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MINERAL  
INTELLIGENCE

# Raw material impact of the lithium ion battery surge

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BMO Capital Markets,  
Global Metals & Mining Conference  
Hollywood, Florida, US  
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[www.benchmarkminerals.com](http://www.benchmarkminerals.com)



# What is Benchmark?

## Price Assessment Subscriptions (Raw Materials)



**Lithium**  
Price surge abates in China, but ROW contracts play catch-up

- Lithium export licenses for Chile and Australia are set to expire
- Hydrolysis process at 11 kg/LiCl/LiOH production worth \$10/kg
- China's demand for lithium carbonate is high
- NEC lithium price index up 5% in June 2016
- NEC lithium carbonate price index up 10% in June 2016
- China's production for fresh construction is high



**Graphite**  
Price collapse continues as excess supplies prevail

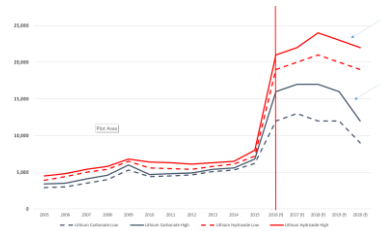
- Production continues under price pressure in China's provinces in other markets
- Production of graphite in China is up 10% in February 2016
- Production of graphite in China is up 10% in February 2016
- Production of graphite in China is up 10% in February 2016

Lithium

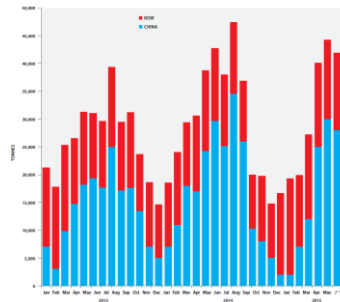
Graphite

Cobalt

## Consultancy



## Price Forecasting



## Supply/Demand Analysis

<b>Vans</b> • Commercial • Personal	<b>Passenger cars in all sizes</b> • Hybrids • Plug-in Hybrids • Electric Vehicles	<b>Buses</b> • Local transportation • Long haul	<b>Trucks</b> • Local delivery • Long haul • Other
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## Raw Material Market blueprints

## Events

Industry conferences



Investment seminars



# Benchmark World Tour 2017

- Global investment seminars on lithium ion battery supply chain
- 14 cities in 2017
- ½ day, free to attend
- <http://benchmarkminerals.com/worldtour2017/>

