EV Battery Raw Materials

STTC – Santa Fe
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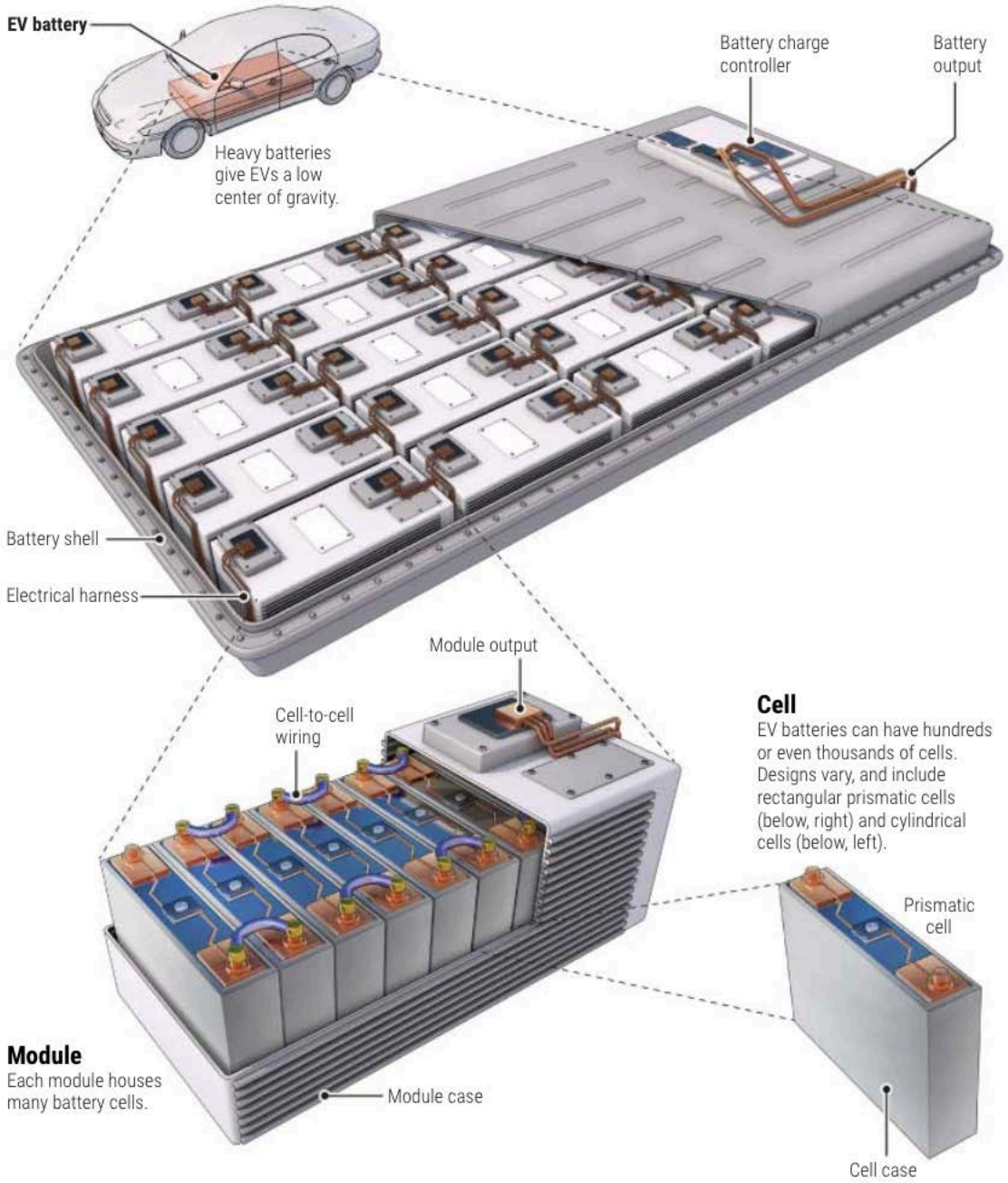
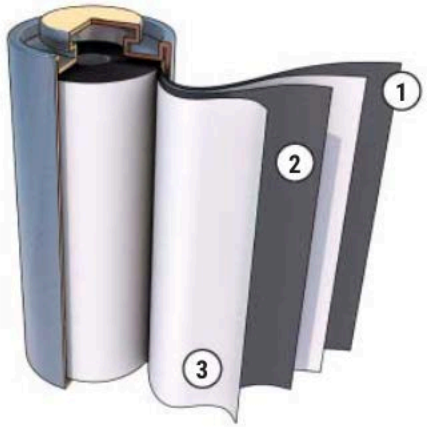
Slide 1



