BALANCING LI BATTERY DEMAND WITH MATERIALS SUPPLY

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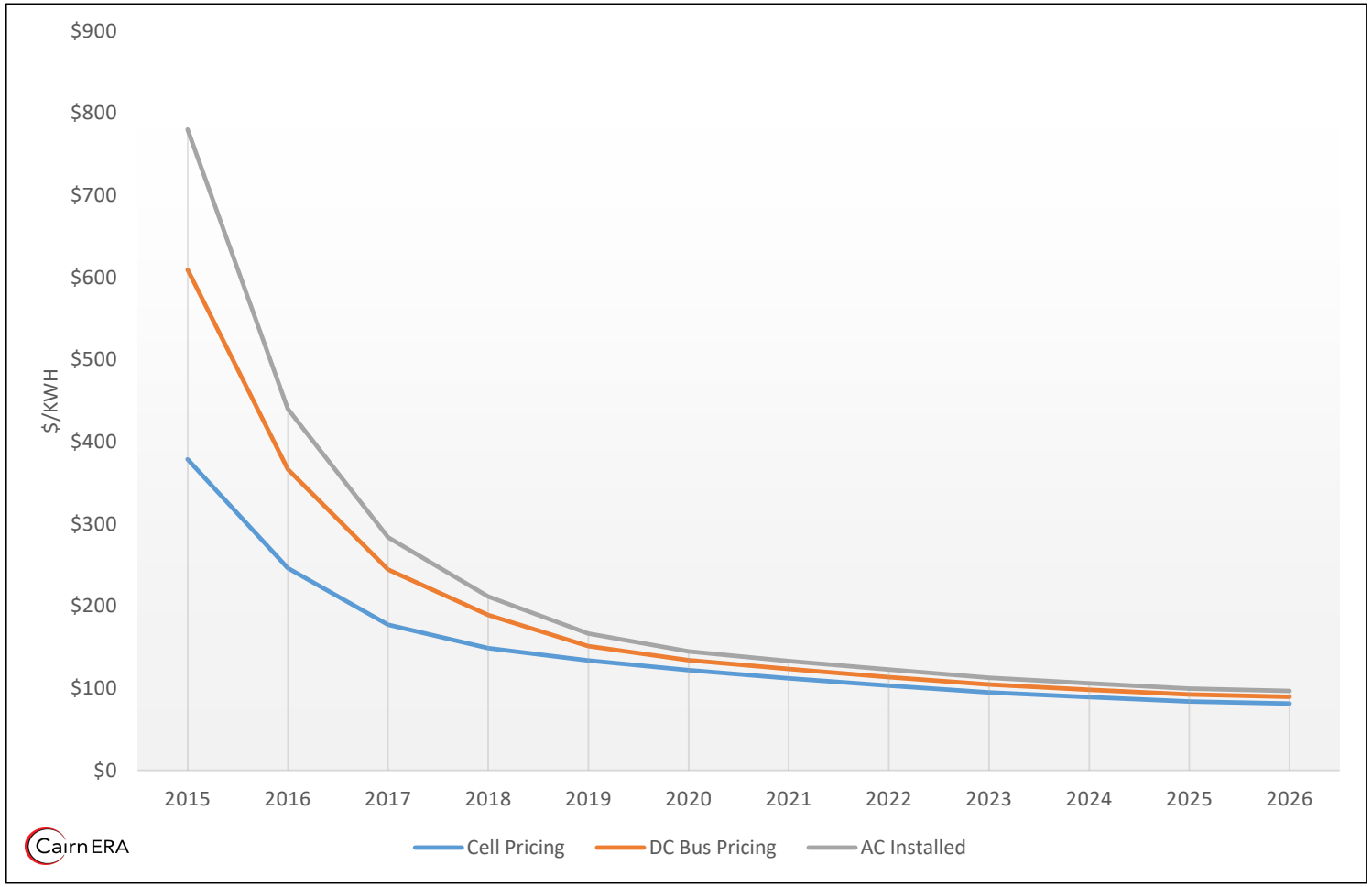
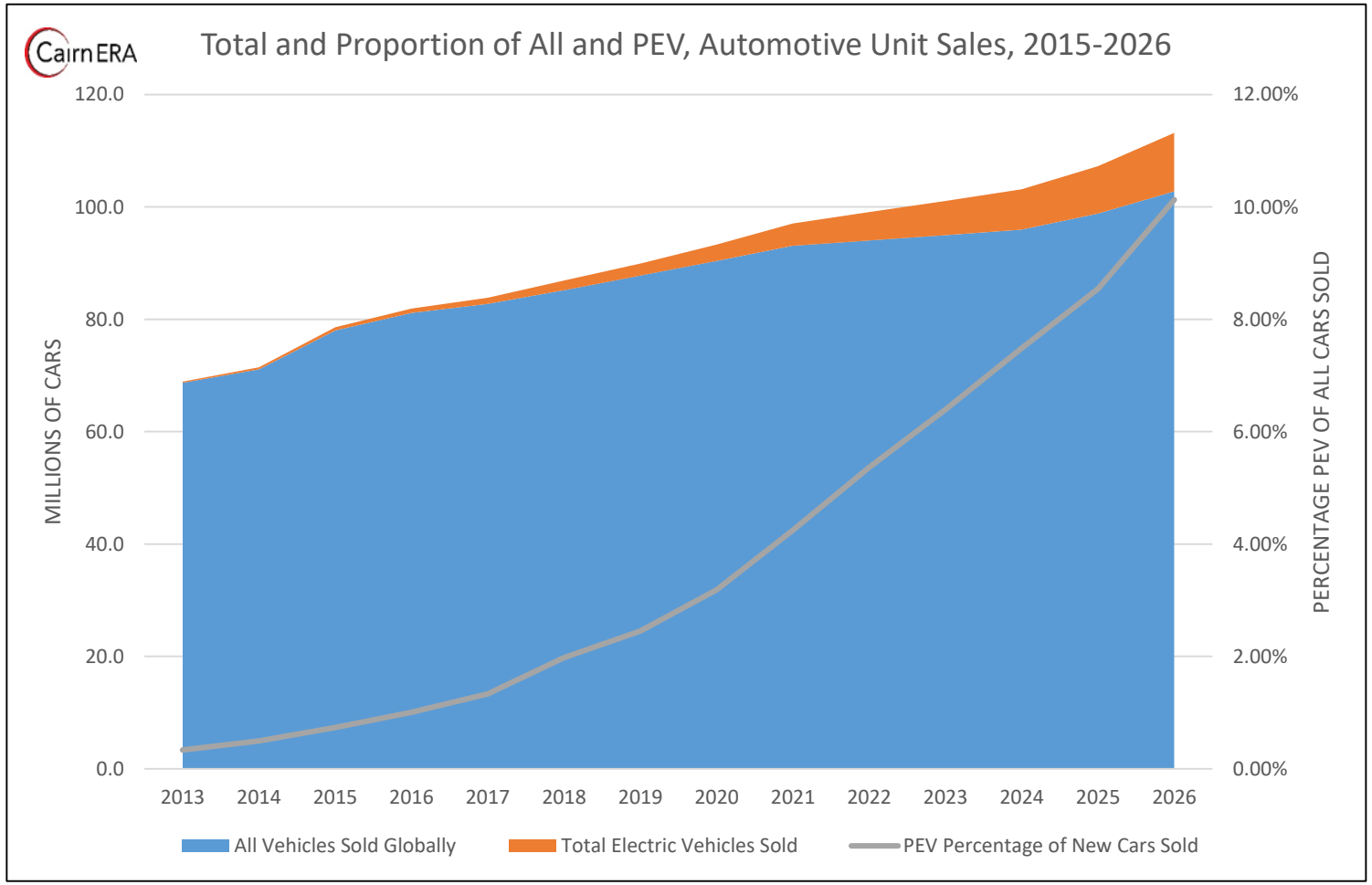
LI BATTERY DEMAND: CELL PRICING

