Materials Supply Chain Assessment: Impact of BEV Growth

Final Report

January 2022

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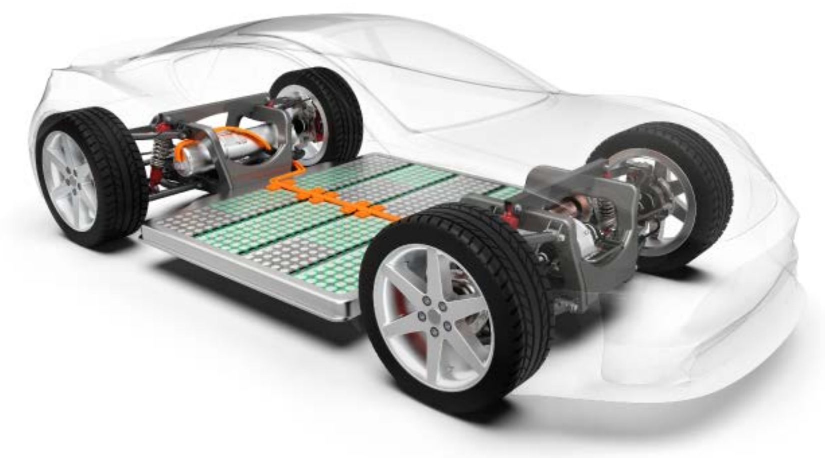
Primary Goal – Materials Supply Chain Assessment

The goal of this project is to deliver intelligence quantifying the size and scope of the impact the challenges of the materials supply chain will have as electric vehicles (EVs) grow in the US and globally over the next 10 – 20 years. This assessment and forecast will include analyzing critical materials on a global basis. Key questions to answer via research include:

1. *Identify and analyze current and future key materials for electrified vehicles*
2. *Map where key materials are mined and processed on a global basis*
3. *Identify competing end applications for same critical materials*
4. *Drivers and barriers impacting EV growth and materials*
5. *Analyze underlying factors and scenarios for critical materials and EV timelines*
6. *Government stance on regulations/mandates on EVs and supply chain*



The purpose of this document is to assess what will be needed to achieve governmental and fundamental goals.

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BEV materials supply chain assessment

SUMMARY

Summary

Martec conducted primary and secondary research to evaluate key material challenges in EV growth

This battery electric vehicle (BEV) materials supply chain assessment evaluates the challenges in meeting the critical mineral demand (e.g., lithium, cobalt, nickel, graphite, aluminum, copper, and rare earth oxides) for EV production under seven different scenarios in both the US and global markets. As the US continues to set goals for reducing carbon emissions, questions about energy security remain a critical topic for policymakers. The information in this report helps to answer if the demand for these minerals is achievable and if it will require significant investment both domestically and globally to meet production increases.

Additionally, the study shows other barriers the US could face in becoming a leader in the EV battery supply chain, such as geological disadvantages, mine permitting process, and price volatility in critical mineral markets.

Martec conducted a feasibility analysis of the material supply chain related to the key minerals needed to support EV growth over the next 10 – 20 years.

- The analysis looked at both a global and US-only basis
- Evaluated material mined production and reserves both globally and in the US
- Martec researched and conducted multiple growth scenarios with an emphasis on BEVs being the predominant long-term solution

Summary *(continued)*

Martec conducted primary and secondary research to evaluate key material challenges in EV growth

Martec highlights from material supply chain modeling:

- The drivers of investment in the EV battery supply chain are largely driven by US and global mandates, not the natural choice of consumers
  - *Potential Prius Effect – will there be a successful BEV outside of Tesla*
  - *Automakers are echoing what government mandates are requiring them to follow*
- To meet the Biden administration's 50% by 2030 scenario, the production of the critical minerals necessary to meet EV demand in the US alone will require a significant increase:
  - *Lithium = 48X*
  - *Cobalt = 29X*
  - *Nickel = 16X*
  - *Graphite that is not produced at scale in the US*
- To meet the global 75% by 2040 scenario, the production of the critical minerals necessary to meet EV demand also will require a significant increase:
  - *Lithium = 8X*
  - *Graphite = 3X*
  - *REOs = 1.5X*

Summary *(continued)*

Martec conducted primary and secondary research to evaluate key material challenges in EV growth

Outside of copper the US has a limited number of active mines in each of the critical minerals.

- Much of this limitation is not due to available mineral reserves but for a variety of other reasons:
    - *Regulatory framework in place (multiple federal and local states process steps)*
    - *Long permit approval process*
    - *Environmental regulations*
    - *Community issues*
    - *Ability to finance due to higher risks and lower ROIs experienced in the US*
- Countries such as China, Australia, Chile, and Canada have perceived quicker and lower cost processes compared to US

China has a significant amount of control in the backend of refining these mined minerals.

- China market share positions globally with ~60% in lithium, ~67% in cobalt, and >80% in both copper and rare earth elements
- Chinese companies have also been extremely active in the last 2 years investing in >20 new mines and processing plants globally in order to maintain its leadership position in the critical minerals needed for BEV growth

Limited supply for critical raw minerals is leading to significant price increases in the market.

- Lithium, rare earth neodymium (Nd), and cobalt have experienced the most significant increases in pricing over the last 12+ months

Global Demand for BEV Materials

Several challenges exist in the global supply chain in order to meet EV demand growth

Three of the seven key materials analyzed will require significant expansion due to BEV growth.

- Lithium:
  - *Significant increase in future lithium (Li) demand, >400% price increase over last 12 months*
  - *Lithium supply chain (mining and refining) are dominated by 4 countries with 90%+ of control*
    - China, Australia, Chile, and Argentina
  - *Next-gen technology (i.e., solid-state Li) tends to demand more Li not less, while other key materials will be reduced over the next 5 to 10+ years (i.e., cobalt and nickel)*
- Graphite:
  - *New mining production will be coming online in Africa (Mozambique and Madagascar) over the next 3 years to deal with automotive demand, much of this additional production is committed to China customers for final processing*
- Rare Earth Oxides:
  - *Rare earth oxides (REOs) are the ideal material for use in high efficiency electric motors (multiple REO types required per motor)*
  - *Key challenges for REOs = New mining is difficult to come on board, dominated by China, long-term environmental concerns, recycling techniques are limited*
  - *Alternative solutions are available but have lower efficiency compared to permanent magnet motors*
- Recycling can help alleviate some of the raw material supply issues but will take at least a decade to see significant volume to make an impact
  - *Even if an ideal recycling technology was available, there still would be a significant challenge in meeting demand for the next 10+ years*