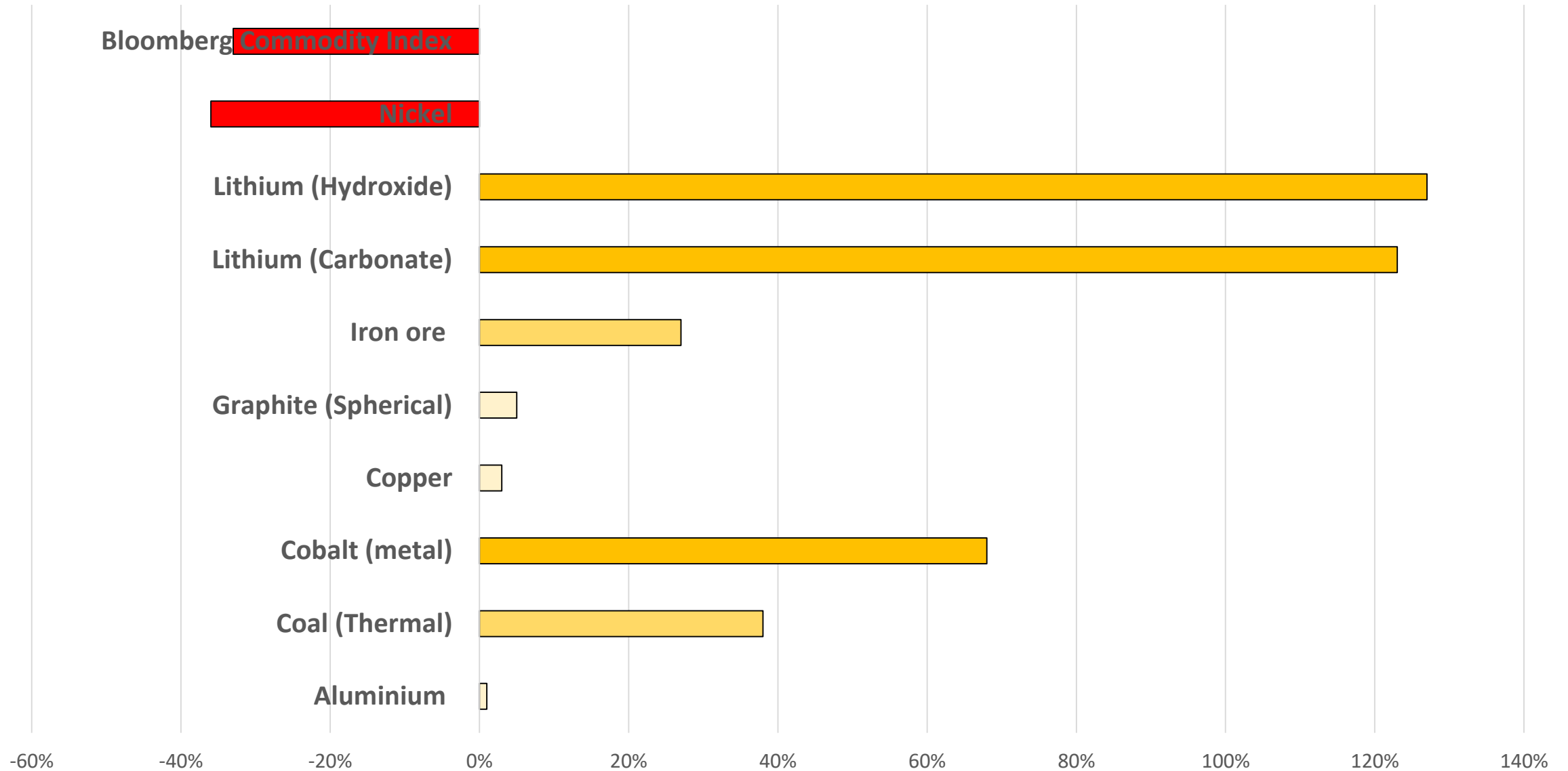


- Vancouver, Canada, Friday 21 April
- Toronto, Canada, Monday 24 April

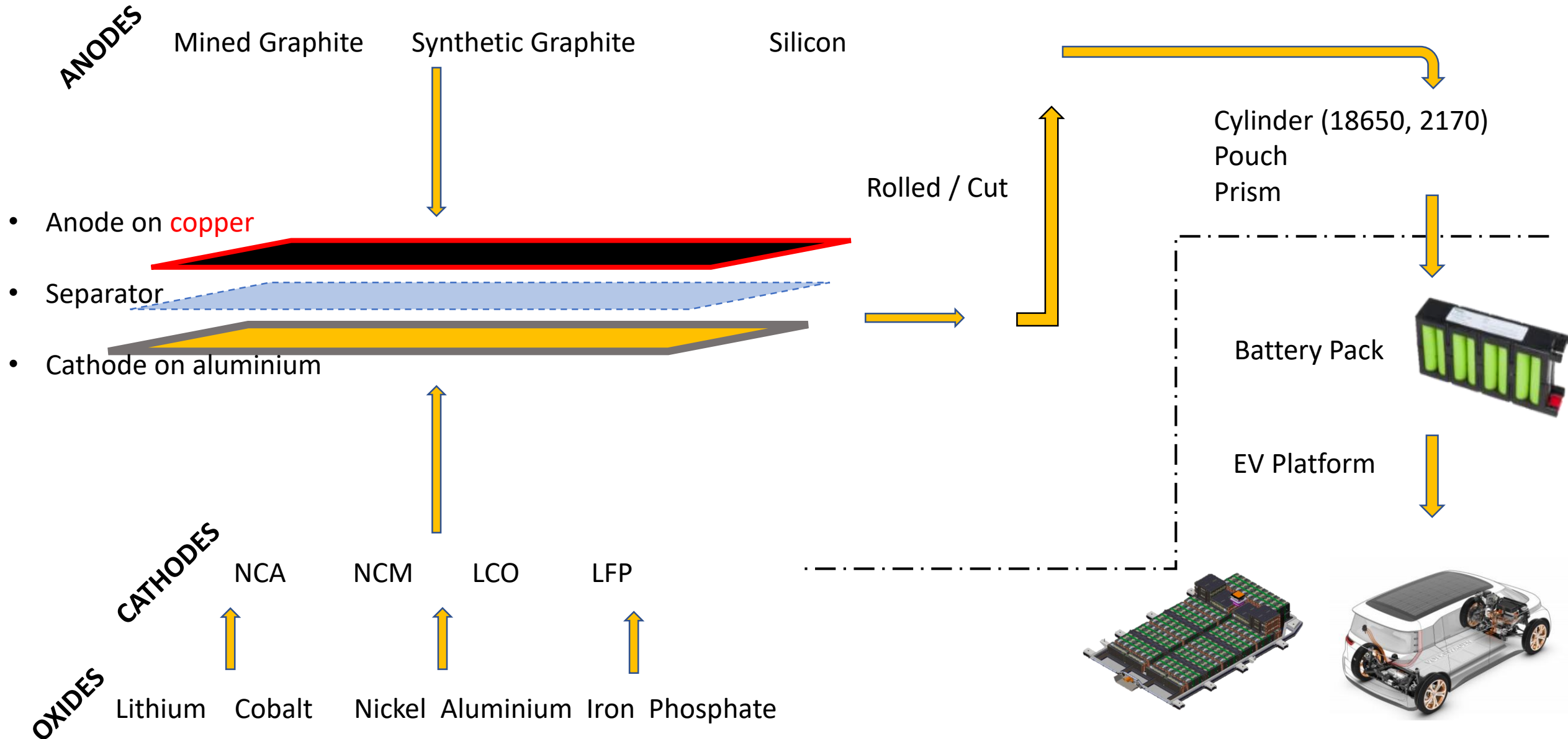


# Prices: 2015 v 2017

## Mineral & Metal Prices: Feb 2015 versus Feb 2017

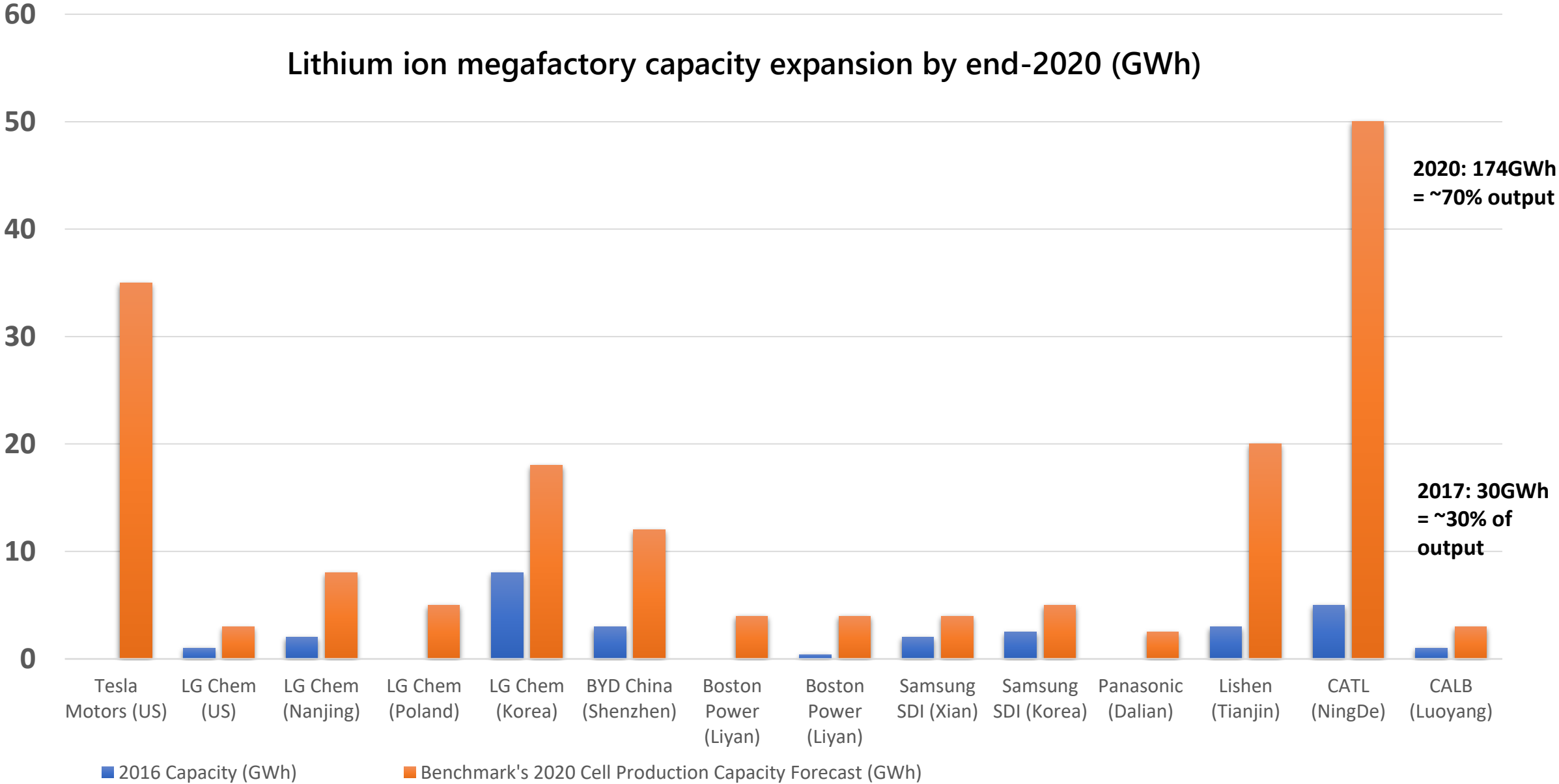


# Lithium ion batteries: From mine to market



# The lithium ion megafactories are coming...

## Lithium ion megafactory capacity expansion by end-2020 (GWh)



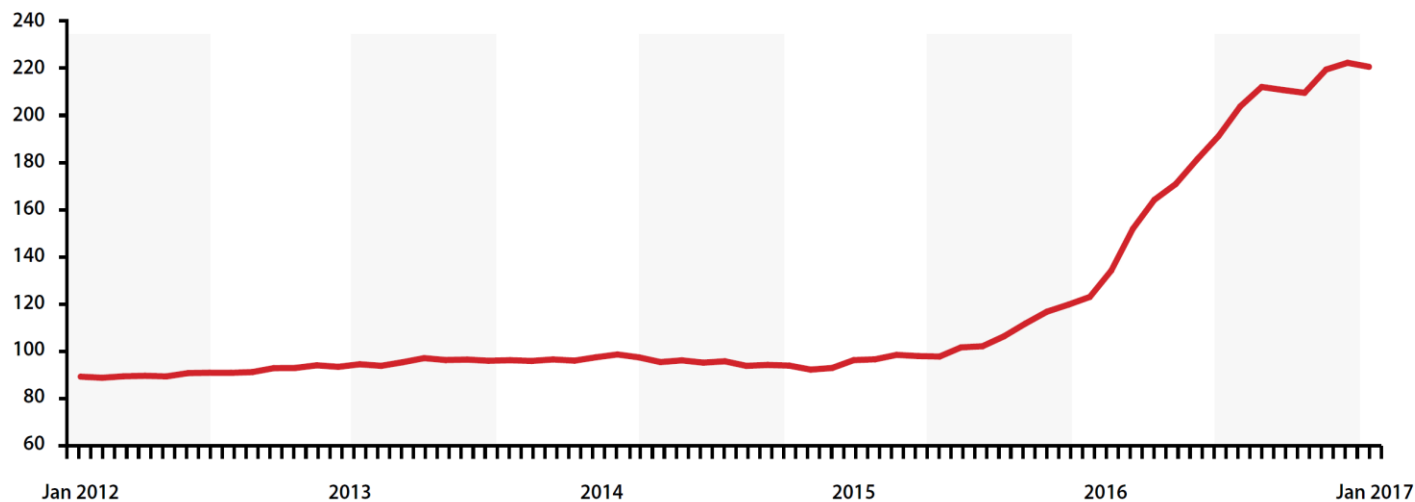


Lithium

# Lithium's price spike is driving interest...

- Up 2-3 x outside of China
- Up 3-4 x within China
- **Lithium Carbonate & Lithium Hydroxide**, both key battery raw materials

## ■ BMI LITHIUM PRICE INDEX



### LITHIUM CARBONATE (GLOBAL AVERAGE)

Current price	\$11,938
Last price	\$12,000
% change	-0.5%

### LITHIUM HYDROXIDE (GLOBAL AVERAGE)

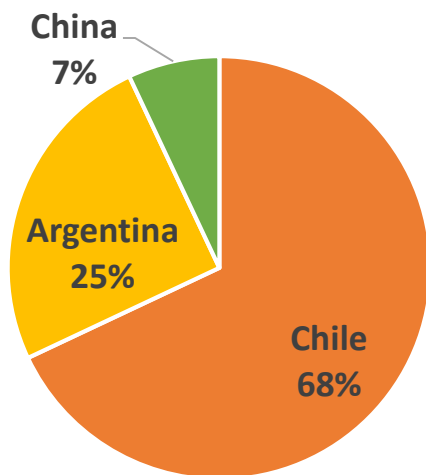
Current price	\$16,625
Last price	\$16,875
% change	-1.5%