- Average pricing for large orders (>20 MWh's for auto or peak shifting applications) in 2018 is $177 at the cell level, $245 at the DC Bus level and $285 at the ESS installed system level.
- Stationary storage pricing has declined rapidly, dropping more than 60% in terms of installed AC systems in just the last three years.
- The decline is softening, but will continue to be significant through the next five years.
- The spread between the cost of the cells, the cost of the DC pack and the AC installed price will contract even more over the next ten years, as economies of scale take effect and reduce the per/kWh difference between the three.



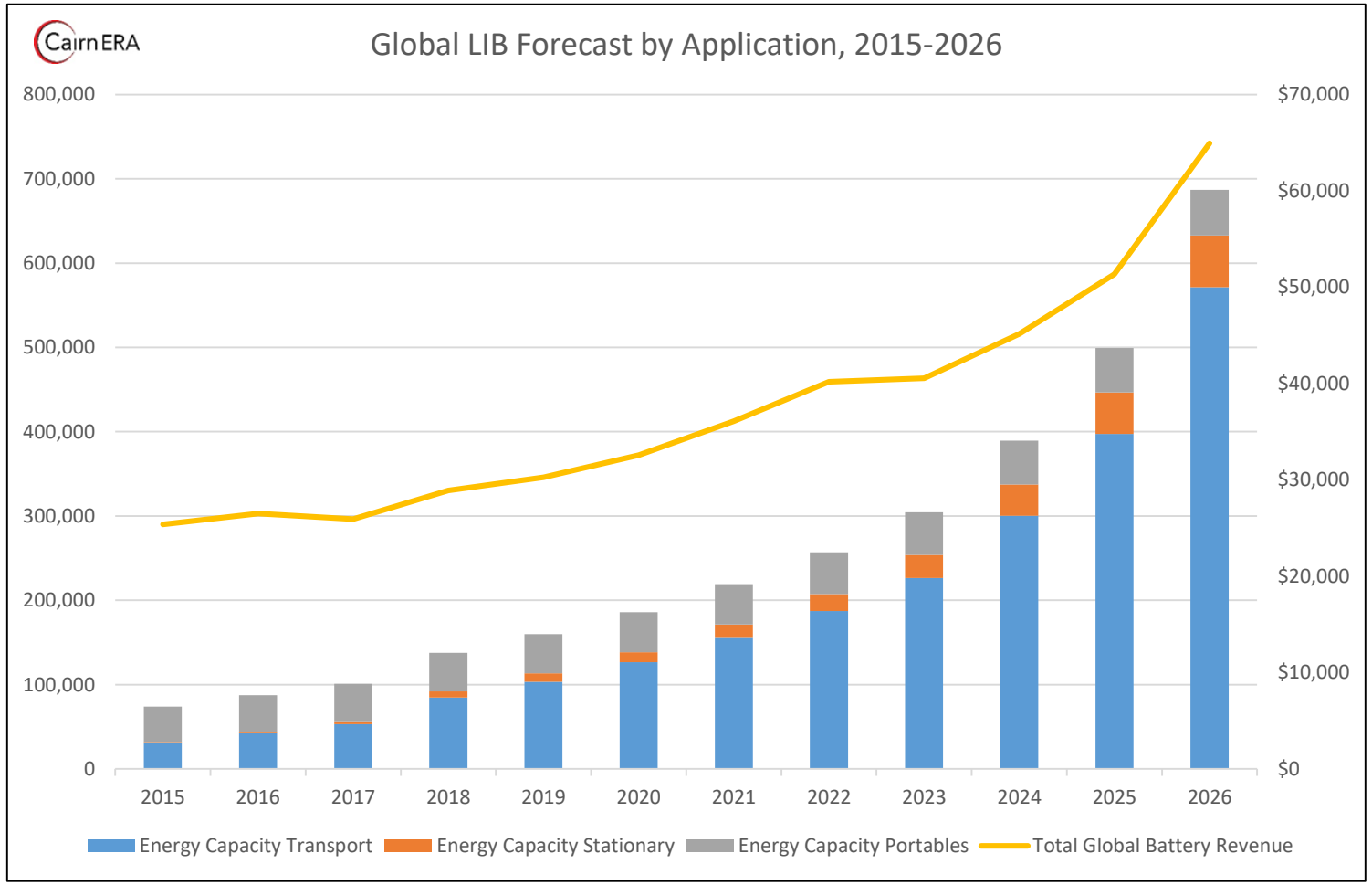
LI BATTERY DEMAND: EV FORECAST

- Cairn ERA expects that global EV penetration will represent only 10% global vehicle sales in the year 2026.
- Geographic distribution will be inconsistent. China will have more than 30% EV sales in 2026. U.S. sales will be closer to 6%. Europe will see 5% penetration.
- Cairn ERA expects a dramatic rise in the late 20's and early 30's. This can only be done if significant capital flows to Lithium mining are accomplished in the early 2020's.

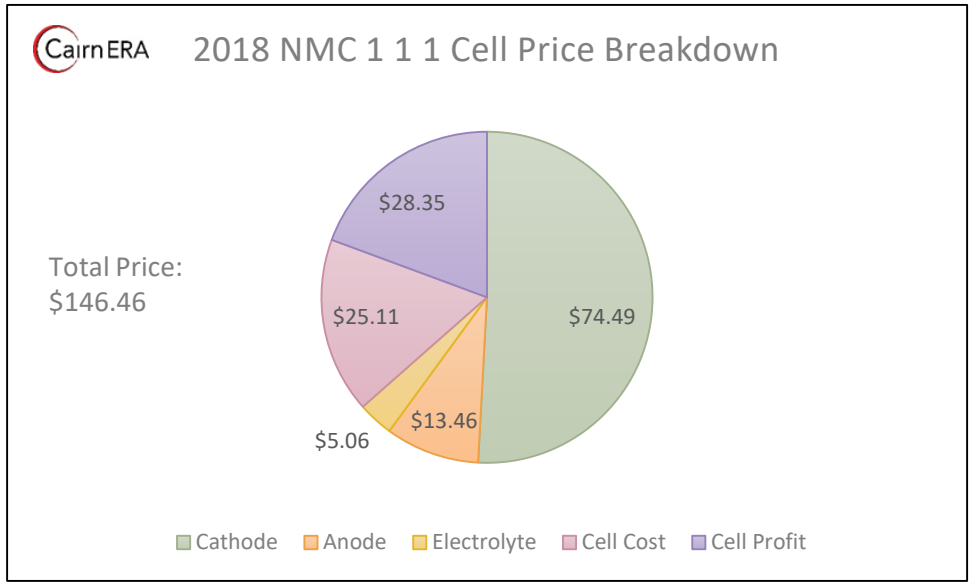


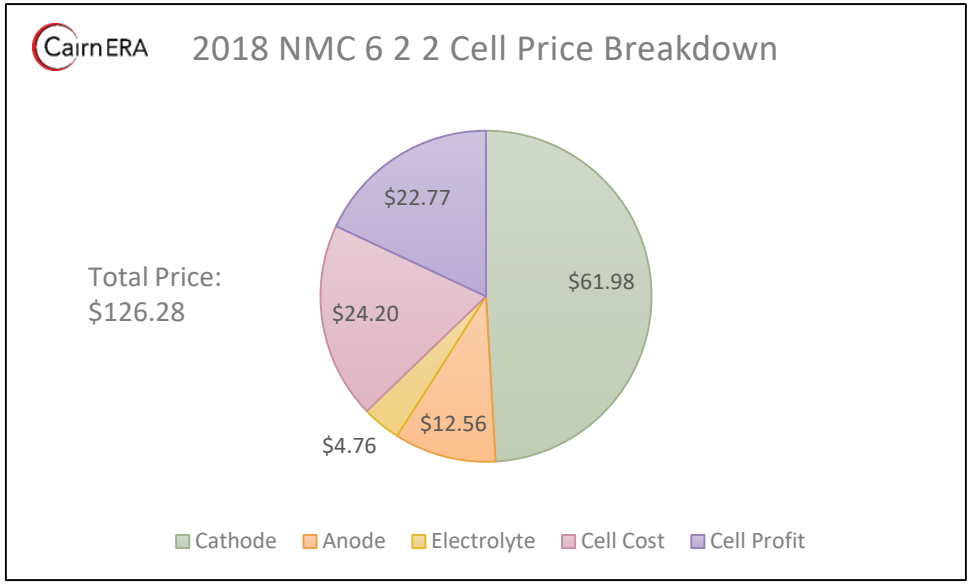
LI BATTERY DEMAND: ALL APPLICATIONS

- The vast majority of Li ion batteries will flow to automotive applications over the next ten years.
- Total Li ion battery energy capacity will grow off a base of 130 GWh's in 2018 to 190 GWh's in 2020 and 686 GWh's in 2026.
- Revenue won't grow at the same pace, reaching $66 billion in 2026.