Leading Challenges for Mining

The following factors were utilized to provide a scorecard on the challenges ahead for each key mineral in order to fulfill future EV growth based on direct feedback from the mining community:

Following are descriptions of each of the factors taken into consideration and a qualitative score from 1 to 5 was provided based on feedback from the mining community. 1 = Low risk; 5 = High degree of risk or challenges ahead*

1. Market Consensus on Demand-Supply gap

- Feedback from mining community on expected growth in specific mineral across all end applications
- How large is the anticipated deficit in available material
- Deficit is compared with the size of the current annual production & capacity
- Larger the deficit/current capacity ratio, the more challenged/ uncertain will be the response of the supply

+ 2. Outlook for Future Demand

- Evaluated two major factors:
  - *1) Whether the mineral is used in a specific technology or broadly across a variety of new technologies*
  - *2) Perceived progress made on substitution of the particular mineral*

+ 3. Advanced Portfolio of Projects

- Evaluation of how much new demand will come from uncommitted mining projects
- Larger the proportion, the more challenged is the supply
- Risks at active mines are also taken into consideration
  - *Future volume from non-traditional mining countries the higher the risk*

+ 4. ESG factors affecting the delivery

- Trends, regulation and any other factor that affects the demand/supply perspectives. Critical minerals could price at a premium based on carbon-free/carbon reduction and sustainable measures
- The higher the challenge or greater amount of risk results in a higher score.

= Final Rank: How challenged is the material supply?

- The higher the score, the higher the challenges that the global supply side faces to provide the minerals for EVs and new sources of demand

**Note: Feedback based on primary interviews conducted with mining community.*

***Note: Scorecard for each mineral can be found on the following page.*

Summary of Mining Community Feedback & Martec Analysis

Mineral	1. Demand-Supply Gap		2. Risks for future demand		3. Advanced portfolio of new projects		4. ESG factors affecting the delivery		Final Rank
	Expected 10-Year Multiplier	Value	Reasons	Value	Factor from Uncommitted Mines	Value	Reasons	Value	
Li	3.50	5	• New demand mostly energy-storage driven with no known commercial level substitution for the next decade • On the contrary, next-gen of batteries could intensify the need for Li (i.e., Solid-State Li)	5	0.25	3	• Half of the present and future production is based on brine which is subject to increasing environmental concerns and challenges in US and globally • Green/ESG production certification likely to emerge	4	17
Ni	0.40	4	• Cross-functional metal used across a large wide range of clean energy technologies (electricity generation, EVs, energy storage, etc.), largely utilized as an alloy in other metals • Higher EOL recycling rates than copper • Important substitution in EV batteries towards 2030 (SS-Li)	4	0.15	3	• Location and recovery processes result in larger environmental and communities’ impacts • ESG Cert. under process following Copper Mark standard • Backend processing using HPAL has environmental challenges due to CO2 generation & hazardous waste tailings	5	16
Cu	0.33	4	• Cross-functional metal used across a large wide range of clean energy technologies (electricity generation, EVs, energy storage, etc.) • Substitution and recycling will not fill the gap at least in the decade, but higher degree of recycling comparatively	4	0.30	4	• Size of the projects result in larger environmental and communities' impacts • ESG Certification to roll out within the decade, could create some challenges in certain regions (Copper Mark)	4	16
REOs (Dy/Tb/ Nd/Pr)	1.47	5	• Demand driven by specific application (PM e-motors) • Limited recycling and substitution for the decade • High risk recycling process which can create hazardous bi-products • Over production of other rare earth materials generated form mining of key permanent magnet motor rare earths • Martec multiplier modeling lower due to induction motor assumptions displacing a portion of PM e-motors	4	Low	2	• Increased concerns about environmental hazards in the production process and post reclamation of mine (radioactive waste and risk of water contamination) • Higher risks in investing far from the final applications manufacturing districts • China dominance in supply and controlling production & backend processing	4	15
Graphite	1.10	5	• New demand is mostly EV/energy-storage (anode) driven • Battery demand set to increase in the decade for cost reduction purposes • Post-2030, substitution expected to ramp up with next-gen batteries	2	Medium-High	4	• Responsible sourcing questionable from new supply growth regions such as Mozambique and Madagascar	3	14
Co	1.79	5	• New demand is mostly EV and energy-storage driven • Rising substitution towards the end of the decade will reduce the need for primary cobalt (ultra-low Co & SS-Li) • Martec modeling does not line-up with this multiplier (1.79)	1	0.15	1	• Artisanal/small-scale illegal mining is a major threat • DRC's instability as source of constant risk • Projects approved for Cu and Ni, which both have solid perspectives (Co is a secondary material to Cu & Ni mines)	2	9