# Price differences, function of supply chain



**Brine**



Chile, Argentina, US, China

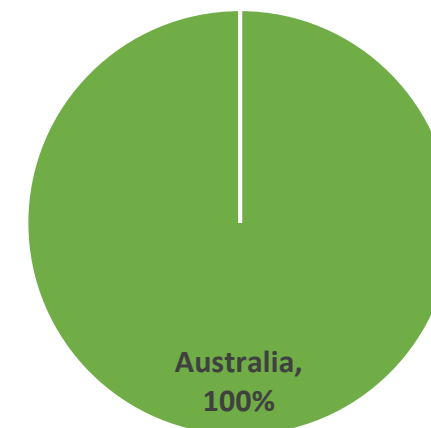
**180-185k tpa LCE**

Battery grade

**76-83k tpa LCE**



**Hard rock  
(spodumene)**

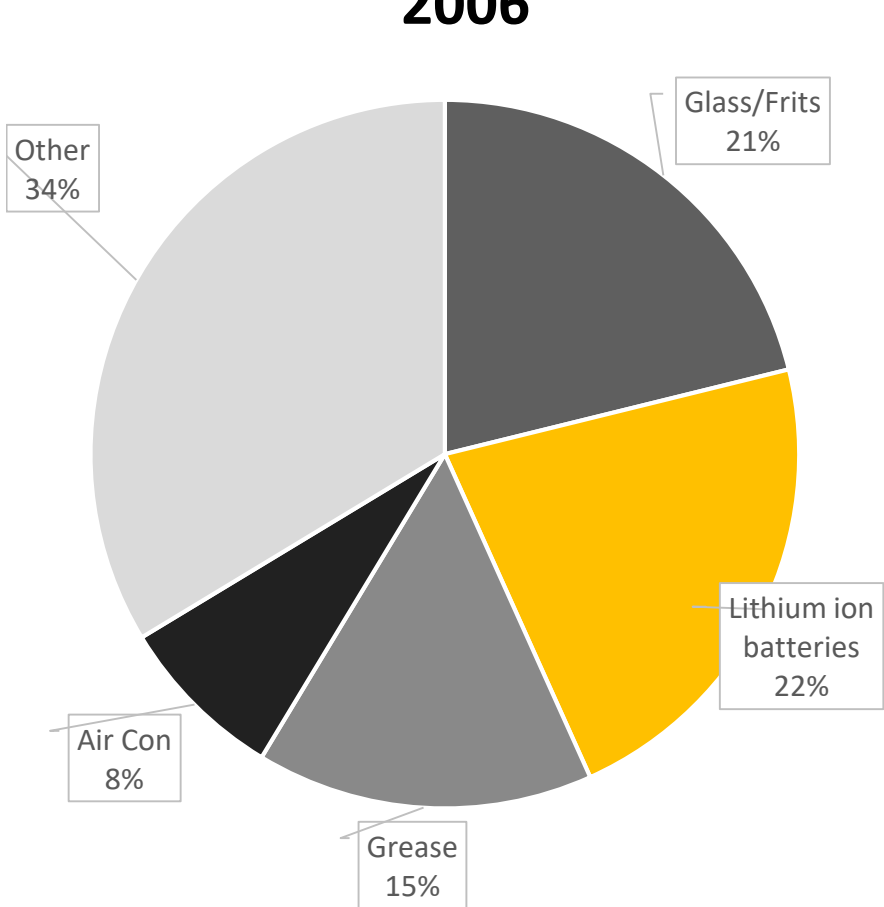


China

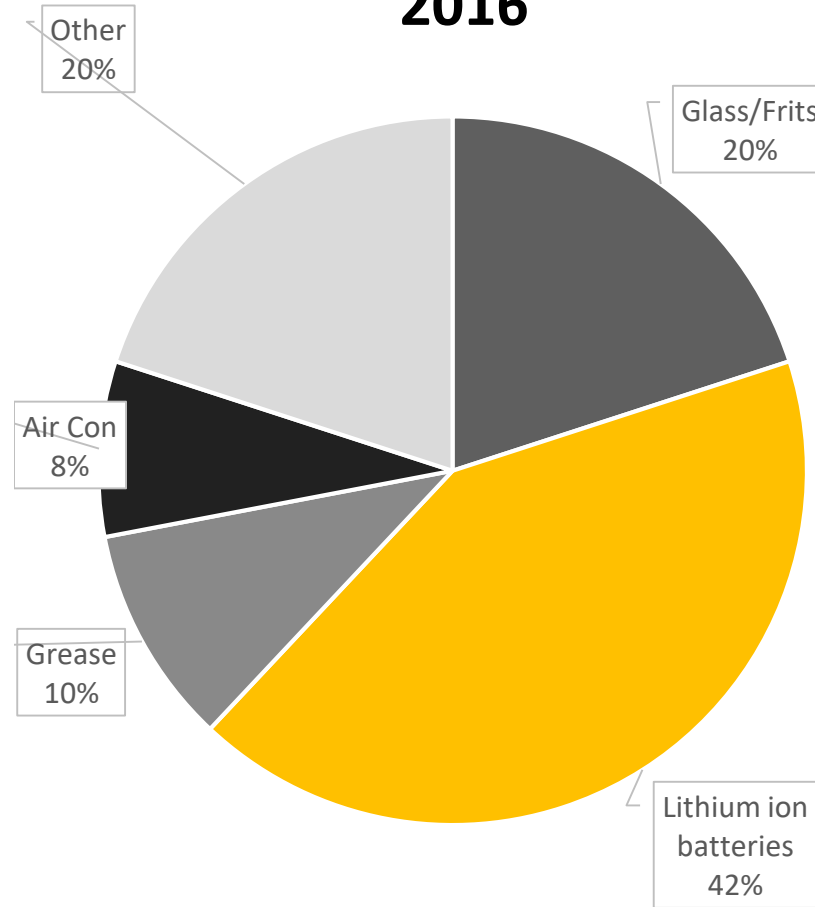
# Lithium ion batteries now the driver...