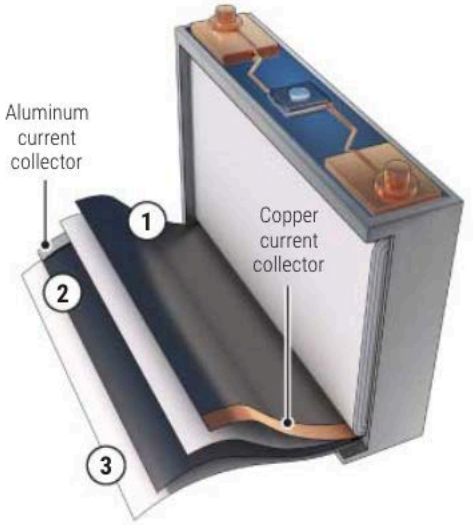
Cylindrical cell

A tough steel casing makes these cells difficult to open. Often durable glue combines thousands of cells into packs.



Cell components

Each cell houses the essential components of a battery. They release and store electricity as lithium atoms move between electrodes.



1 Cathode
The cathode typically holds the most valuable recyclable material, made up of many metals.

2 Anode
Negative electrodes are composed of graphite, carbon, or silicon-based components.

3 Electrolyte and separator
Lithium travels through a separator sheet soaked in electrolyte.

Source: www.science.org

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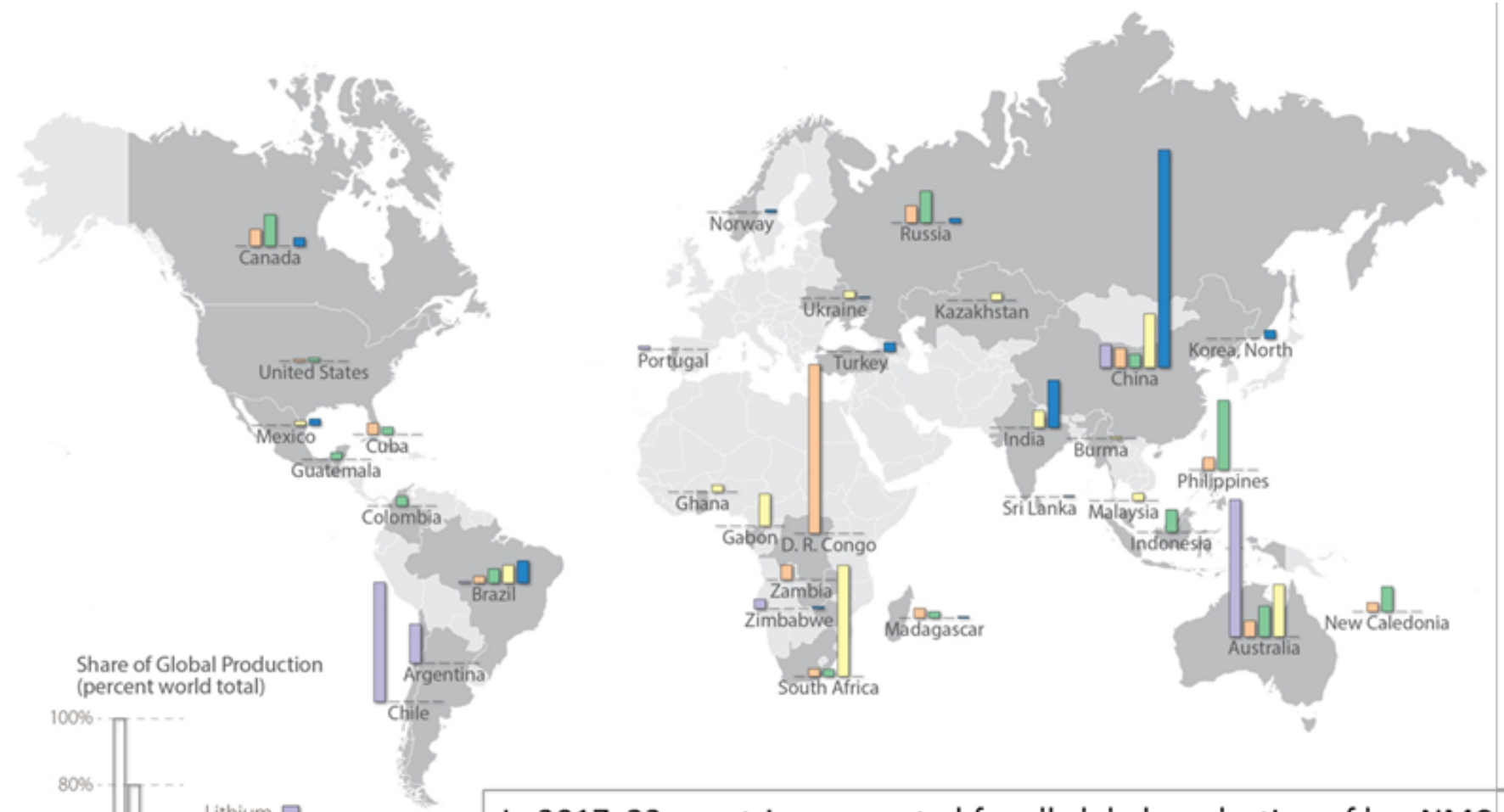
Tesla Model X:

100 kWh battery has 8,256 cylindrical cells

Location of Key Raw Materials



In 2017, 32 countries accounted for all global production of key NMC materials

- **43,000 tons lithium**: 44% Australia 34% Chile, Argentina 13%
- **1.2 million tons natural graphite** : 67% China, 13% India, Brazil 8%
- **2.1 million tons nickel**: 11% Philippines, 10% Canada, 9% Russia, 9% Australia
- **16 million tons manganese**: 33% South Africa, 16% China, 14% Australia
- **110,000 tons cobalt**: 59% Democratic Republic of Congo, 5% Russia, 5% Australia

Global Production Levels

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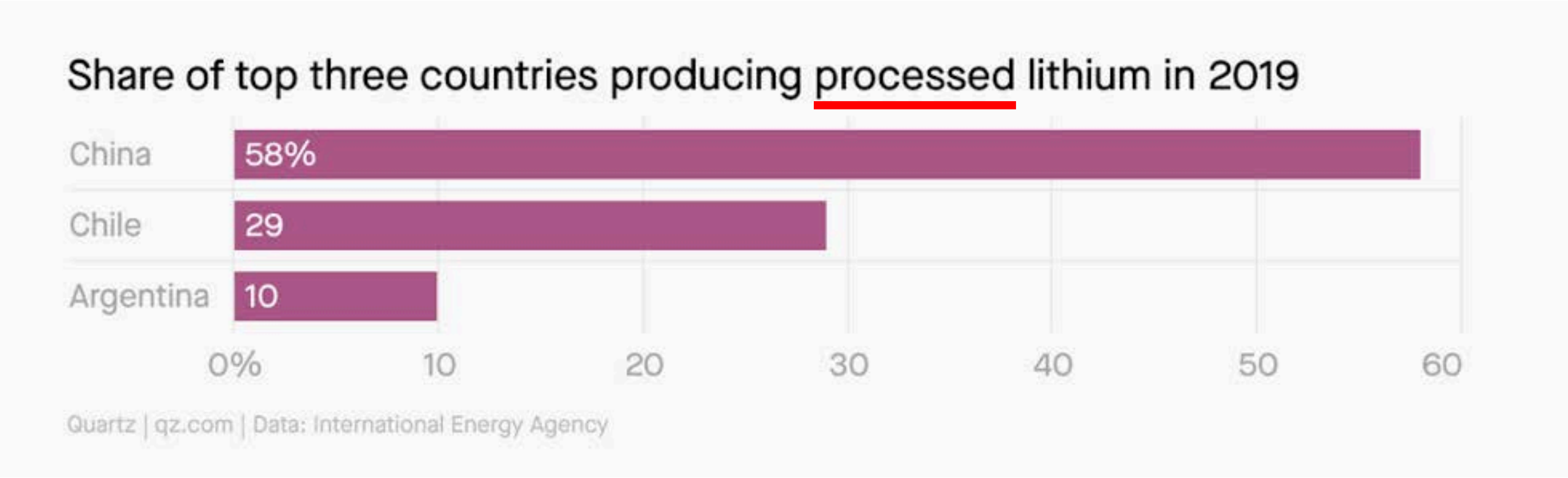