**Note: Scorecard based on feedback from mining community..*

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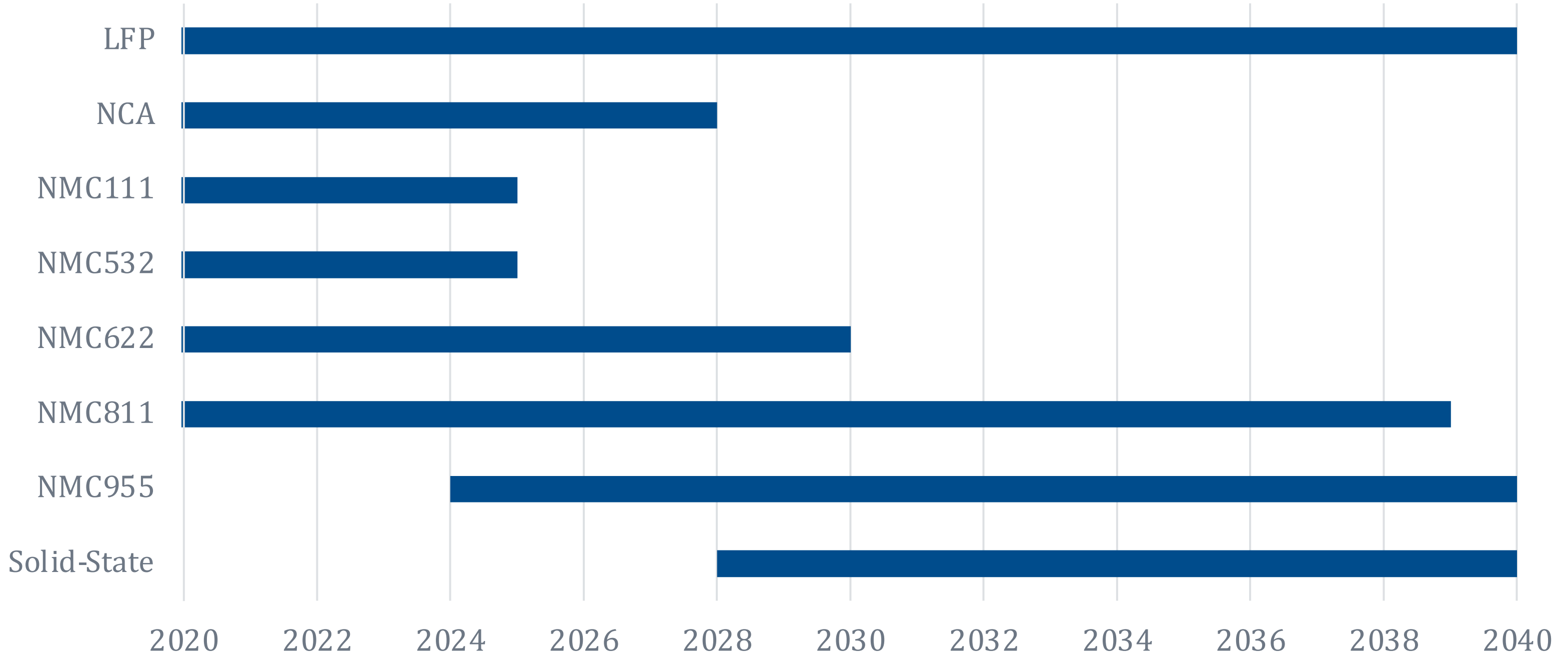
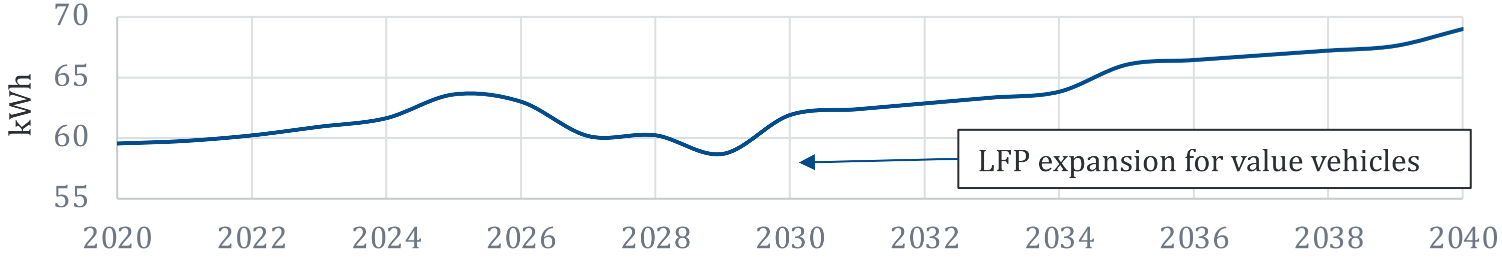
Battery Chemistry Introduction Timeline

Major available chemistries



Global Average BEV Battery Pack Capacity (kWh)



Source: Martec Analysis

Martec took a variety of the leading EV battery technologies into consideration for its modeling. Both technologies in current production but will be phased out, and those designated for future introduction.

- LFP is a low-cost battery solution for vehicles not requiring long range
  - *Smaller European and Chinese vehicles*
  - *Tesla "low-cost" EV offering*
- NCA is a chemistry that is exclusive to Tesla/Panasonic
  - *Being phased out so Tesla can align with global chemistry solutions*
- NMC 111 & 532 are already phasing out
  - *NMC 622 not far behind*
- NMC 811 and 955 are the current benchmarks for performance and cost
  - *Lower cobalt usage means lower cost, higher nickel means more energy*
- Solid-state still in development, expected for LD automotive production in next 6–7 years
- Drop in avg. kWh power density will be driven by growth of LFP in low-cost vehicle applications primarily in China

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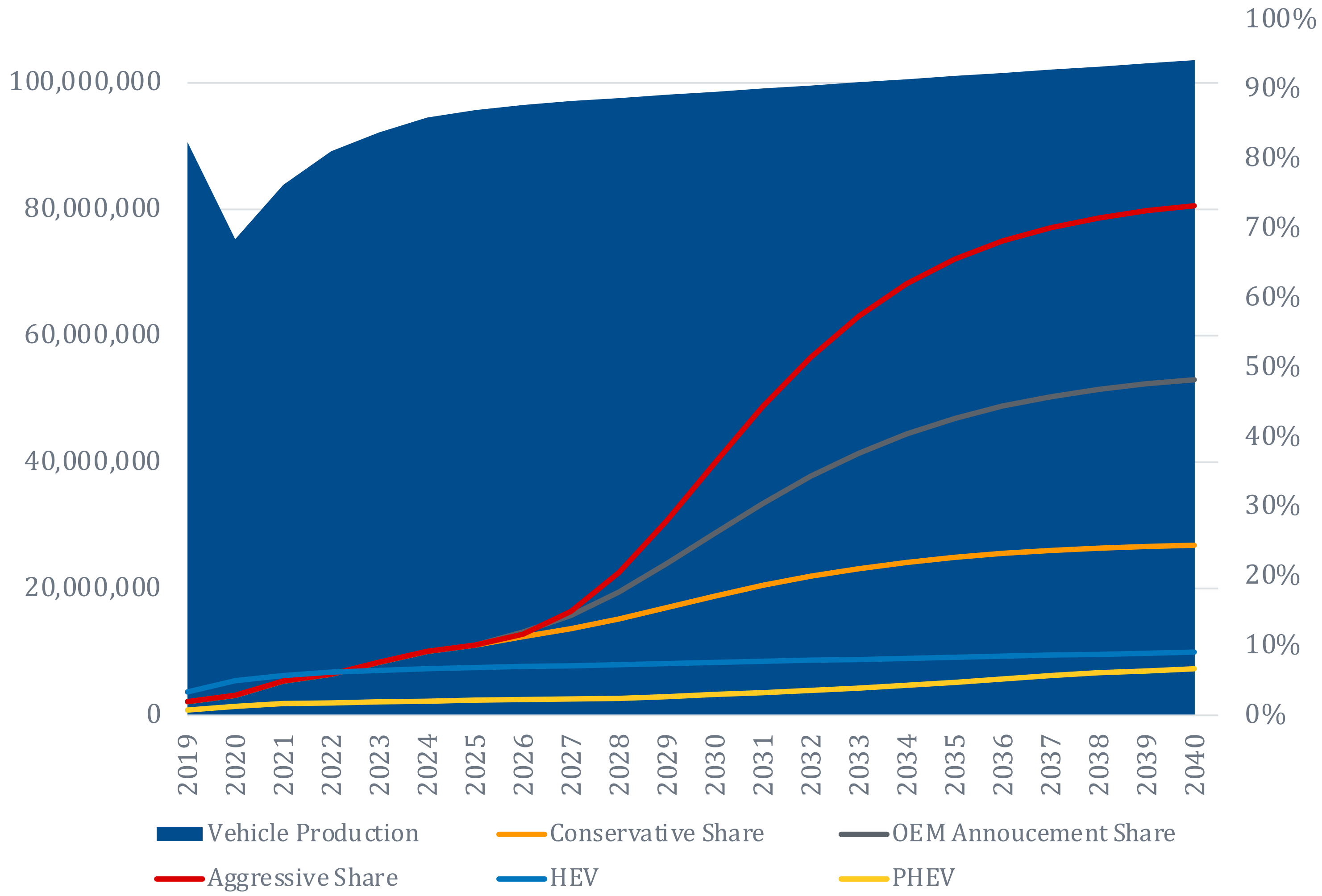
Global LD Auto xEV Production Forecast*

