM/CAM process versus Nano One process for Ni-rich cathode material commercial production scale	Scoping Study (FEL1)	Cathode Material	2021-2022
Confidential	Confidential	Confidential	Technical Due Diligence on Cathode Manufacturer – scale-up, process, R&D,	Due Diligence	Cathode Material	2022
Confidential	Confidential	Confidential	Cathode Material Synthesis – Scale-up, Process optimization	Concept Study (FEL1)	Cathode Material	2022
Confidential	Confidential	Confidential	Cathode active material production	Pre-Feasibility study (FEL2)	Cathode Material	2020-2022
Battery recycling hydromet hub	Li-Cycle	Rochester, USA	Detailed Engineering of the 35,000tpy black mass hydromet hub for battery recycling	Detailed engineering (FEL4)	Battery recycling	2020-2022
Confidential	Confidential	Confidential	Concept study for the construction of plants to produce precursor of Cathode Active Materials (pCAM) and CAM.	Concept Study	Cathode Material	2020-2021
Confidential	Confidential	Confidential	Concept studies of pCAM/CAM processes to compare innovative	Concept Study – Process comparison	Cathode Material	2020-2021

Project	Client	Location	Project scope	Hatch scope	Metal	Date
			process versus conventional pCAM and CAM synthesis method.			
Confidential	Confidential	Confidential	Technology comparison of Battery recycling methods, from black mass production to battery grade material preparation	Concept Study – technology comparison	Battery Materials, BG chemicals	2020
Confidential	Confidential	Confidential	Market review for Battery recycling landscape, with focus on US recycled batteries availabilities	Concept Study – Market review	Battery Materials, BG chemicals	2021
Confidential	Confidential	Confidential	Market review for Battery recycling landscape, investigating global battery production and chemistry breakdown	Concept Study – Market review	Battery recycling, BG chemicals	2021
Confidential	Confidential	Confidential	The project consists of a concept study for a Nickel metal dissolver to produce battery-grade nickel sulphate.	Concept Study	Ni	2020-2021
Confidential	Confidential	Confidential	Market study and Process Option review for production of BG NiSO4.	Concept Study	Ni	2020-2021
James Bay Project Processing Capacity Assessment	Galaxy Lithium (Canada) Inc.	Canada	Evaluation of the current processing capacity of the Spodumene Conversion, Lithium Processing Plant and identify the optimal plant capacity for further study.	Concept Study	Li	2020
Confidential	Confidential	Confidential	Trade-off study to select optimum lithium recovery process technology	Concept Study	Li	2020
Salar de Los Angeles	Lithium X	Argentina	The construction of a new lithium carbonate production facility, recovering lithium from chloride brines. Scope of facilities included evaporation ponds, boron SX, ion exchange, lithium carbonate production, drying and classification, as well as power generation and natural gas receiving facility.	Feasibility Study	Li	2020
Mt Holland Concentrator and Kwinana Refinery	Covalent (SQM and Wesfarmers JV)	Australia	The Mt Holland Earl Grey Lithium deposit is in the advanced stages of resource definition and metallurgical testwork to recover spodumene and petalite minerals.	Pre-Feasibility Study (FEL-2), Feasibility Study (FEL-3) and Detailed Engineering (FEL-4) for Concentrator and Lithium Hydroxide refinery	Li	2020

