LITHIUM MARKET OUTLOOK

Foro del Litio
August 2018

Daniel Jimenez
SVP Iodine, Lithium and Industrial Chemicals
Agenda

1. Lithium Market
2. Demand
   2.1 Global
   2.2 Li-ion Batteries and Electric Vehicles
3. Supply
4. Lithium at SQM
Lithium is widely spread in nature(1).

Lithium is found in:

- Continental brines (100-2,700 ppm)
  - Dried out “Salares” (e.g. Atacama in Chile, Hombre Muerto in Argentina, Uyuni in Bolivia and Silver Peak in the US).
  - Salt lakes (e.g. Zhabuye and Qinghai in China).

- Minerals (2,300-18,000 ppm)
  - About 145 mineralogical species, however only a few are commercial sources of Lithium (e.g. spodumene, petalite and lepidolite).

- Other resources
  - Oil field brines (e.g. Smackover, Texas, USA) (60-500 ppm)
  - Geothermal brines (e.g. Imperial Valley, California, USA) (50-400 ppm)
  - Sedimentary clays (e.g. hectorites in USA and jaderites in Serbia) (2,000-3,000 ppm)
  - Sea water (0.17 ppm)

(1) 20 ppm, similar in abundance as other common elements (Nickel: 84 ppm, Zinc: 70 ppm, Copper: 60 ppm, Cobalt: 25 ppm, Lead: 14 ppm, Tin: 1.3 ppm, Beryllium: 2.8 ppm, Molybdenum: 1.2 ppm.)
Lithium Market
World resources

**USGS Lithium Reserves 2017**

<table>
<thead>
<tr>
<th>Country</th>
<th>Reserves (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>2,000,000</td>
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<tr>
<td>Australia</td>
<td>2,700,000</td>
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<tr>
<td>Brazil</td>
<td>48,000</td>
</tr>
<tr>
<td>Chile</td>
<td>7,500,000</td>
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<tr>
<td>China</td>
<td>3,200,000</td>
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<tr>
<td>Portugal</td>
<td>60,000</td>
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<tr>
<td>US</td>
<td>35,000</td>
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<tr>
<td>Zimbabwe</td>
<td>23,000</td>
</tr>
<tr>
<td><strong>Total (Li)</strong></td>
<td><strong>15,566,000</strong></td>
</tr>
<tr>
<td><strong>Total (LCE)</strong></td>
<td><strong>82,811,000</strong></td>
</tr>
</tbody>
</table>

Source: USGS

- **SQM Reserves (20F Report 18):**
  8,130,000 MT-Li
  → Enough to supply **200 years** of world’s 2017 lithium demand.

Source: SQM
Lithium Market
Global resources

Existing and New Projects

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Producing [2017]</td>
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<tr>
<td>Brownfield [2018 - 2022]</td>
<td>8</td>
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<tr>
<td>Greenfield [2018 - 2022]</td>
<td>10</td>
</tr>
<tr>
<td>Total Projects</td>
<td>35</td>
</tr>
</tbody>
</table>
Agenda

1. Lithium Market

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3. Supply

4. Lithium at SQM
Demand: global

End use

Energy storage market share in 2017: 59%

Lithium Chemicals Demand 2017

- Energy Storage: 59%
- Greases: 8%
- Air Conditioning: 3%
- Greases: 8%
- Frits: 4%
- Glass: 5%
- CC Powder: 2%
- Cement and Adhesives: 1%
- Aluminium: 1%
- Others: 17%

212 kMT - LCE
Demand: global
End use

Lithium Chemicals Demand 10-year comparison

2007

- Energy Storage: 24%
- Others: 30%
- Glass: 7%
- Frits: 9%
- Greases: 14%
- Air Conditioning: 6%
- CC Powder: 3%
- Cement and Adhesives: 3%
- Aluminium: 4%
- Others: 17%

21 (kMT-LCE) 89 kMT-LCE

2017

- Energy Storage: 59%
- Others: 17%
- Glass: 5%
- Frits: 8%
- Greases: 14%
- Air Conditioning: 6%
- CC Powder: 3%
- Aluminium: 4%
- Cement and Adhesives: 1%

212 kMT-LCE

Source: SQM
Demand: global
Overview of Lithium production (2017)