Primary scenarios



Source: Martec Analysis

**Notes: Forecast is inclusive of both residential & commercial fleet for LD automotive vehicles (passenger cars, SUVs and LD trucks). Excludes MD & HD vehicles.*

xEV = Industry term standing for electrified vehicles (BEV, HEV, and PHEV combined).

Scenario Logic:

- All scenarios follow expected vehicle OEM launch programs through 2025 as these programs are already in scheduled production plans.

Conservative

- Global demand peak of ~25% by 2040

OEM Announcements

- Follows announcements of all global OEM's expectations for EV penetration
- Global demand peak of ~50% by 2040

Aggressive

- Rapid acceptance of BEVs in all markets during the next 2-3 vehicle cycles
- Global demand peak of ~75% by 2040

PHEV

- Consistent forecast for each scenario (same %)
- Optional OEM compliance solution

HEV

- Full Hybrids will continue to be an alternative in electrification, but growth will be limited due to push towards BEVs

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Recycling – Idealistic vs. Not; Timing of its Impact

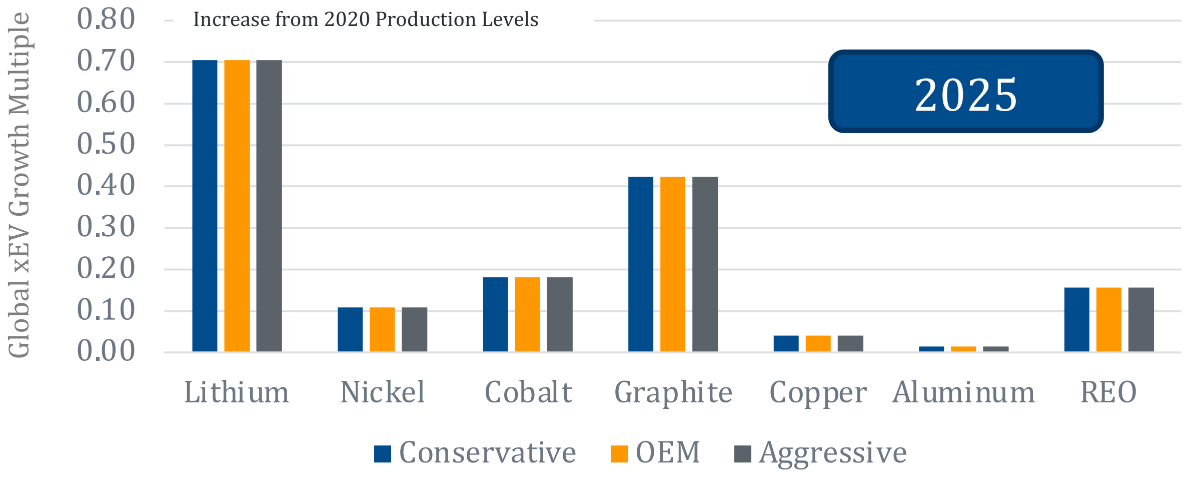
Recycling plays a key role in future battery production but will take considerable time to build capacity

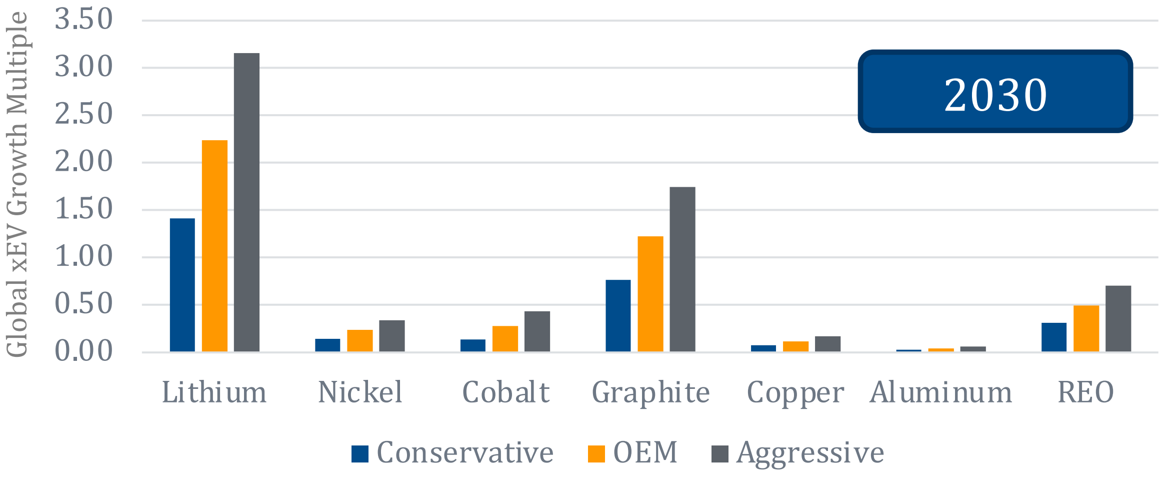
Recycling of batteries is something the automotive industry is focusing on to reduce the long-term impact of raw material shortages and cost increases.