## Lithium's End Markets

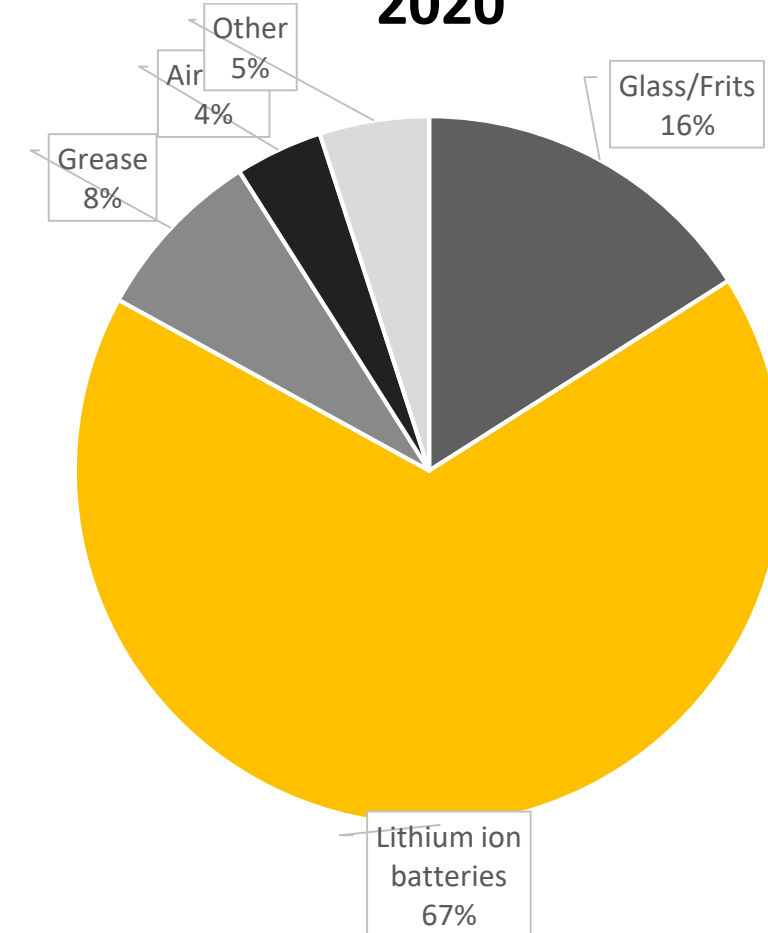
2006



2016



2020



## Lithium trends to watch...

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- No huge oversupply of lithium
- 5 year growth trajectory: 12-15% a year
- Lithium Carbonate & Hydroxide Prices to remain high for the medium term
  - No price crash
- Spodumene to fill the 2017-2018 supply deficit
  - China has 30% excess capacity
- New brine resources 2020 and beyond
- M&A and JVs to continue
  - Albemarle, Tianqi, Ganfeng most aggressive