Lithium Concentrates

Minerals

115 kMT-LCE

Concentrate

• Glass
• Frits
• Metallurgy

85 kMT LCE

Lithium Carbonate

• Battery Materials
• Glass
• Frits
• Aluminum
• CC Powder
• Construction

1997

Lithium Hydroxide

• Greases
• Battery Materials
• Dyes

Inorganic derivatives

Lithium Carbonate:
• Lithium Bromide
• Lithium Fluoride
• Lithium Nitrate

Lithium Hydroxide:
• Lithium Carbonate HP
• Lithium Peroxide

Lithium Chloride

• Molecular Sieves
• Air treatment
• Construction

Lithium Metal

• Batteries (Primary)
• Al-Li alloys
• Pharmaceutical
• Chemicals

Organic derivatives

Butyllithium
• Lithium
• Diisopropylamide
• Lithium Hydride
• Others

Source: SQM
Demand: global Lithium products

2017 Lithium Hydroxide : Lithium Carbonate ratio = 2:5

Lithium Chemicals 2017 (%)

- Li2CO3 60%
- LiOH 23%
- LiCl 3%
- LiM 5%
- Buli 4%
- Other Deriv 5%

212 kMT-LCE

Li2CO3 = Lithium Carbonate
LiOH = Lithium Hydroxide
LiCl = Lithium Chloride
LiM = Lithium Metal
Buli = Butyrylilithium
Other Deriv = Inorganic and Organic Derivatives
Demand: global Evolution

Required investment: USD 10-12 Billion over the next 10 years. Typical greenfield Capex: KUSD/MT-LCE capacity 13-20
## Demand: global
Lithium market relative to Copper market

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2027</th>
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<tbody>
<tr>
<td><strong>Global</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>bUS$126</td>
<td>~ bUS$146</td>
</tr>
<tr>
<td>Li</td>
<td>bUS$3</td>
<td>~ bUS$9</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2027</th>
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<tbody>
<tr>
<td><strong>Chile</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>bUS$34</td>
<td>~ bUS$39</td>
</tr>
<tr>
<td>Li</td>
<td>bUS$1</td>
<td>~ bUS$4</td>
</tr>
</tbody>
</table>

Source: Cochilco, SQM

Note: Assuming a US$2.8/lb as long-term Cu price
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NCM cathodes: Lithium (Li) mixed with Nickel (Ni), Cobalt (Co) and Manganese (Mn)

OEM target: higher energy density (High Ni) and lower cost (Low Co)

Demand: Li-ion Batteries

Cathode types

Higher Nickel content → More Lithium Hydroxide use

Low cost region

High stability region

High capacity

Reversibility

Safety

Capacity

Source: SQM
Demand: Li-ion Batteries
Expected battery technology commercialization timeline

Higher Lithium Hydroxide demand compared to Lithium Carbonate

Source: International Energy Agency 2018
NCM: Lithium Nickel Manganese Cobalt Oxide
Demand: Li-ion Batteries
Li-ion vs Lithium Metal

Trend: higher energy density

Increasing density

Liquid Electrolyte → Solid Electrolyte

(Lithium source: Li2CO3 / LiOH)

Gen 1 Li-ion
200-250 Wh/kg
600 Wh/L

Gen 2 Li-ion
250-300 Wh/kg
700 Wh/L

Gen 3 Li-Metal
400-500 Wh/kg
1200 Wh/L

Source: MIT
Demand: Li-ion Batteries

Li-ion battery cost breakdown

Lithium cost is ~ 7% of Li-ion battery materials

LIB cost does not include depreciation not labor (only materials)
Demand: Electric Vehicles
Lithium content today

Lithium content in each device, kg-LCE (Lithium Carbonate Equivalent)

- **Tesla Model S**: 51 kg
- **Other Electric Vehicles**: 10-63 kg
- **Hybrid Electric Vehicles**: 0.8-2 kg

- **Power Tool Batteries**: 40-60g
- **Laptop Batteries**: 30-40g
- **Tablet Batteries**: 20-30g
- **Smartphone Batteries**: 2-3g

Source: Deutsche Bank
OEM: Original Equipment Manufacturer
Demand: Electric Vehicles
Best selling Battery Electric Vehicles (BEV)

Renault Zoe
- EU Q1-18 Sales: 8,947 units
- Range: 241 Km
- Battery Pack: 41 kWh
- Li used: 31 Kg LCE
- MSRP: US$ 23,000