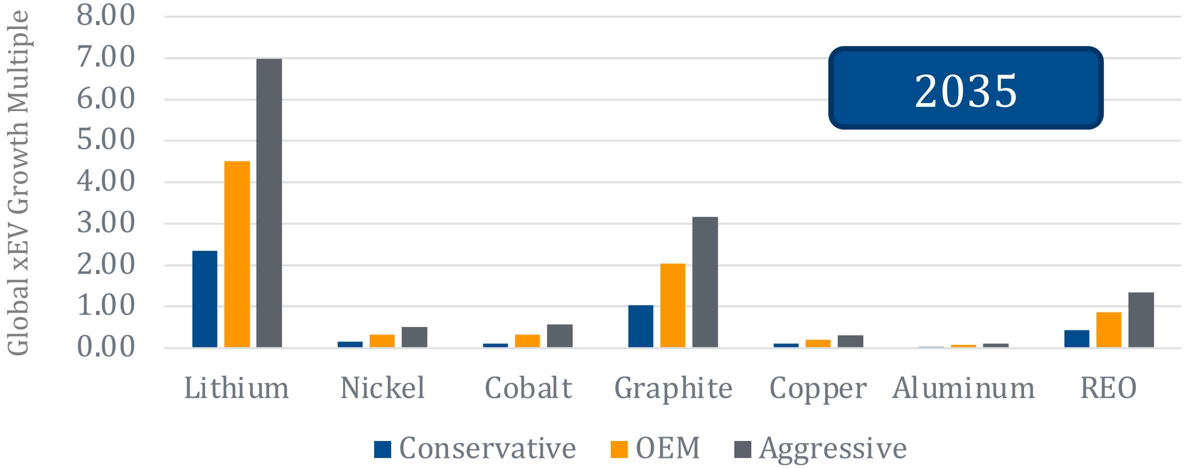
- Realistically, ~50-70% of the raw materials can be recovered with the latest recycling methods
  - *Some of the materials are not recoverable due to processing losses*
- Ideally, the recyclers could recover 100% of the raw materials from the battery to use in a new battery
  - *This is likely impossible with known recycling techniques, but the Martec material supply-chain model assumes this as a best-case scenario for the lowest raw material demand increase needed to achieve xEV market shares in the global and US only scenarios*
- With either assumption of recycling there is a significant "delay" in returning these materials back to the market
  - *Batteries need to be recovered from vehicles/batteries that have been retired from service or scrapped*
    - Vehicle life span varies by region (10 – 14 years), impacting the timing for recyclability back into market
  - *The model follows a vehicle retirement curve generated from a real-world retirement schedule in the US used by the EPA in their modeling of the US vehicle fleet (US ~12-year avg. vehicle lifespan)*
    - The lifecycles of vehicles do vary by market but overall, the average global retirement rate is close to the US, so this assumption was used to approximate the global vehicle retirement rate

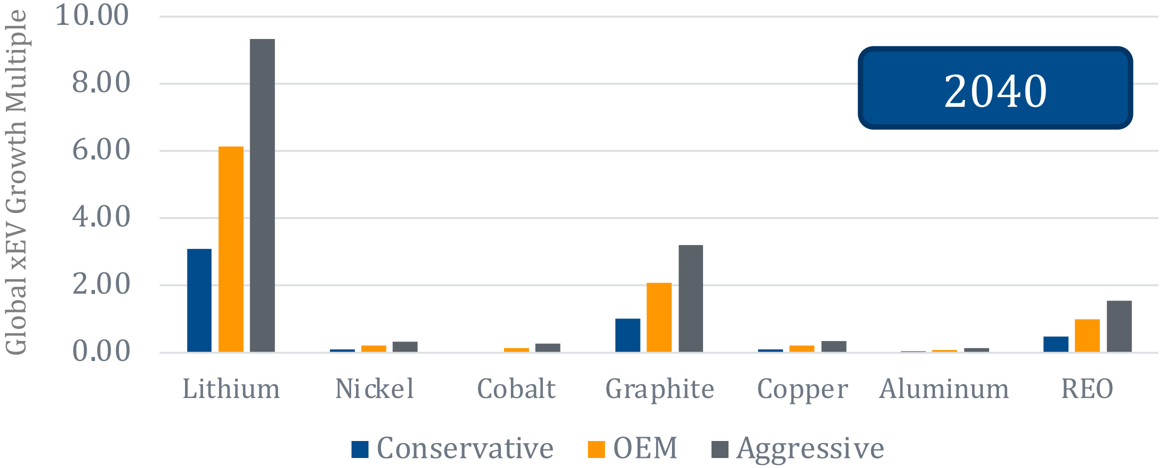
Summary of Global Material Demand Scenarios from xEV Growth*

Lithium, Cobalt, and REOs are expected to have the largest increase in production from 2020 levels









**Notes: 2025 material demand does not change based on the different scenarios as production plans from vehicle OEMs are already in place. The different scenario plans have a bigger impact when looking at materials needed by 2030 and beyond. This analysis assumes no recycling takes place.*

xEV = Industry term standing for electrified vehicles (BEV, HEV, and PHEV combined).

US Policy Changes Driving EV Adoption

Biden administration targeting 50% EV production in US by 2030

Consistent EV targets across the government and industry.

- Biden 50% EV target by 2030
- EPA 17% plug-in target by 2026
  - *GHG reduction of 26% by 2026*
- CA targets 100% EV by 2035
  - *Newsom EO Sept. 2020*
- Automakers claiming high US EV sales share
  - *GM 100% by 2035*
  - *Ford 40% by 2030*
  - *Stellantis 40% by 2030*
  - *VW 50% by 2030*

Aug. 5, 2021 – 50% EV target by 2030 Executive Order signing

Buy American push by the Biden administration.