Project	Client	Location	Project scope	Hatch scope	Metal	Date
Confidential	Confidential	Confidential	This project consisted of an evaporation ponds installation yield improvement.	EP	Li	2020
Future Battery Industry Scene Setting Study	Queensland University of Technology	Australia	Repurpose of pilot plant for pCAM and CAM production	Concept Study (FEL1)	Battery recycling, pCAM, CAM	2020
Confidential	Confidential	Confidential	The project consists of a concept study for a Nickel metal dissolver to produce battery-grade nickel sulphate.	Concept Study FEL-1 to Detailed Engineering FEL-4	Ni	2018-2022
Confidential	Confidential	Confidential	To study three potential flowsheets to determine which one is the most favourable for a European lithium refinery.	Concept Study	Li	2020
Confidential	Confidential	Confidential	The extraction of nickel-cobalt-manganese (NMC) through battery recycling.	Scoping Study and Pre-Feasibility Study for commercial plant and Feasibility Study.	Battery Recycling , Ni, Mn and Co	2019-2021
Piedmont Lithium Project	Piedmont Lithium	USA	The flowsheet was a conventional mixed pyrometallurgical and hydrometallurgical facility with calcination, acid bake, water leach, impurity removal and causticization for the production of lithium hydroxide.	Pre-Feasibility Study	Li	2019-2020
Kachi Lithium Brine Project	Lake Resources NL	Argentina	The treatment of brine with low levels of lithium via direct extraction (LILAC) to produce a lithium chloride stream for further processing to lithium carbonate.	Pre-Feasibility Study	Li	2019-2020
Vulcan Energy Resources Limited	Vulcan Project	Germany	The geothermal brine contained low levels of lithium and the project aimed to upgrade the lithium via direct extraction for the production of lithium hydroxide.	Scoping Study	Li	2019-2020
Confidential	Confidential	Confidential	The project scope focused on the extraction of nickel-cobalt-manganese (NMC) and Li through battery recycling.	Scoping Study and Pre-Feasibility Study for commercial plant	Li	2019-2020
ICS Lithium	Integrated Carbon Sequestration (ICS) Pty Ltd	Australia	The concept study of a novel lithium recovery process and comparing the process and costs to sulfate process.	FEL-1	Li	2019-2020

Project	Client	Location	Project scope	Hatch scope	Metal	Date
Confidential	Confidential	Confidential	Battery Chemical Commercial Plant	Scoping Study (FEL0)	Battery recycling, pCAM	2019
SMPP Project	Fortune Minerals	Canada	The evaluation of the final flowsheet including concentrator, Bi plant, Au plant, Co POX, impurity removal, Cu cementation, Co crystallization to produce Co product as sulphate or carbonate.	Pre-Feasibility Study and Feasibility Study	Co and Cu	2019
Cinovec Lithium Chemicals Plant Update	European Metals Holdings Limited	Czech Republic	Cinovec hosts the largest lithium resource in Europe, and one of the largest undeveloped tin resources in the World. The recently completed Preliminary Feasibility Study indicated that Cinovec has the potential to be the lowest cost hard rock lithium producer in the World.	Pre-Feasibility Study	Li	2019
Paradox Pilot Plant Project	Anson Resources	USA	Anson Resources were seeking to recover oil and gas from the well field, with the contained brine being processed for lithium recovery via direct extraction.	Pre-Feasibility Study	Li	2019
The DeepGreen Metals Project	DeepGreen Metals Inc.	Canada	DeepGreen has been developing the first project to recover and process deep-sea polymetallic nodules to produce battery chemicals, copper cathode and a manganese silicate. As part of this development they intend to develop a $3B smelter and refining complex that will produce 60,000 tpa Ni as battery grade nickel sulfate, 50,000 tpa Cu as copper cathode and 6,000 tpa Co as battery grade cobalt sulfate and about 3.8 million tpa of manganese silicate.	Conceptual Studies, Testwork Support and Engineering Development	Ni, Co and Cu	2018-Present
Centenario Project	ERAMET	Argentina	A novel lithium carbonate process to produce product from the Centenario Salar.	Feasibility Study	Li	2018-Present
Hell's Kitchen Geothermal Brine Lithium Project	Controlled Thermal Resources	USA	A novel process to extract lithium from geothermal brines. Detailed technology assessment was completed to determine technology with most potential.	PEA and Process Development including testwork coordination and oversight	Li	2018-Present