BATTERY MATERIAL SUPPLY: COST BREAKDOWN

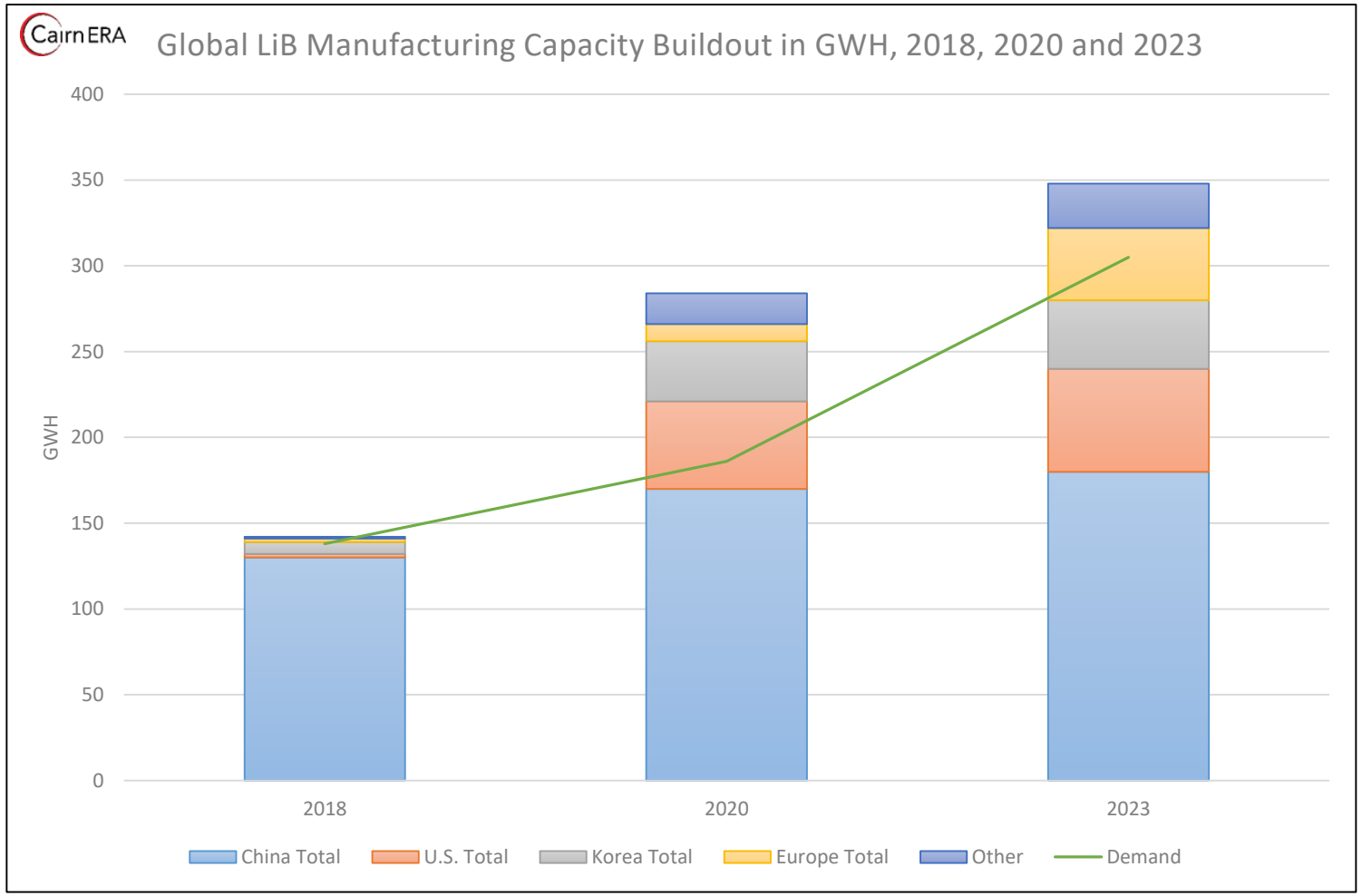




- Cobalt price increase has raised NMC 1 1 1 price by ~$15/kWh above Cairn ERA's estimates for 2018
- Only Cobalt pricing pressure valve is to migrate to lower-Cobalt cathode chemistries