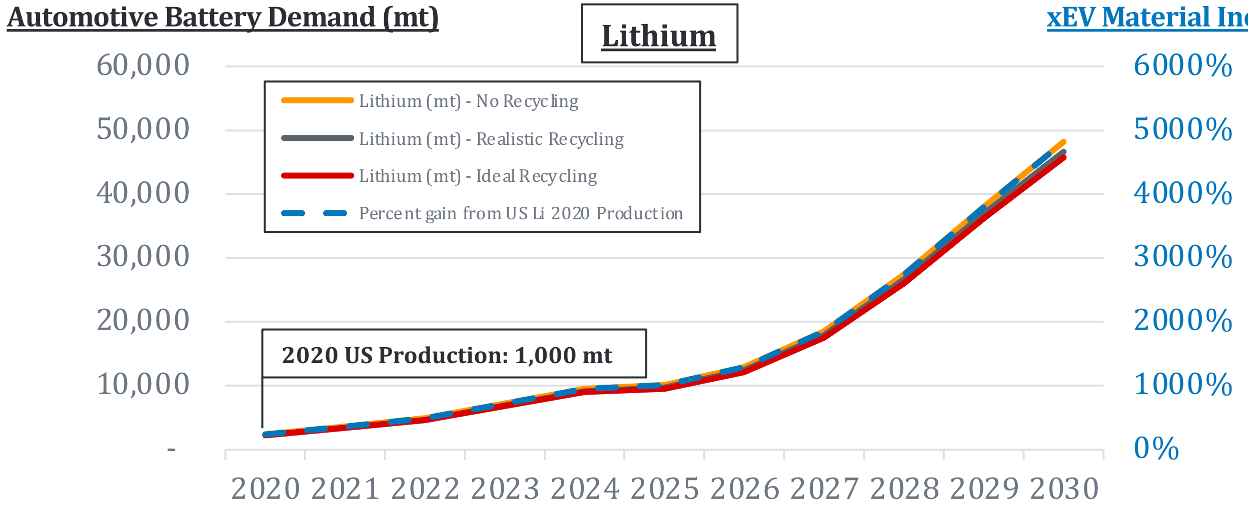
- Executive Order for entities receiving federal funds to buy American made products and services
- USMCA requires 75% regional content up from 62.5% regional content under NAFTA
  - *Significant challenge for EV content – raw materials, semiconductors*

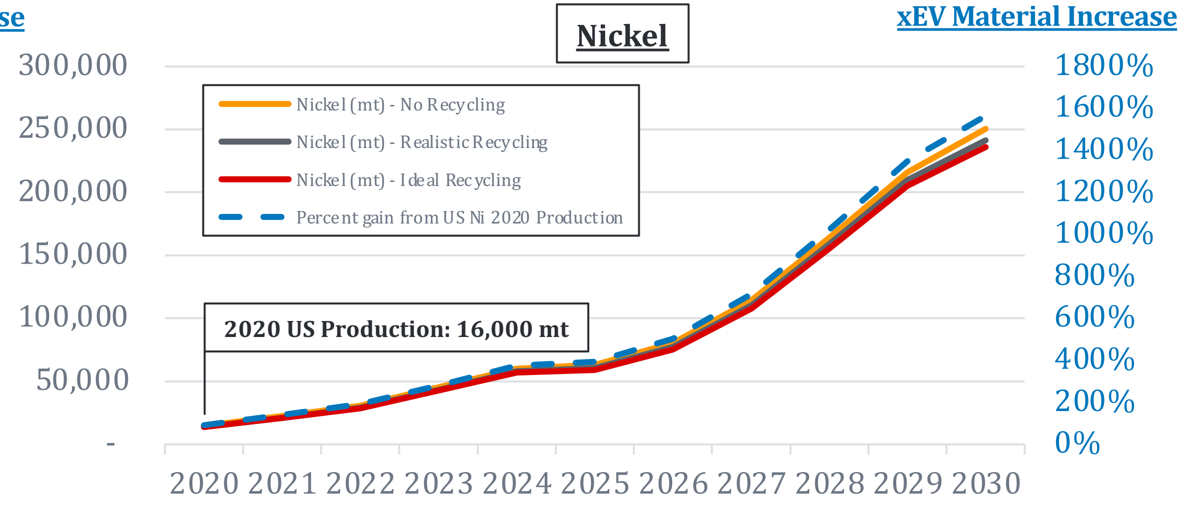
Pressure on raw material prices are driven by lack of competition.

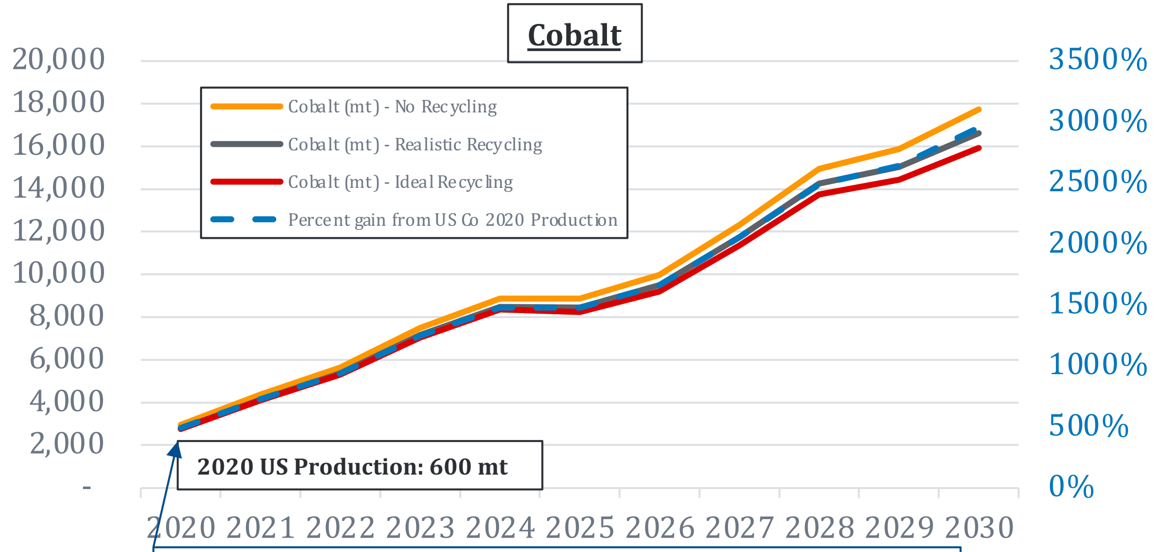
- Forcing electric vehicle volumes give raw material suppliers more pricing power for their goods

Material Demand for BEV, PHEV, & HEV: 2020 – 2030(F)