Processed Lithium = Lithium Carbonate and Lithium Hydroxide

Raw Materials by Weight

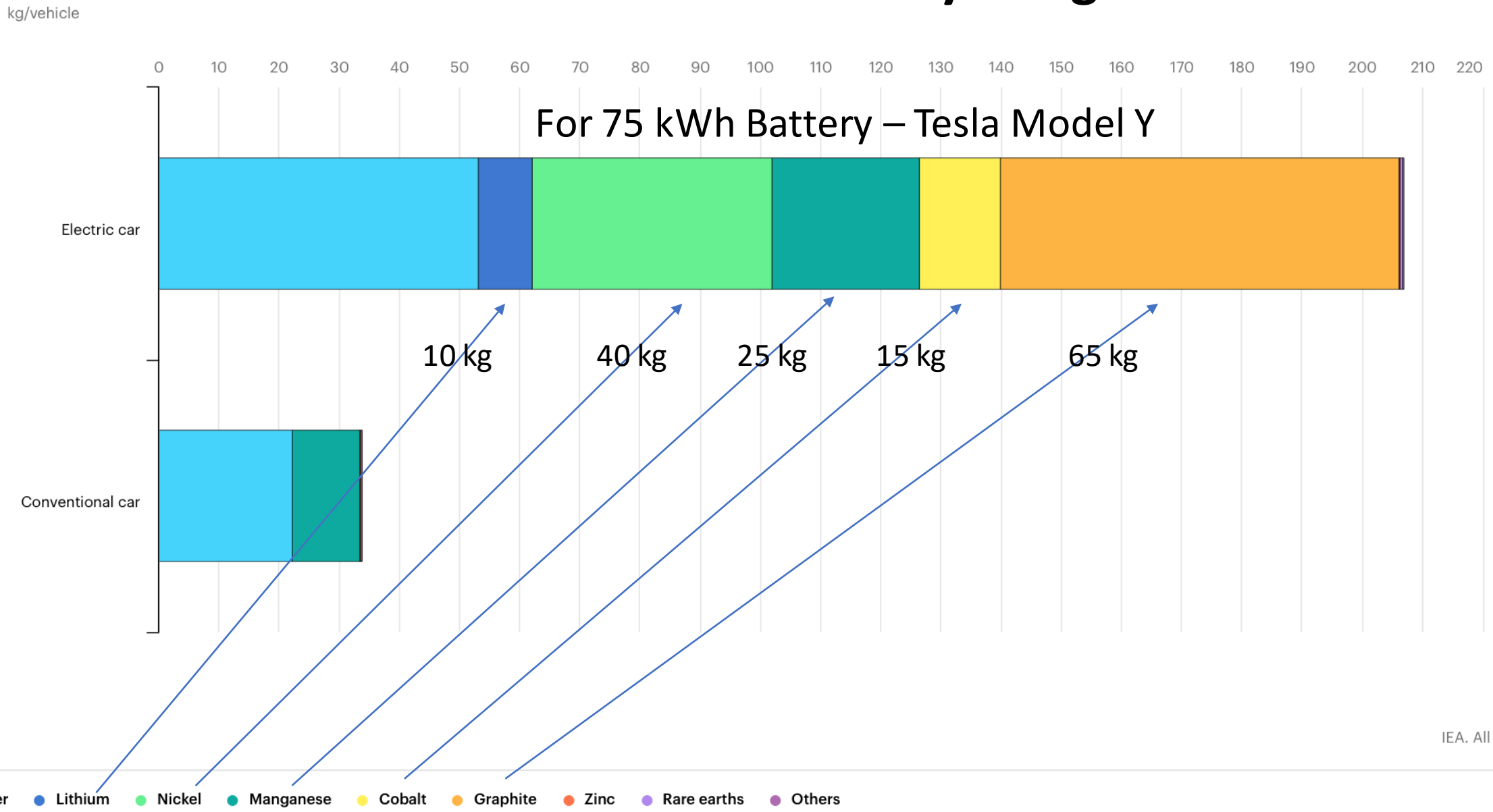

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Table 1. LDV Materials Use Estimates (2014–2016)

Years	Total LDV	Units	Material Consumption				
			Cobalt	Lithium[1]	Nickel	Manganese	Graphite
2014		metric tons	1,691	1,381	4,558	1,595	10,649
	(9,600 MWh)	% of mine production	1.40%	4.40%	0.20%	0.00%	
2015		metric tons	3,593	2,935	9,685	3,390	22,630
	(20,400 MWh)	% of mine production	2.90%	9.30%	0.40%	0.00%	
2016		metric tons	5,505	4,497	14,841	5,195	34,677
	(31,260 MWh)	% of mine production	5.00%	11.80%	0.70%	0.00%	

Notes: Total LDV LIB use (MWh capacity) estimates for 2014–2016 are based on CEMAC "Benchmarks of Global Clean Energy Manufacturing" 2017 report.[1] Lithium consumption estimates represent material used in cathode and electrolyte manufacturing. At least 60% of graphite used in LDV batteries is synthetic.