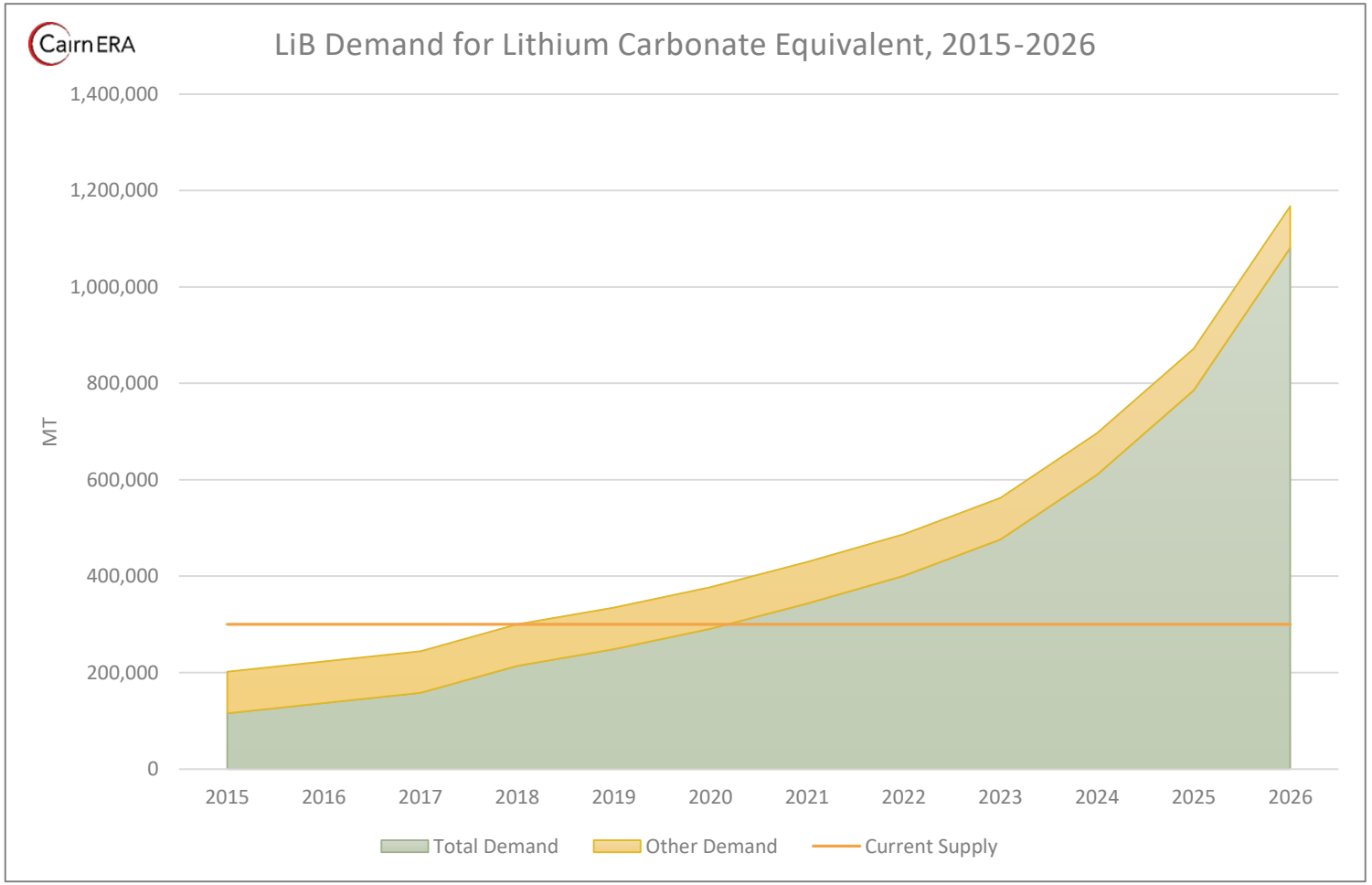
BATTERY MATERIAL SUPPLY: MANUFACTURING CAPACITY

Country	Manufacturer	2018 Total	Transport	Electronics
China	Other China	24	6	18
NA	Panasonic	24	20	4
Taiwan	TenPower	14	2	12
Korea	LGC	11	5	6
Korea	SDI	11	4	7
China	Guoxan	10	10	0
China	BYD	9	6	3
China	CATL	6	6	0
China	Wanxiang	6	6	0
Korea	Other Korea	5	2	3
China	Lishen	4	2	2
China	CALB	3	3	0
China	Microvast	3	3	0
China	Optimum	2	1	1
China	AESC	2	2	0
Europe	Other Europe	2	1	1
NA	Other NA	2	1	1