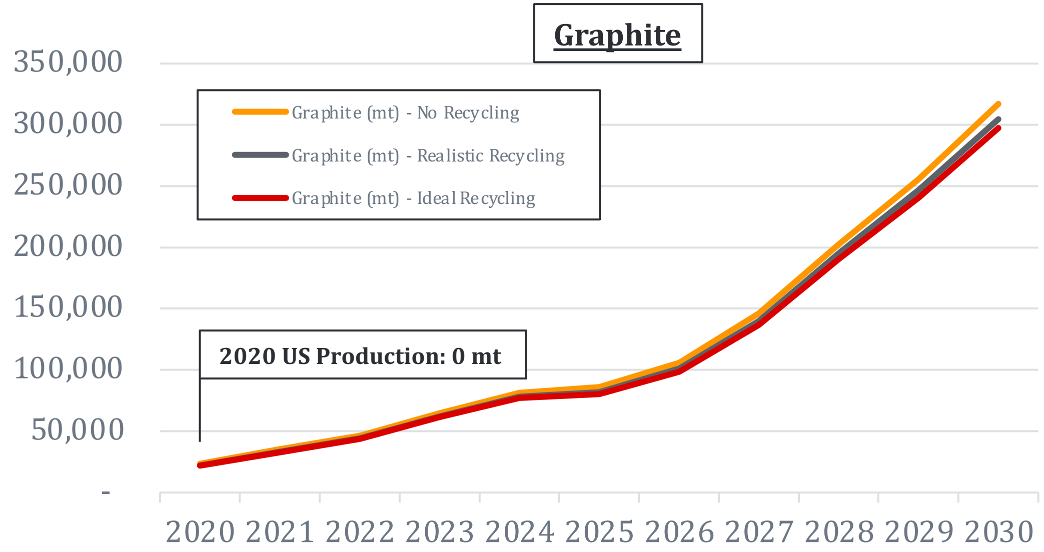
US-Only Biden EV Scenario: 50% BEV by 2030







2020 demand was already 5 times current US production.



Source: Martec Analysis

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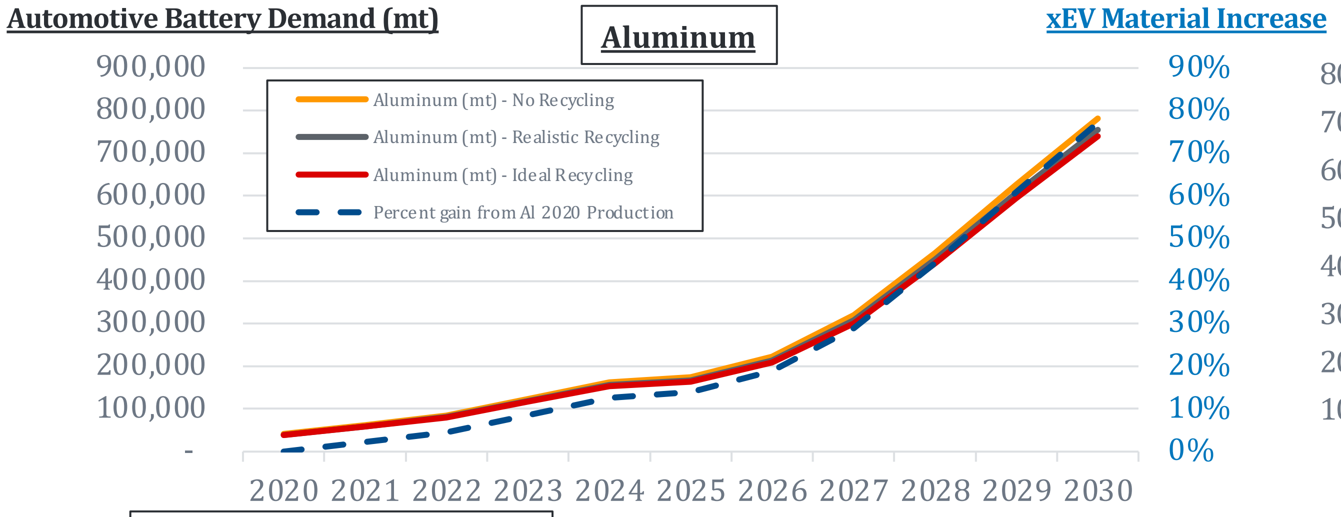
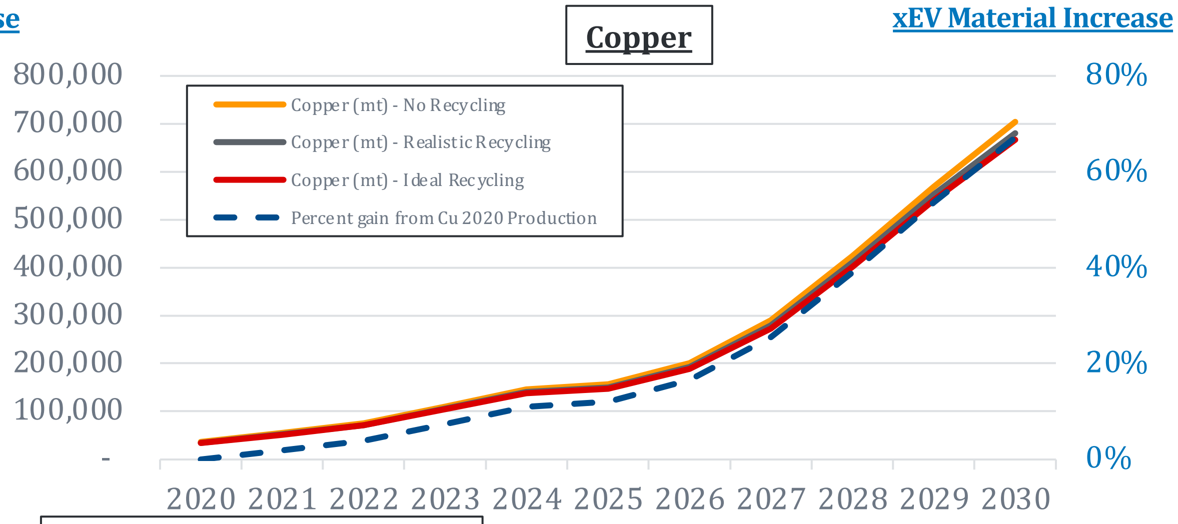
Material Demand for BEV, PHEV, & HEV: 2020 – 2030(F)