Source: NREL estimates

SQM

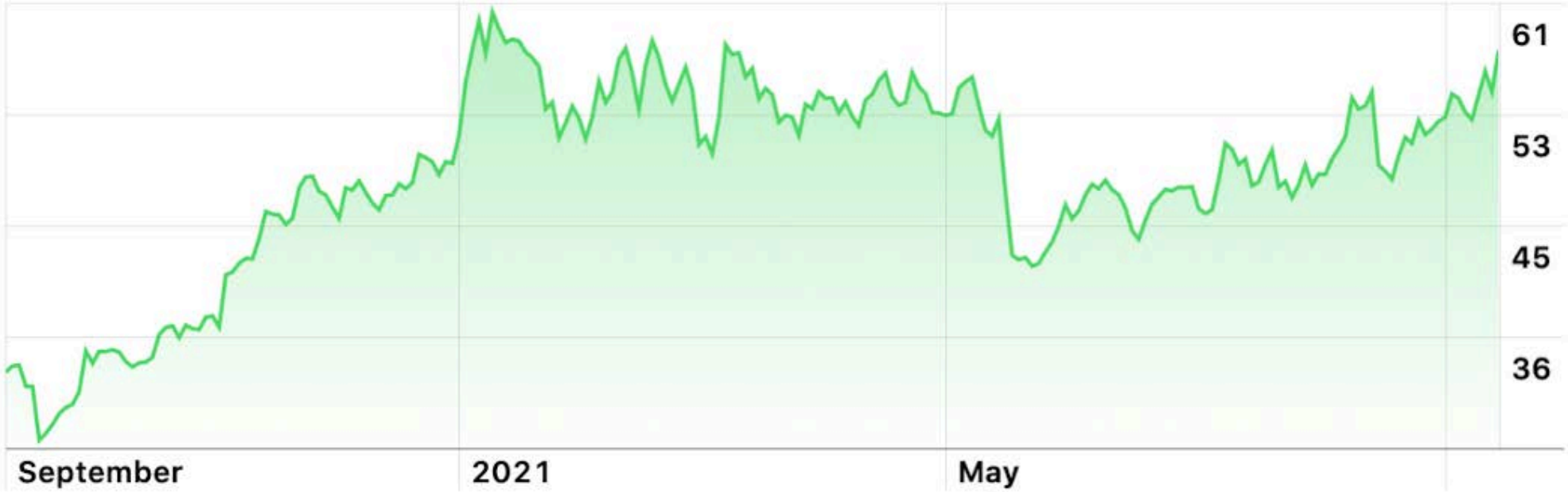
Sociedad Química y Minera de Chile S.A.

57.28 +1.88
At Close

57.47 +0.19
After Hours

Add to Watchlist

1D 1W 1M 3M 6M 1Y 2Y 5Y 10Y ALL



Open	56.03	Vol	1.058M	52W H	60.74	Yield	1.03%
High	57.43	P/E	69.43	52W L	28.47	Beta	0.88
Low	55.97	Mkt Cap	16.36B	Avg Vol	1.276M	EPS	0.82

More Data from Ya

Tesla Model Y – Energy Used per Mile Driven

0.23 kWh per Mile = 5.75 kWh for 25 miles
Energy Cost @ 0.13 cents per kWh = 75 cents