China	Farasis	1	1	0
China	Eve	1	1	0
China	Coslight	1	1	0
Korea	SKI	1	1	0
Total		142	84	58



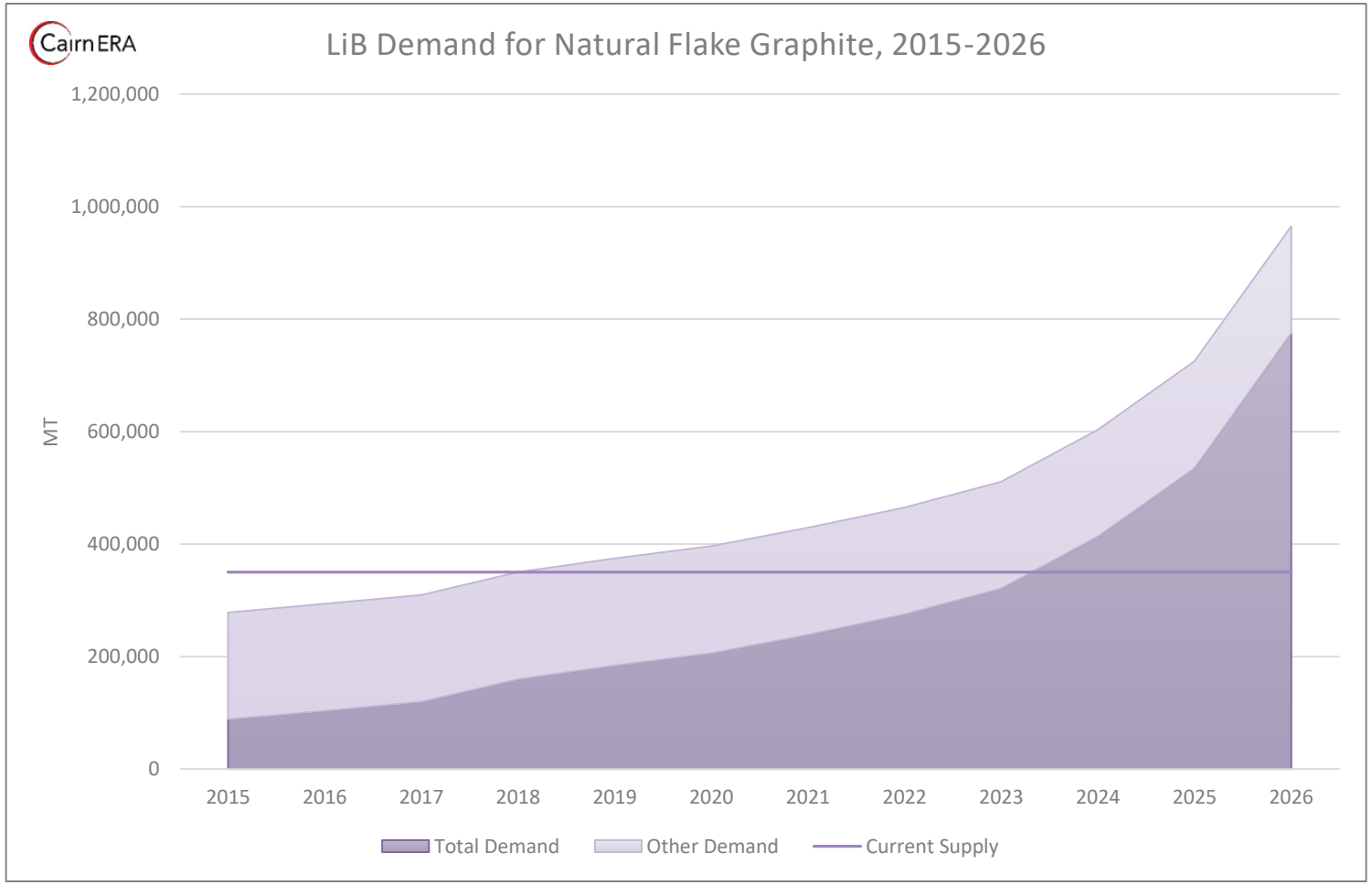
BATTERY MATERIAL SUPPLY: LITHIUM

Based on Cairn ERA's LiB growth, LCE production will surpass 2018 production at the end of this year. Cairn ERA expects supply and demand to oscillate over the next three years, causing significant pricing pressure on Lithium. By 2021, investments in new assets will correct and supply will exceed demand from 2023 onwards.



