Miércoles | 8 Julio | 09:30 hrs.

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The future of Energy Storage: Cobalt and Lithium Markets Strategic View

Expomin 2020 - Webinar
8 July 2020

Benchmark Mineral Intelligence Contact:
Jose Hofer, Senior Analyst, jhofer@benchmarkminerals.com | @j_m_hofer

www.benchmarkminerals.com | info@benchmarkminerals.com
HQ: London, UK | Offices: Fort Lauderdale, Shanghai, Santiago, San Francisco, Tokyo
From niche to mainstream: the rise of Benchmark Mineral Intelligence

World’s number one intelligence provider for lithium ion battery supply chain, from raw material to cell

Proprietary Data
• Prices
• Market Data

Actionable insight and strategic advisory

True understanding of the entire supply chain

Raw Materials

<table>
<thead>
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<th>Li</th>
<th>Co</th>
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<tbody>
<tr>
<td>C</td>
<td>Ni</td>
</tr>
<tr>
<td>Mn</td>
<td>Si</td>
</tr>
</tbody>
</table>

Cathodes

Battery Cells

Automotive / Energy Storage
Benchmark offers a suite of prices, data and intelligence services...

- **Price Assessments & Market Trackers**
  - Lithium (6 Carbonate, 4 Hydroxide, 1 Spodumene)
  - Cobalt (Sulphate, Metal, Hydroxide)
  - Graphite (11 Flake, 3 Spherical Graphite)
  - Nickel Sulphate (EXW China & ROW)
  - Lithium ion Battery Megafactory Assessment
  - Anode & Cathode Market Assessments

- **Forecasting & Consultancy**
  - Lithium
  - Cobalt
  - Graphite
  - Nickel
  - Lithium ion battery demand – EVs, Energy Storage, Portable Tech

- **News & Bulletins/Events/Presentations**
  - News & analysis
  - Supply chain commentary & bulletins
  - Presentation archive
  - Webinars / Events
  - Quarterly Review Magazine

Monthly (Lithium moving to twice a month)
Quarterly
Regular
Quarterly
Megafactories: State of the art
Capacity from Megafactories increased 7-folded in 4 years

88 Active plants 2020

Battery Megafactories Capacity 2016 - 2020 (GWh)

* Over US$60 billion of investment in cell capacity to be built

Active plants in red

© Benchmark Mineral Intelligence 2020
The lithium-ion battery arms race: China leads - EU follows

**2019**
- **China**: 73%
- **USA**: 10%
- **Europe**: 6%
- Other regions

**2029**
- **China**: 70%
- **USA**: 9%
- **Europe**: 16%
- Others

- **Global Capacity**: 2,224 GWh
- **USA**: 200 GWh
- **Europe**: 356 GWh
- **Other**: ≈ 1,670 kMT-LCE

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EV sales forecast to reach 2.1% of global sales in 2020

Global policy statements supporting EV adoption:

**Canada**: Target of 30% penetration of electric vehicle sales by 2030. Quebec targeting 100% zero emissions by 2050.

**Brazil**: Target of 30% penetration of electric vehicle sales by 2030.

**USA**: No Federal target set. 10 states have set targets for 100% zero-emissions vehicles by 2050.

**Mexico**: Target of 30% penetration of electric vehicle sales by 2030.

**UK and France**: Proposal to end ICE sales by 2040.

**Norway and Netherlands**: Proposal to end ICE sales by 2035, Germany by 2030. Considerations for EU wide ban by 2030.

**Italy**: Target of 30% penetration of electric vehicle sales by 2030.

**Japan and South Korea**: Target of 30% penetration of electric vehicle sales by 2030.

**China**: Target of 5% penetration of electric vehicle sales by 2020, 20% by 2025.

**India**: Proposal to end ICE sales by 2030.

**Israel**: Proposal to end ICE sales by 2030.

Note: ICE - Internal Combustion Engine

*Assuming flat future raw material prices, excludes margin, module and pack costs, figure account for top 80% of producers by scale only.
Increasing scale and new technologies

Average EV cell costs falls to below $100/KWh in 2023-2024

Megafactory Capacity (GWh)

Lithium ion battery cell cost fall $/kWh* (average NCM cell cost including cathode evolution)

*Assuming flat future raw material prices, excludes margin, module and pack costs, figure account for top 80% of producers by scale only.
EV sales as share of total cars (2020 penetration of 2.1%)

There are a number of factors underpinning the expected growth in EV penetration, notably government transport emission policies, and Original Equipment Manufacturer (OEM) strategy.

*Assuming flat future raw material prices, excludes margin, module and pack costs, figure account for top 80% of producers by scale only.
Supply chains & cathode mix
China leads global capacity today, and will likely continue to do so for next decade

China will continue to dominate cell manufacturing with demand for European and US made cells out-stripping supply. This is especially the case for Tier 1 producers who may only have limited volumes available outside the large OEMs
How much raw material does a 30GWh LIB Megafactory consume?