Tesla Model 3*
- US Q1-18 Sales: 8,180 units
- Range: 354 Km
- Battery Pack: 50 kWh
- Li used: 38 Kg LCE
- MSRP: US$ 35,000

BAIC EC-SERIES **
- China Q1-18 Sales: 19,808 units
- Range: 156 Km
- Battery Pack: 20 kWh
- Li used: 15 Kg LCE
- MSRP: US$ 24,000

Performance between 6-8 Km/kWh

Several sources
*Base Model
** Features for BAIC EC-180 EV
# Demand: Electric Vehicles

## OEMs announcements

<table>
<thead>
<tr>
<th>Region</th>
<th>OEM</th>
<th>Year</th>
<th>Investment</th>
<th>xEV Target</th>
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</thead>
<tbody>
<tr>
<td>NAFTA</td>
<td>Ford</td>
<td>2022</td>
<td>$11 billion</td>
<td>40 xEV including 16 BEV</td>
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<tr>
<td></td>
<td>GM</td>
<td>2022</td>
<td></td>
<td>&gt;20 BEV</td>
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<td></td>
<td>Tesla</td>
<td>2024</td>
<td></td>
<td>Sales of Model 3 around 274 kunits</td>
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<tr>
<td>EMEA</td>
<td>BMW</td>
<td>2025</td>
<td>€ 12 billion</td>
<td>xEVs to account for 15-25% of sales</td>
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<td></td>
<td>Daimler</td>
<td>2025</td>
<td></td>
<td>25 electrified models (12 BEV)</td>
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<td></td>
<td>Volvo</td>
<td>2025</td>
<td></td>
<td>xEVs for 15-25% of sales</td>
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<td></td>
<td>VW</td>
<td>2025</td>
<td>Over € 20 billion</td>
<td>&gt;10 BEV models</td>
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<td>2030</td>
<td>$40 billion</td>
<td>40 hybrid models</td>
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<td>50% of sales to be electric</td>
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<tr>
<td>ASIA</td>
<td>Honda</td>
<td>2030</td>
<td></td>
<td>2/3 of total car sales to be electrified</td>
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<td></td>
<td>Toyota</td>
<td>2020</td>
<td></td>
<td>Launching 10 EVs</td>
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<td>2030</td>
<td></td>
<td>Selling 5.5 million electrified vehicles (including hybrids and hydrogen fuel cells)</td>
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<td>Nissan</td>
<td>2022</td>
<td></td>
<td>8 new EV models</td>
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<td>Dongfeng</td>
<td>2022</td>
<td></td>
<td>Sales of 1 million units</td>
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<td>BYD</td>
<td>2020</td>
<td></td>
<td>xEV sales accounting for 30% of total sales</td>
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<td></td>
<td>BAIC</td>
<td>2020</td>
<td></td>
<td>Sales of 600 kunits</td>
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<td>Production of 800 kunits</td>
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Several Sources

OEM: Original Equipment Manufacturer
Demand: Electric Vehicles
Penetration by OEM 2020 and 2025

Most dramatic change in sales during 2020-2025

Source: Citi Research 2018
More stringent government regulations

Source: International Council of Clean Transportation (ICCT)
Demand: Electric Vehicles
ICE announced sales bans and access restrictions

### Country Sales Bans

<table>
<thead>
<tr>
<th>Country</th>
<th>2025</th>
<th>2030</th>
<th>2032</th>
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<td>Scotland</td>
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<td>United Kingdom</td>
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**Legend:**
- Green dot: ICE sales ban or 100% ZEV sales target
- Purple dot: Fleet without ICEs

### Local Jurisdiction Sales Bans

<table>
<thead>
<tr>
<th>Local Jurisdiction</th>
<th>2024</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
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<td>Vancouver</td>
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**Legend:**
- Dark green dot: Diesel access restrictions
- Light green dot: ICE access restrictions
- Pink dot: Fossil-Fuel-Free Streets Declaration
- Purple dot: ICE sales ban

Source: International Energy Agency 2018
Demand: Electric Vehicles
Lithium-ion battery cost forecast

Li-ion battery cost today: barrier for adoption

The decision of buying an electric is not only economics.