Project	Client	Location	Project scope	Hatch scope	Metal	Date
FEL-1 Study for Centaur Resources	Centaur Resources Pty Ltd	Argentina	The scoping study of lithium carbonate production (pilot plant size) at the Pastos Grandes Salar.	FEL-1	Li	2018-2019
Alrosa	Alrosa PJSC	Russia	The study of valuable component recovery from groundwater at the Udachny Mine – mainly comparing two technologies for lithium, plus bromine.	FEL-1	Li	2018-2019
Pilgangoora Lithium-Tantalum Project	Pilbara Minerals	Australia	Pilbara Minerals have been constructing a spodumene concentrator in Western Australia. Concurrently with the concentrator development, Pilbara Minerals asked Hatch to complete a scoping study for a plant to produce both lithium carbonate and lithium hydroxide.	Scoping Study	Li	2018-2019
Wodgina Project	Mineral Resources	Australia	Examination of the production of 25,000 LCE tpa of lithium chemicals from spodumene at Wodgina, Australia.	Pre-Feasibility Study	Li	2018-2019
Nina do Barroso Lithium Scoping Study	Savannah Resources	Portugal	The scoping study of the mining, concentration and processing of spodumene to lithium carbonate or lithium hydroxide in a number of global sites.	Scoping Study	Li	2018
Missouri Small Plant Gap Analysis and Process	Doe Run	USA	To check the feasibility of the hydrometallurgy plant with the newly designed Flubor Process Technology.	Gap Analysis Engineering	Cu	2018
Neolithium 3Q Project	Neolithium	Argentina	Hatch undertook scoping studies to assist Neolithium with developing the chemistry to enhance the crystallisation of CaCl2 hexahydrate (antarctictite) which removed water from the brine and concentrated the lithium.	Scoping Study	Li	2018
Terrafame Oy NiSu Feasibility Study	Terrafame Oy	Finland	Terrafame Oy planned to construct a new Metals Converting Plant at their existing Sotkamo, Finland site to process the current mixed sulfide product into nickel sulfate and cobalt sulfate. A significant amount of ammonium sulfate by-product will also be produced. Nickel sulfate and cobalt sulfate are primarily used in battery production and have a higher payability when compared to the current sulfide product.	Feasibility Study	Ni and Co	2018

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Lithium Conversion Plant	LG Chem	South Korea	Study of the potential design and construction of a lithium chemicals plant in Korea to supply the growing demand from its battery division.	Pre-Feasibility Study	Li	2018
Confidential	Confidential	Confidential	Due diligence of existing cobalt purification facilities which included various leaching stages, SX, precipitation, crystallisation and calcination.	Due Diligence Assessment	Co	2018
Shawinigan Commercial Hydrometallurgical Plant	Nemaska Lithium	Canada	Production of 37,000 tpa of lithium hydroxide monohydrate from spodumene concentrate using Nemaska's proprietary electro membrane process.	Feasibility study to Detailed Engineering	Li	2017-Present
Kidman Project	Covalent Lithium Pty Ltd	Australia	A process of converting a lithium oxide concentrate to battery grade material in a 44,000tpa lithium hydroxide plant.	Feasibility Study and detailed design	Li	2017-2020
Lithium Chemicals Localisation Project	Lithium Korea	South Korea	To establish a lithium chemicals plant in the Saemangeum Industrial Park in Korea and Spodumene would be sources from Australia to produce a battery grade lithium.	Preliminary Basic Engineering and Environmental Emissions Report	Li	2017-2018
Arcadia Lithium Project	Prospect Resources	Zimbabwe	The production of lithium carbonate and lithium hydroxide from a mixed petalite/spodumene concentrate.	Prefeasibility Study	Li	2017
Debottlenecking and Optimization Project	North American Lithium	Canada	To modify and complete the construction of a 23,000 tpa lithium carbonate from spodumene plant.	Feasibility Study and EPCM	Li	2016-Present
Lithium Project – AMG Mineracao	Advanced Metallurgical Group	Brazil	The processing of approximately 100,000tpa of by-product spodumene from AMG's operation at Nazareno, Minas Gerais, Brazil to produce lithium carbonate or lithium hydroxide.	Pre-Feasibility Study Testwork scoping and supervision	Li	2016-2020
Namibia Project	Desert Lion Energy (DLE)	Namibia	DLE have been developing a lepidolite mine, beneficiation plant and chemical plant in Namibia.	Prefeasibility Study with NI 43-101 filing	Li	2016-2018
Lithium Processing Plant	Ironstone Resources	Canada	Ironstone Resources examined the potential recovery of lithium and other valuable elements from formation waters in Alberta, Canada.	Concept Study	Li	2016