30 GWh = 25,000 MT-LCE

- Lithium: 25,000 tonnes
- Nickel: 19,000 tonnes
- Cobalt: 6,000 tonnes
- Graphite anode: 33,000 tonnes

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Raw materials becoming a higher proportion of cell costs

With solid state unlikely to meet mass commercialisation until the 2030’s we do not expect major changes to cost structure.
And demand for Energy Storage is becoming more important

Today demand for LIB (Transportation – Energy Storage Systems - Portables) accounts for 55% of total Demand

Note: LTO - Lithium-titanate, LFP - Lithium iron phosphate, LMNO – Lithium Manganese Nickel Oxide, LMO - Lithium Manganese Oxide, NMC - Lithium Nickel Manganese Cobalt Oxide, NCA - Lithium Nickel Cobalt Aluminum Oxide, LCO - Lithium Cobalt Oxide

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Cathode evolution – next 10 years

NCM is and will continue to be the predominant chemistry for the next ten years

*L includes NCM 111, 532, 622 & 811*
Investments in the Lithium-ion Battery Supply Chain
Covid 19 Impact – dual effect on both Supply and Demand

Demand quickly recovers, while the effect on project delays is long lasting.
EV supply chains are complicated and need billions in investment

Investment in clean tech can also include processing, components, R&D and new technologies

**Extraction**
- Lithium (spodumene/brine producers)
  - 26 producers (up from 16 in 2026¹)
  - 48 new projects in pipeline

**Chemical Processing**
- Nickel Sulphate
  - 36 producers
  - 13 expansion projects
- Lithium Chemical Plants
  - 69 producers (up from 25 in 2016¹)
  - Increasing to 114

**Cathode/Anode Production**
- Cathodes
  - 73 producers
  - 11 new producers
  - 49 expansion projects
- Anodes
  - 49 producers
  - 54 expansion projects

**Cell Manufacturing**
- Cell Megafactories
  - 88 current producers (up from 28 in 2016)
  - 29 new plants
  - 72 expansion projects

**Application**
- Full BEV light vehicle producers
  - 54 producers, up from 31 in 2015 and a quadrupling of production

---

$50-70bn required
(split across lithium, cobalt, nickel, manganese)

$15bn required
Nickel Sulphate
- 36 producers
- 13 expansion projects

Lithium Chemical Plants
- 69 producers (up from 25 in 2016¹)
- Increasing to 114

$40bn required
Cathodes
- 73 producers
- 11 new producers
- 49 expansion projects

Anodes
- 49 producers
- 54 expansion projects

$130bn planned
Cell Megafactories
- 88 current producers (up from 28 in 2016)
- 29 new plants
- 72 expansion projects

$40bn required
Full BEV light vehicle producers
- 54 producers, up from 31 in 2015 and a quadrupling of production

---

1. Excludes some small-scale Chinese producers

Source: Benchmark Mineral Intelligence and RHO Motion
It takes much longer to build a lithium project than a battery or car plant – with the current pace, lithium shortages are expected.

Approximate timeline to progress supply step

Example — Lithium chemicals Supply Demand balance

Source: Benchmark Mineral Intelligence Lithium Forecast
Cobalt Market - It’s easier to ramp up Demand than Supply

Approximate timeline to progress supply step

Example — Cobalt chemicals Supply Demand balance

Source: Benchmark Mineral Intelligence Lithium Forecast
Market outlook
There is no one lithium price – 11 grades assessed

Key
- Supply
- Demand
- Supply & Demand

Supply & Demand

Location
China

Contract Basis
EXW, VAT Included

Currency
RMB

Shipping port
Domestic

Form
Power

UOM
Tonnes

Delivery window
30 days

Min size
5 tonnes

Max size
500 tonnes

Main suppliers
China

Consumption (2017)
96,000 tonnes

Production (2017)
75,500 tonnes

Publication
Final working day of the month, 4pm GMT

Lithium Carbonate

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Formula</td>
<td>Li₂CO₃</td>
</tr>
<tr>
<td>Li₂CO₃ Content</td>
<td>Min 99.5%</td>
</tr>
<tr>
<td>Particle size</td>
<td>&lt;15 µm</td>
</tr>
<tr>
<td>Common impurities</td>
<td>Na&lt;0.25%; Mg&lt;0.008%; Ca&lt;0.005%; Fe&lt;0.001%; Si&lt;0.003%</td>
</tr>
</tbody>
</table>

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Long-Term lithium supply – Price incentive

- **Expansions have stalled** at a critical stage in meeting 2022-onwards demand growth
- **New entrants** need to see economic incentives according to the energy storage sector
- Unitary CAPEX between US$ 20,000-30,000/MT:
  - Risk - Demand
  - Return of investment
  - Provision of capital (debt/equity)
Cobalt - In the immediate term supply can meet demand, but without higher prices development horizon will not sustain this
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GRACIAS

THANK YOU