Demand: Electric Vehicles
Qualitative aspects

High Tech, forefront design & environmentally friendly

Several Sources
# Agenda

<table>
<thead>
<tr>
<th></th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lithium Market</td>
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<tr>
<td>2</td>
<td>Demand</td>
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<tr>
<td>2.1</td>
<td>Global</td>
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<tr>
<td>2.2</td>
<td>Li-ion Batteries and Electric Vehicles</td>
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<tr>
<td>3</td>
<td>Supply</td>
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<tr>
<td>4</td>
<td>Lithium at SQM</td>
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</tbody>
</table>
Supply
Capacity by player and country 2017 - 2022

Lithium Chemicals Supply and Announced Capacity
Note: Raw material for direct use not included.

Australia 2022: 46%
Supply
Competitors Australia

<table>
<thead>
<tr>
<th>Miner</th>
<th>Production start</th>
<th>Offtake partner(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galaxy Resources (GXY)</td>
<td>Early 2017</td>
<td>Panasonic, BMW, Mitsubishi, Shandong RuiFu Lithium Co</td>
</tr>
<tr>
<td>Pilbara Minerals (PLS)</td>
<td>Mid-2018</td>
<td>POSCO (South Korea), Great Wall Motors (China), General Lithium (China), Ganfeng Lithium (China)</td>
</tr>
<tr>
<td>Altura Mining</td>
<td>Mid-2018</td>
<td>Optimum Nano (Shaandi J&amp;F Optimum Energy), Loney</td>
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<td>Kidman Resources</td>
<td>Late 2019</td>
<td>SQM (Chile)</td>
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<td>Tawana Resources</td>
<td>March 2018</td>
<td>Bunwill Holdings (Hong Kong)</td>
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<td>Neometals/Mineral Resources JV</td>
<td>February 2017</td>
<td>Ganfeng Lithium</td>
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<td>Core Exploration</td>
<td>Mid-2019</td>
<td>Ya Hua International Investment and Development</td>
</tr>
<tr>
<td>Mineral Resources</td>
<td>Early 2017</td>
<td>Shandong RuiFu Lithium Co</td>
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Source: ACBR
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Lithium at SQM
Immediate Lithium capacity - Chile

- Current capacity: 48 kMT/year
- Expansion to 70 kMT/year (end 2018)
- Expansion to 120 kMT/year (end 2019)
- Expansion to 180 kMT/year (end 2021)

- Current capacity 6,000 MT/year
- Expansion to 13,500 MT/year (end 2018)
Project description:

- Salar de Cauchari-Olaroz
- JV 50/50 with Lithium Americas Corp.
- Resource: brine
- Similar technology as in Salar de Atacama
- Capacity: 25 KMT-LCE/year (Li2CO3)
- Startup: 2020
Project description:

- Mt. Holland
- JV 50/50 with Kidman Resources
- Resource: spodumene
- Capacity: 40 KMT-LCE/year (Li2CO3/LiOH)
- Startup:
  - Spodumene concentrate: 2020
  - Li2CO3/LiOH: 2021
Lithium at SQM
Challenges for brine producers

Continuous quality improvement

Lithium Carbonate
- **Chemical:**
  - Higher purity
  - Customized contaminants profile
  - Magnetic metallic particles
- **Physical:**
  - Micronization: Customized particle size distribution

Lithium Hydroxide
- **Chemical:**
  - Higher purity
  - Customized contaminants profile
  - Magnetic metallic particles
- **Physical:**
  - Micronization: customized particle size distribution
  - Caking
- **Process Development:**
  - Brine to Lithium Hydroxide

Lithium Metal
- **Chemical:**
  - TBD
- **Process Development:**
  - Efficiency
  - Low cost

Source: SQM
Lithium is abundant and well spread geographically

Lithium demand growing at high rates: CAGR 15% (2017-2027)

Main driver: energy storage (particularly Electric Vehicles)
  - OEM commitment + Environmental regulations + Consumer preferences + Mass production / Cost reduction

Lithium-ion battery the predominant technology for Electric Vehicles (10-15 years)
  - High Nickel Lithium-ion: Lithium Carbonate / Lithium Hydroxide

New battery technologies will continue requiring lithium
  - Solid-State: Lithium Metal

Lithium represents a small portion of Li-ion battery total cost

Many new lithium projects, Australia to become the leading Lithium producer

SQM to take back the # 1 global lithium producer:
  - Technical know-how and deep commercial knowledge
  - Diversified resource base
  - Ready to face the future industry challenges (e.g. quality, product)
Thank You...