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EXAR Cauchari-Olaroz	Lithium	Argentina	The project included a new lithium carbonate production facility, recovering lithium from chloride brines. The process incorporated a novel impurities removal step, boron SX, crystallization, ion exchange, lithium carbonate production, drying and classification.	Pre-Feasibility Study, Feasibility Study and EPCM	Li	2015-Present
Kings Valley	Lithium Americas	USA	The scope included the production of lithium hydroxide using a novel flowsheet. The study evaluated various potential methods for lithium hydroxide production. The recommended option employed concentration techniques, calcination, dissolution, crystallization, lithium carbonate precipitation and lithium hydroxide conversion.	Due Diligence	Li	2015
Site Feasibility Study	Albemarle/Rock wood Lithium	USA	The construction of a 50,000 tpa lithium hydroxide monohydrate production facility.	Determination of Concept Level Capital and Operating Costs	Li	2014-2015
Sonora and Magdalena Projects	Bacanora Minerals	Mexico	Bacanora developed both lithium carbonate and borate projects near Hermosillo, Mexico. The feed material for lithium was a hectorite/polylithionite clay that requires a different sulfation chemistry to that typically used.	Process, pilot plant and execution plant review	Li	2014-2015
Lake Lithium Project	Lake Lithium	China	Lake Lithium utilised a Russian patented ion exchange agent to recover lithium from well-feed.	Operational Improvements	Li	2014
Jadar Project - Prefeasibility Study	Rio Tinto	Serbia	The Jadar project consisted of the development of the world's first lithium/boron separation plant. Jadar is a unique deposit that contains jadarite – a new lithium sodium borosilicate mineral. This high-quality, large-scale lithium and boron deposit is located below the Jadar River in Serbia.	Pre-Feasibility Study and Bridging Work to DFS	Li	2013-Present
Mineral Conversion Plant	Talison	Australia	The production of 20,000tpa lithium carbonate plant using Greenbushes spodumene feed.	Conceptual Study, Scoping, Pre-Feasibility Study, Feasibility Study	Li	2013
Mt Marion Study	Reed Resources (Neo Metals)	Malaysia	The production of 17,000 tpa lithium carbonate processing plant to be located in Asia, with spodumene	Scoping Study and Pre-Feasibility Study	Li	2012

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			concentrate provided from Western Australia.			
James Bay Project	Galaxy Resources	Canada	Building a greenfield lithium carbonate plant to produce lithium carbonate from spodumene.	FEL-2	Li	2011
Salar de Olaroz Project	Orocobre & JV Partner	Argentina	The Olaroz Lithium Facility, located in Jujuy Province in northern Argentina, produces lithium carbonate.	Reviewing Pond and Lithium Carbonate Plant Design and Costs at the Completion of FEL-2 Engineering.	Li	2011
Lithium Carbonate Processing Plant	Galaxy Resources Limited	China	The scope of project included: To support the development of Galaxy's maintenance capability to be ready to support operations; To support the development of Galaxy's operational capabilities to be ready to operate effectively.	FEL-2 and FEL-3 Design of a Lithium Battery Manufacturing Facility	Li	2011
Salar del Rincon Project	Rincon	Argentina	Rincon operated a 1700tpa semi-commercial plant at the site and supplied product samples to prospective battery maker buyers.	Engineering Cost Study for Recovering Potash and Lithium carbonate from Salar Brine	Li	2010-2012
Salton Sea Project	Simbol Mining	USA	Hatch designed and helped to commission the Simbol pilot lithium adsorption facility to produce lithium, zinc and other metals from a hydrothermal brine. The plant is currently being operated in California, USA.	FEL-2	Li	2010
Galaxy Jiangsu Lithium Carbonate Plant	Galaxy Resources (Jiangsu) Co. Ltd	China	The plant produced 17,000 tonnes per annum of EV-grade lithium carbonate (99.9%) from spodumene concentrate shipped from Galaxy's operations near Ravensthorpe, Western Australia.	EPCM	Li	2009-2012
Salar de Atacama	SQM	Chile	To support all operations from ponds to products.	EPCM operational support completing pond and well hydraulic improvements	Li	1994-Present

About Hatch

Whatever our clients envision, our engineers can design and build. With over six decades of business and technical experience in the mining, energy, and infrastructure sectors, we know your business and understand that your challenges are changing rapidly.

We respond quickly with solutions that are smarter, more efficient, and innovative. We draw upon our 9,000 staff with experience in over 150 countries to challenge the status quo and create positive change for our clients, our employees, and the communities we serve.

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