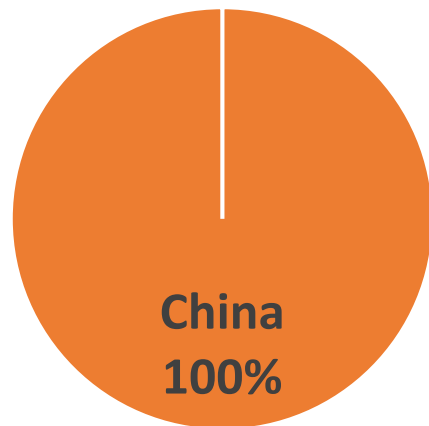


Graphite

# Anode grade graphite, dominated by China



**Natural Spherical Graphite**



China, Japan, Korea

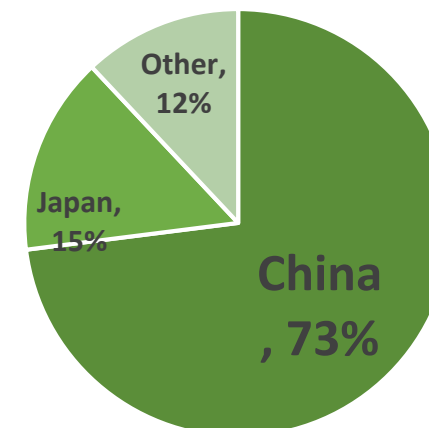
All Graphite  
**1.5m tpa**

Battery grade

**90-100k tpa**



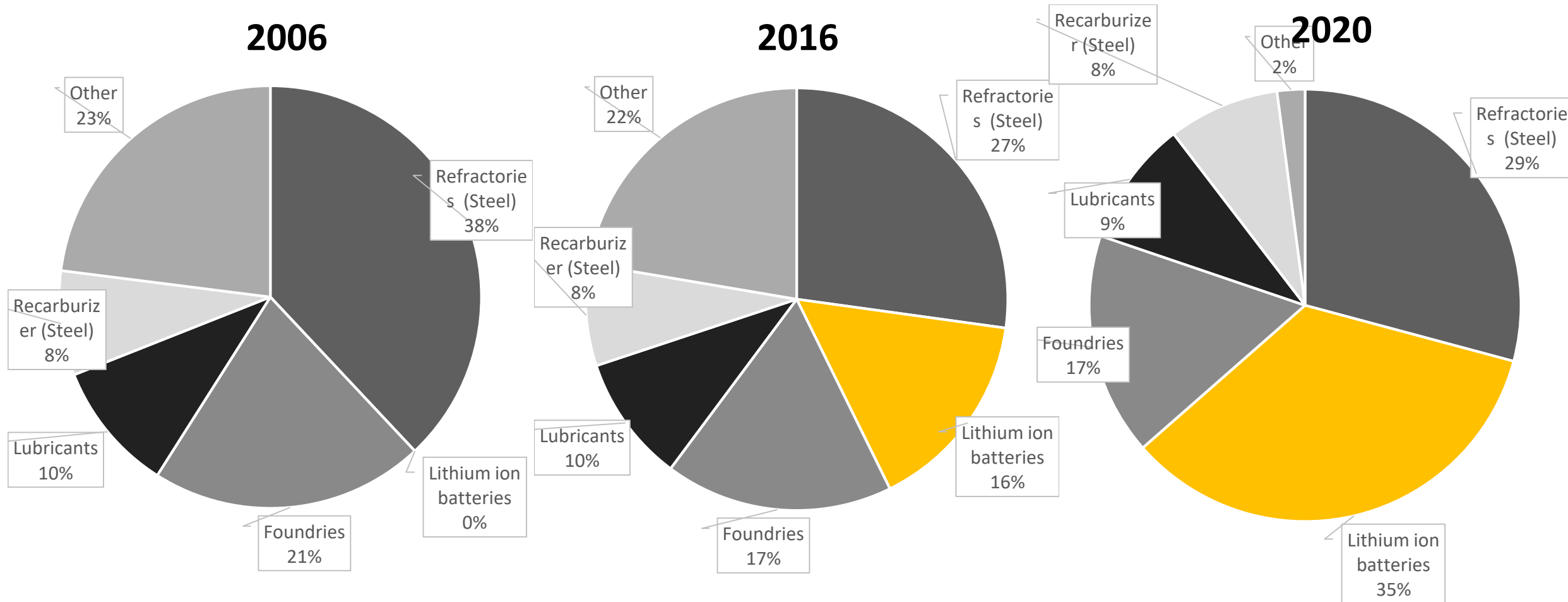
**Synthetic Graphite**



China

# Lithium ion batteries to challenge for top spot...

## Flake Graphite's End Markets



## Graphite trends to watch...

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- **5 year growth trajectory: 13-16% a year**
- **Natural graphite anodes to increase market share over synthetic**
  - Supply issue, improving quality, lower cost
  - Synthetic will operate in a high quality niche
  - CO2 footprint becoming a consideration
- **Coated Spherical Graphite to become cheaper**
  - From \$12-16/kg today to sub \$8/kg
- **Silicon to not be a major substitution factor medium term**
  - 3-6% additive to improve capacity