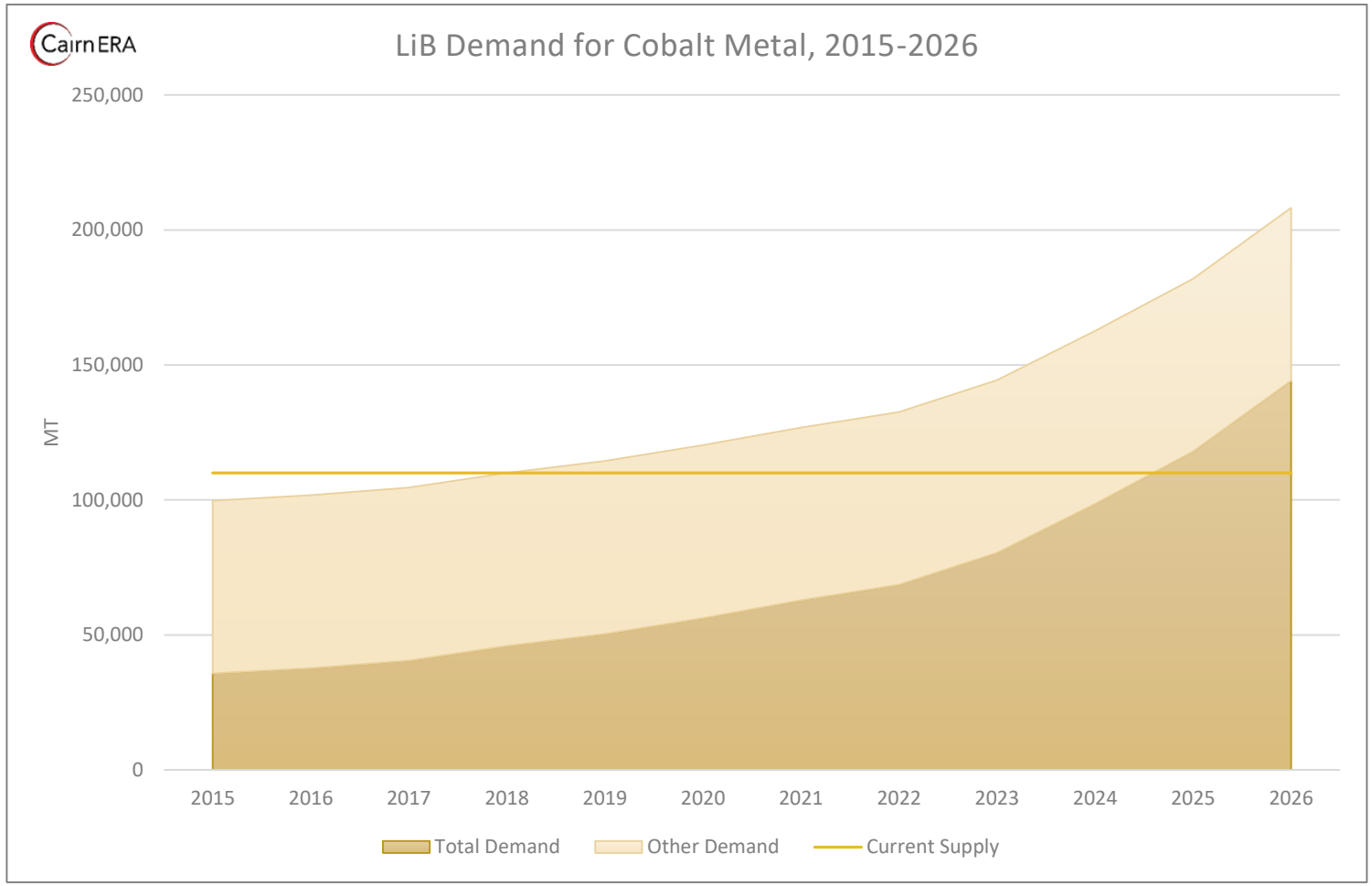
BATTERY MATERIAL SUPPLY: GRAPHITE

Of all the battery materials, Graphite has the most flexibility to meet demand as well as tamp down pricing pressure. This is due to the ease of bringing up new graphite production and the presence in the market of Syrah Resources, which has the capability to quickly bring on almost 600 KT. Additionally, other users of graphite are price sensitive and therefore can migrate to other materials.