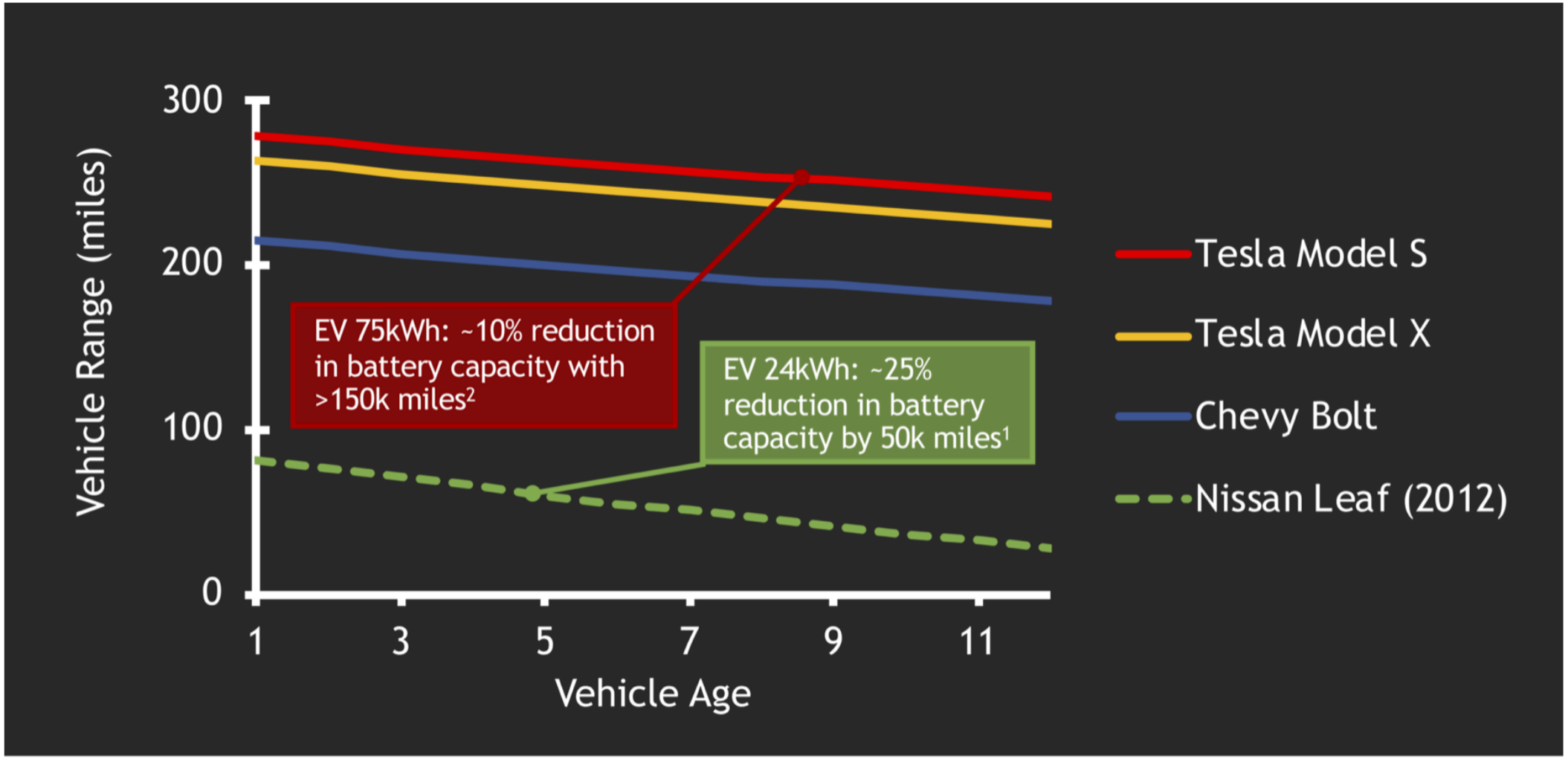
MPG for Avg Car = 25 Miles per Gallon = $4

Tesla Model Y – Emissions Comparison

5.75 kWh for 25 miles
2.21 lbs. of CO_2 per kWh
5.75 kWh releases 12.7 lbs. of CO_2

1 gallon of gasoline = 19 lbs. of CO_2

EV Battery Degradation



[1] Shirk, M. and J. Wishart (2015). Effects of Electric Vehicle Fast Charging on Battery Life and Vehicle Performance, SAE Technical Paper.

[2] Lambert, F. (2018). Tesla battery degradation at less than 10% after over 160,000 miles, according to latest data. Electrek.

Recycle Batteries or Second Use?

Recycling:

Expensive to extract NMC from used batteries

Second Use in Stationary Applications:

Frequency Regulation

Spinning Reserve

Distribution Support

Energy Arbitrage

NOTES:

1. **Second use of Pb-acid submarine batteries**
2. **Does second use offer an economic development opportunity for New Mexico?**

Second Use Pilot Project in Germany