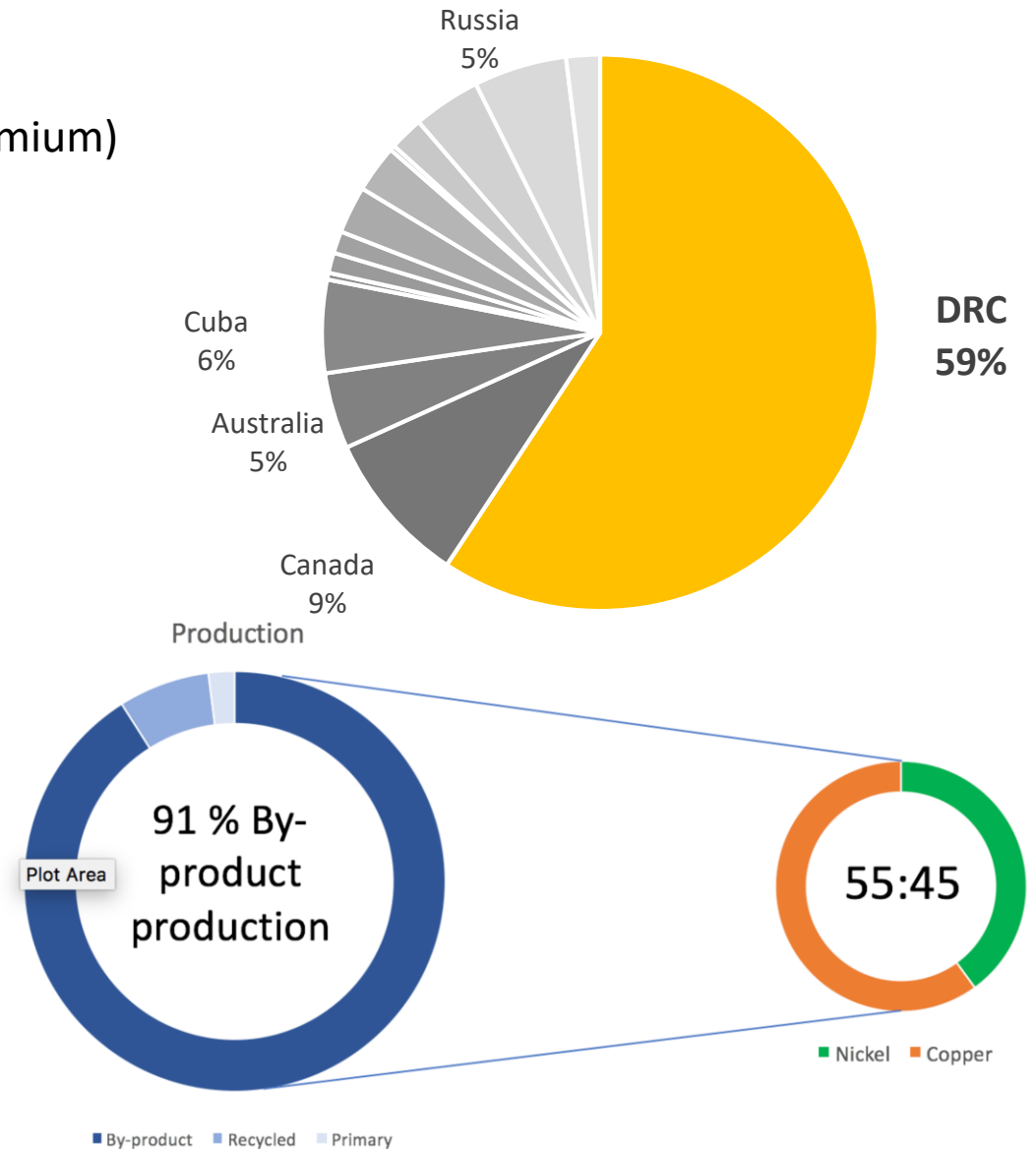


Cobalt

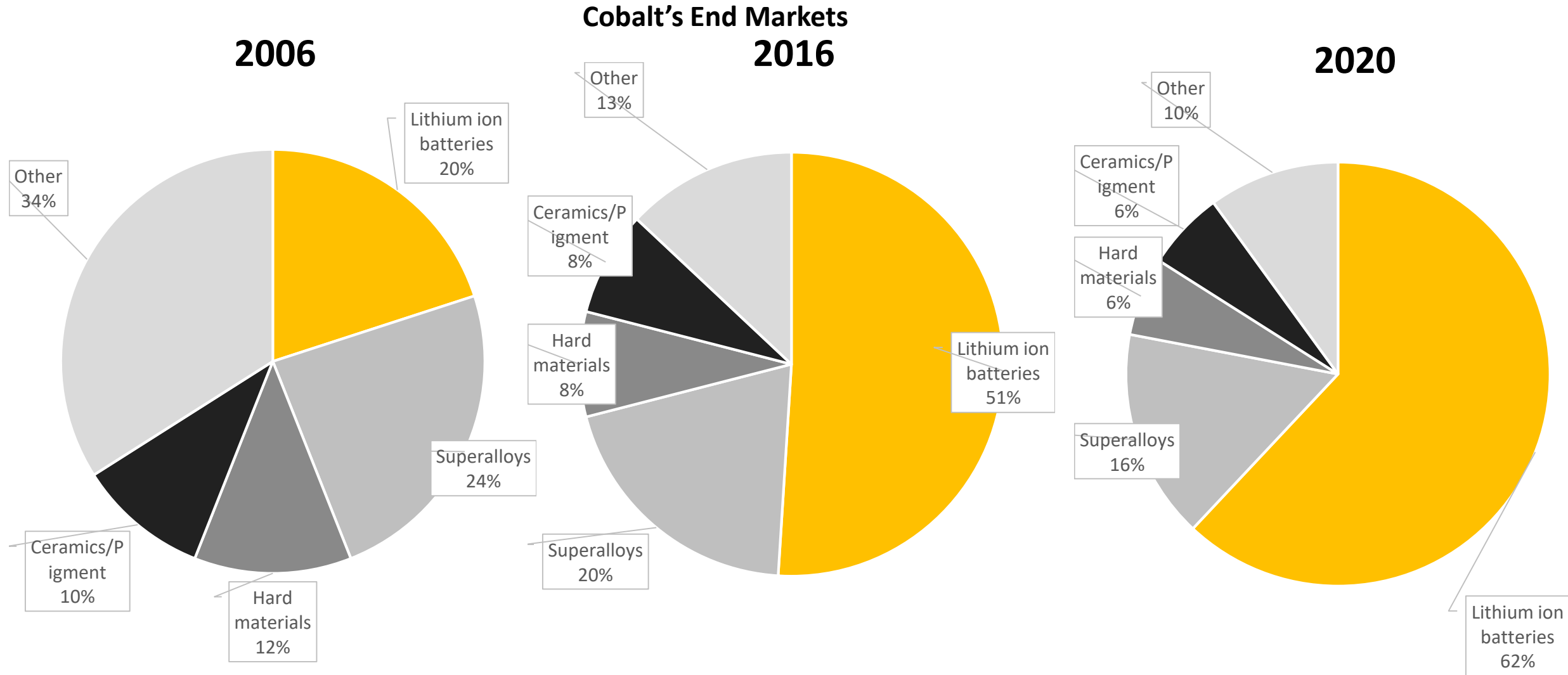


# After years of depression, cobalt's price is spiking

- 2016: 100,000 tpa market
- LME Cobalt metal Up >60% in 12 months
- Battery grade precursor – Cobalt sulphate heptahydrate (premium)