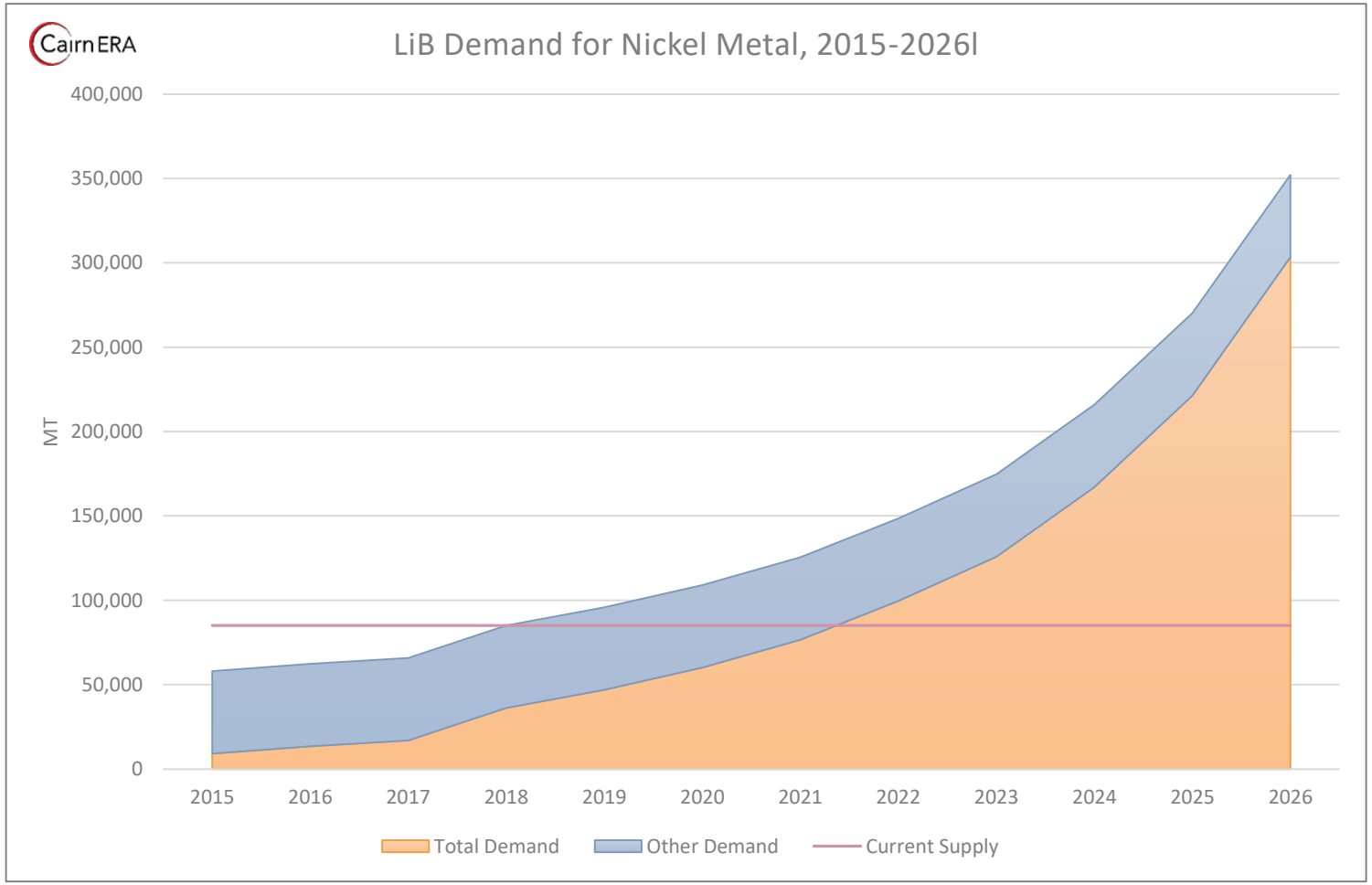
BATTERY MATERIAL SUPPLY: COBALT

Cobalt scarcity is a non-solvable problem. Increased production at existing Copper and Nickel mines that co-extract Cobalt, as well as a scattering of junior miners, will lead to a minor bump in Cobalt production, but not nearly enough to satisfy demand. The only “valve” to reduce pricing pressure is for the battery industry to migrate towards low and no-Cobalt cathodes.



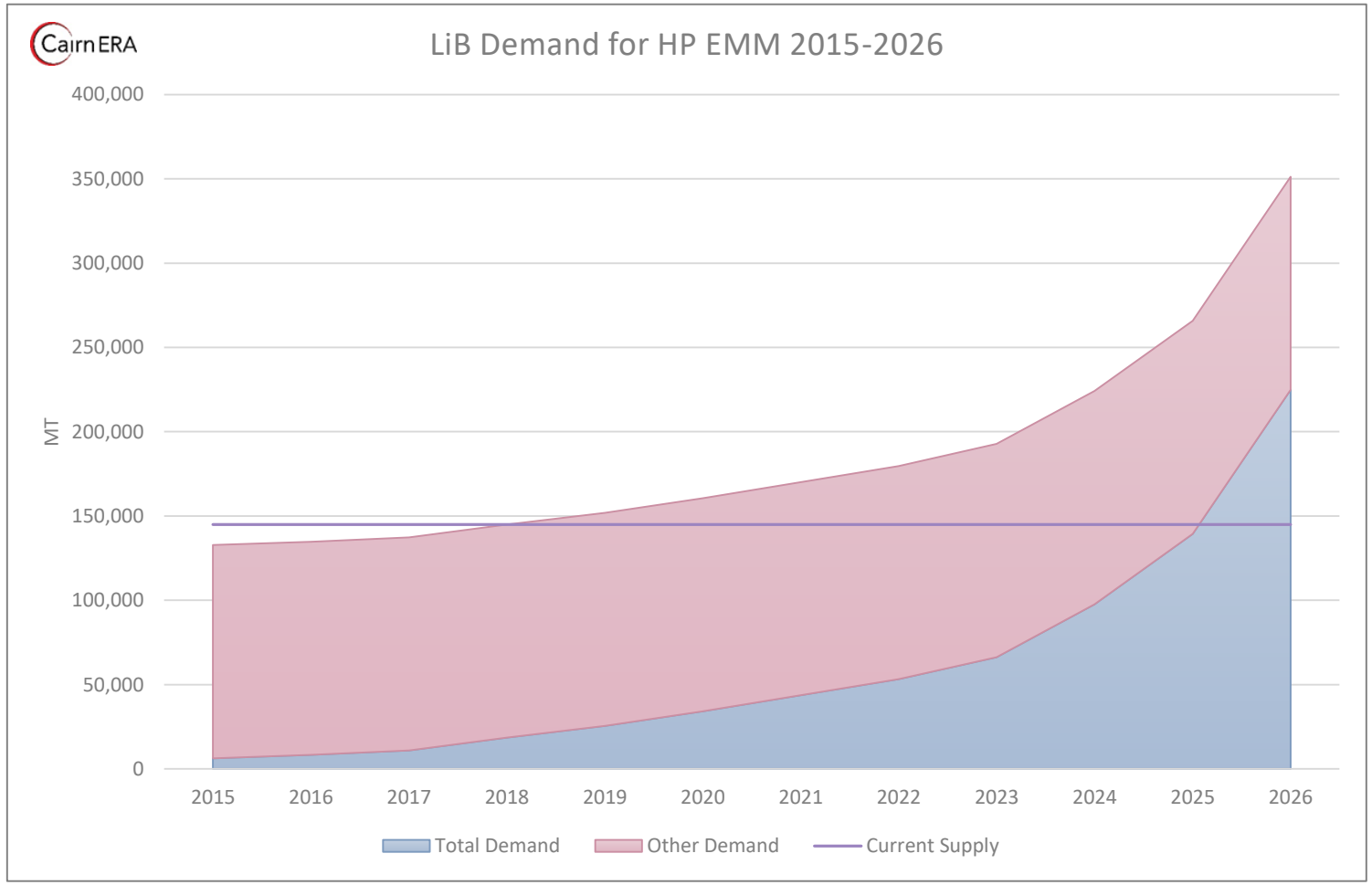
BATTERY MATERIAL SUPPLY: NICKEL

Nickel metal production will never be moved or price-impacted by Nickel demand from LiB. However the purity and tolerances required for Nickel used in LiB will lead to an inequality for electroless 99.9 Nickel sulfate. Therefore, significant investment in Nickel processing will be required.



BATTERY MATERIAL SUPPLY: MANGANESE

Like Nickel, Manganese requirements for LiB have little to do with overall Mn production and focus on a small portion of the market called HP EMM. It requires a different processing and refining route, which limits the ability to quickly grow in response to LiB demand. As manufacturers turn to low Co chemistries, Mn will increase dramatically along with Ni.



BATTERY MATERIAL SUPPLY: INVESTMENT REQUIRED

Investment in Lithium sites has been significant in the last 18 months, leading to a nearly doubling production since the end of 2016. Nearly quadruple the capital has to flow to the Lithium mining space in the next four years to satisfy demand from 2023 onwards.

Other materials, especially Nickel and Manganese will require considerable new capital flows, especially for deposits that are especially suited for feeding the LiB industry.

Lithium Producers	Location
Orocobre	Argentina
Albemarle	Australia, U.S., Chile
SQM	Argentina, Australia
Gangfeng	China, Argentina, Australia
Tianqi	China, Australia
FMC	Argentina
Impending Producers	Location
Galaxy Resources	Canada, Argentina, Australia
Altura Mining	Australia
North America Lithium	Canada
Standard Lithium	U.S.
Nemaska Lithium	Canada
Lithium Americas	U.S., Argentina
Bacanora Minerals	Mexico
Critical Elements	Canada
Kidman Resources	Australia
Pilbara Minerals	Australia
Neo Metals	Australia

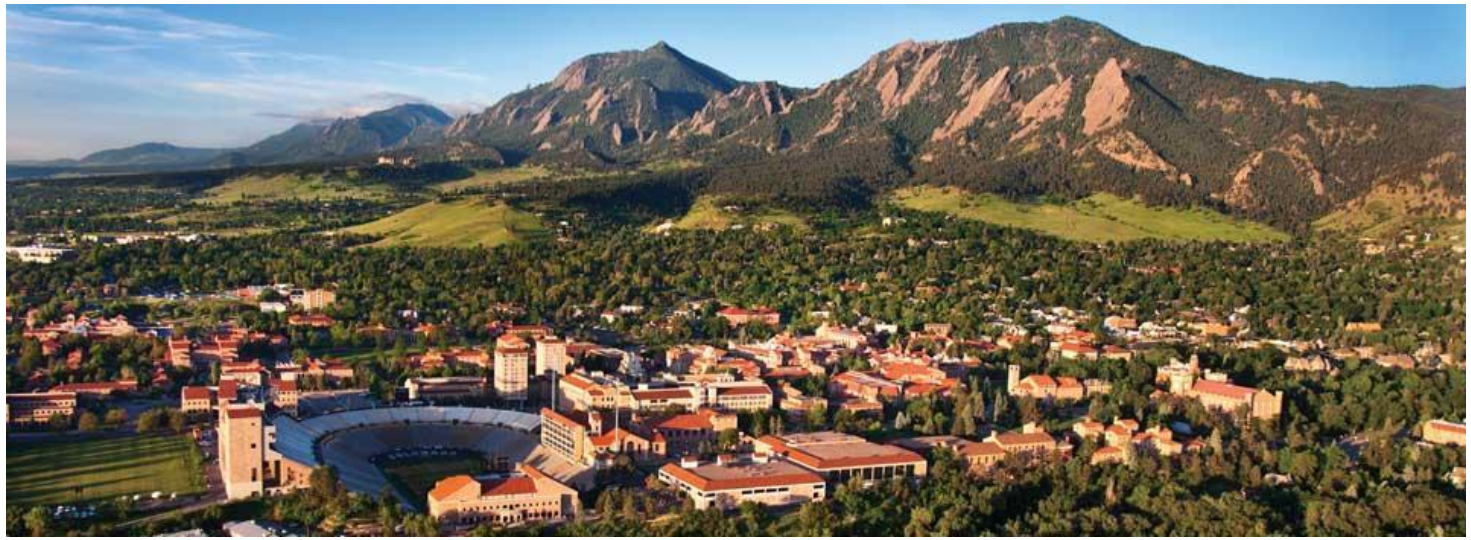
CAIRN ERA LITHIUM ION BATTERY DATA SERVICE

- Annual Lithium Ion Battery Data Service for Financial Companies includes:
  - Full LiB database of forecasts, including Stationary, Transportation, Portable Devices
  - Full forecast of global EV sales by model
  - All battery forecasts broken down by global region and major countries, energy capacity, power capacity and cell revenue
  - Material flows from the supply chain going in to the LiB industry by shipments and revenue
  - Pricing information for cells, major supply chain components and pricing forecast for cells

- All forecasts are updated quarterly, with accompanying report explaining updates and trends

- Service is designed specifically to meet compliance requirements of financial institutions--all data is vetted and processed in a way to ensure that no non-public information is input into the database and accompanying reports

QUESTIONS?



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