# Lithium ion dominance to grow...

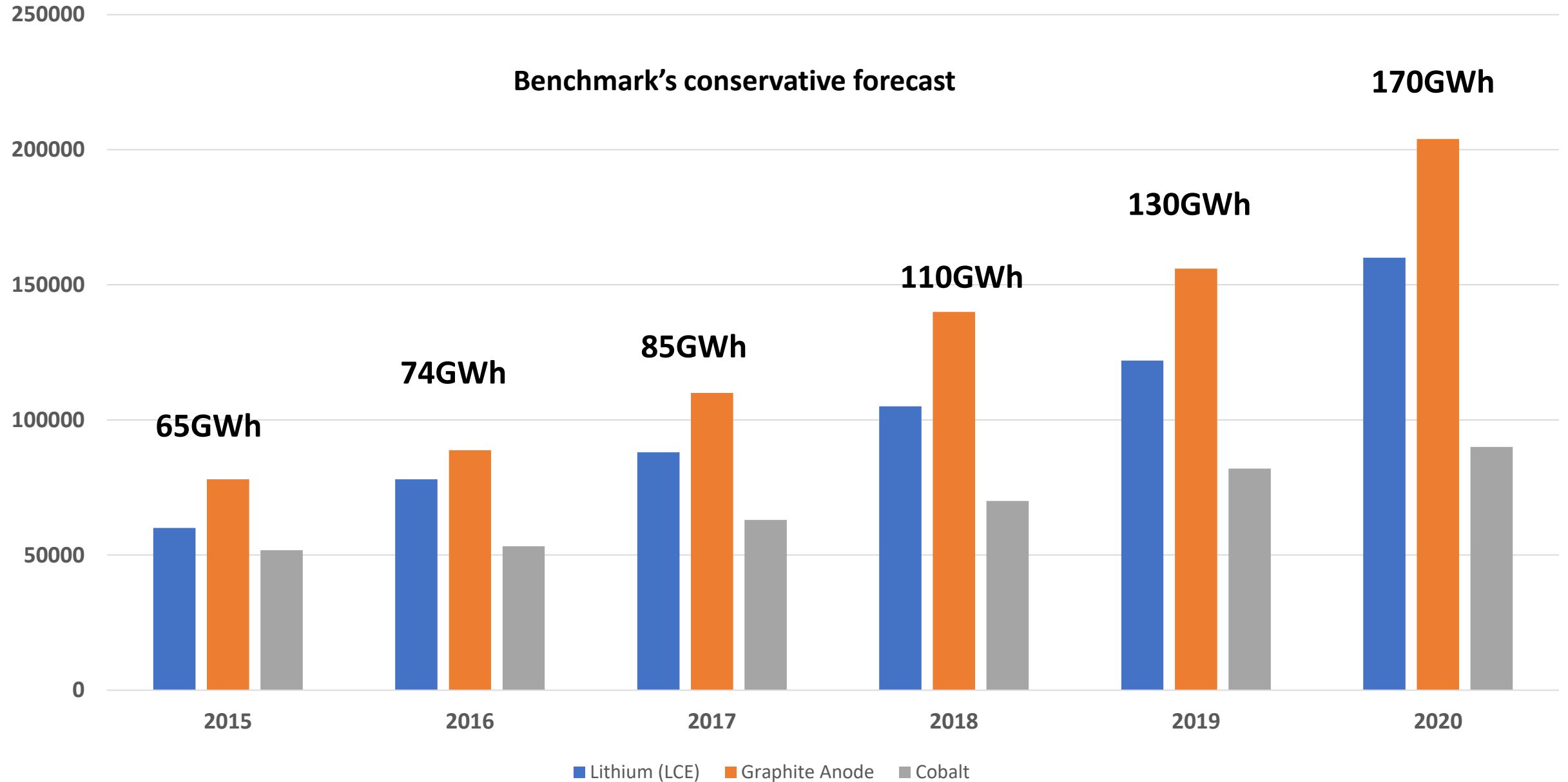


## Cobalt trends to watch...

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- **5 year growth trajectory: 8-10% a year**
- **Supply to return H2 '17 – Glencore (Katanga) amid rising prices**
- **Political resolution in DRC emerges**
- **Rising Prices: >60% increase in 12 months**
  - ~\$16/lb versus crisis price of ~\$52/lb
- **Battery demand the biggest prevailing factor**

# What does this mean for raw material demand ...



## Benchmark's Price Assessments...

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Each month Benchmark Mineral Intelligence undertakes market price assessments for key minerals and chemicals used in the manufacturing of lithium ion batteries.

Our prices are collected and published through methodologies that are specific to:

- Lithium
- Graphite
- Cobalt

Each price assessment gathers the prevailing volumes traded that month, rather than just a small volume, spot trade.

Benchmark is the world's only company to be dedicated to the collection of lithium ion battery raw material data.

# Subscribe to Benchmark's Price Assessments Today

## Contact Andy Miller on [amiller@benchmarkminerals.com](mailto:amiller@benchmarkminerals.com)



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## Lithium

Price surge slows in China, but ROW contracts play catch up

July 2016



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- Lithium majors increase prices for carbonate and hydroxide H2 contracts
- Hydroxide jumps towards \$15/kg while carbonate moves north of \$10/kg
- China's domestic rises slow but prices stay high
- BMI Lithium Price Index up 5.5% in June; 43% ytd
- H2 Lithium ion battery cathode demand outlook strong on e-bus subsidies
- China's EV production up for fourth consecutive month

### TERMINOLOGY

**Lithium feedstock:** This refers to lithium concentrate, the majority of which is converted into lithium chemicals for a wide range of end markets including lithium ion batteries.  
**Lithium chemicals:** This refers to any downstream chemicals that are produced from spodumene feedstock or lithium brine. For the purposes of this report, it will refer to the general trend of lithium carbonate and hydroxide; any other chemicals will be specifically cited.  
**Lithium carbonate:** the primary base chemical produced by the lithium industry used in a wide range of end markets including lithium ion battery cathodes, ceramics and glass, and pharmaceuticals.  
**Lithium hydroxide:** the second largest chemical produced by the lithium industry, traditionally used in the production of greases but also competes with lithium carbonate in the lithium ion cathode sector, specifically NCA chemistry.

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Lithium

## Graphite

Price collapse continues as excess supplies prevail

February 2016



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- Finer mesh grades come under further price pressures as Chinese producers re-enter the market
- Benchmark Graphite Index slumps a further 0.4%, down 16.5% y-o-y
- Seasonal uptick in Chinese consumption outweighed by falling demand elsewhere
- Further demand side pressures expected in Asia approaching Q2 2016
- Heavy discounts continue as producers attempt to clear stockpiles; High-cost Chinese producers under pressure

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Email: [info@benchmarkminerals.com](mailto:info@benchmarkminerals.com)

Graphite

Cobalt Chemicals  
Coming in Q2 2017