US-Only Biden EV Scenario: 50% BEV by 2030

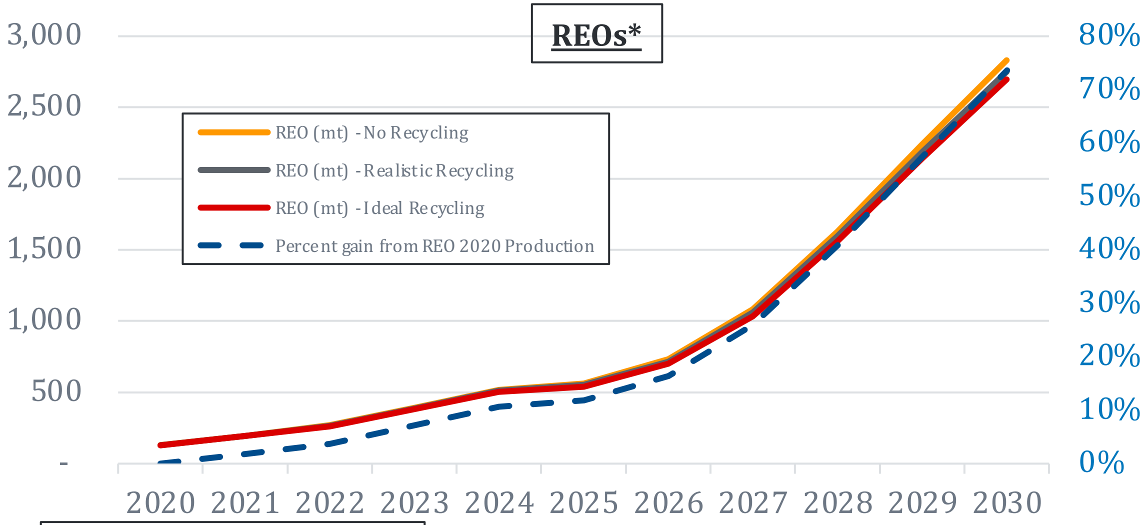


2020 US Production: 1,000,000 mt



2020 US Production: ~1,000,000 mt

Note: *2020 production is higher than xEV Automotive Demand due to use in other end applications (e.g., building and construction, consumer electronics, etc.).*



2020 US Production: ~3,800 mt

Source: Martec Analysis

**Note: REOs are primarily utilized in xEV motors vs. batteries.*

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Lack of US Mining and Backend Processing

US production of critical materials is lacking

The US is at a severe geologic disadvantage in the mining of certain critical materials and the number of active mines in order to support domestic BEV growth based on the current situation:

Mineral	US Percent of Global Mined Production (2020)	Number of Active Mines in the US
Lithium	1.2%	1
Nickel	0.6%	1
Cobalt	0.4%	2 *(as a secondary material)*
Graphite	0.0%	None
Copper	5.8%	19
Aluminum (Bauxite)	0.1%	4 *(mined for non-metal purposes, such as abrasives)*
Rare Earth Elements	15.6%	1

The majority of backend processing (smelting) is done in China and SE Asia for all the critical minerals.

- China has dominant backend processing market share positions globally with ~60% in lithium, ~67% in cobalt, and >80% in both copper and rare earth elements
- China also has a dominant position in backend processing of graphite with share unreported

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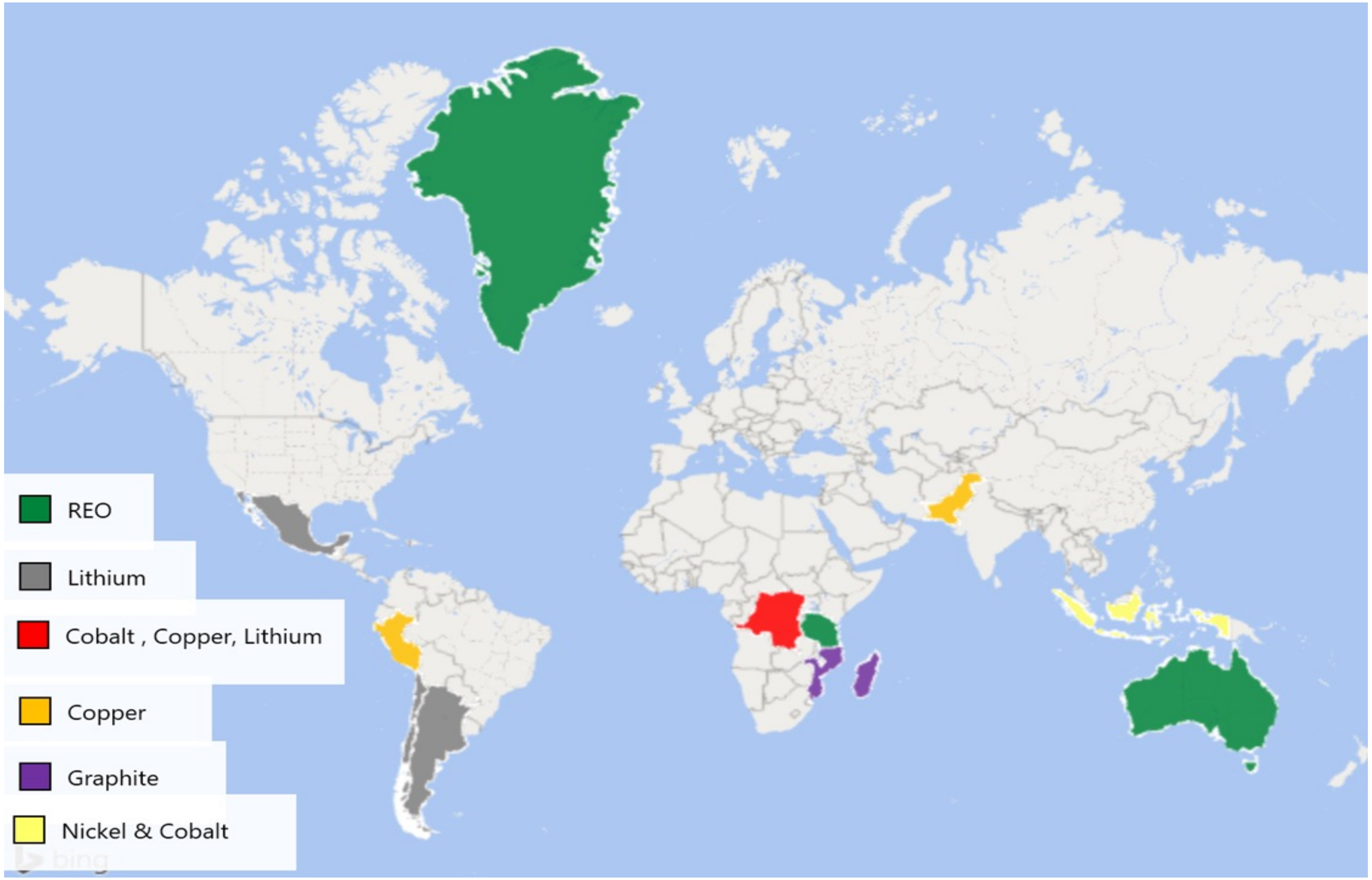
China's role in new mining projects globally is increasing

Chinese companies have been taking a very active role investing or committing to resources in other countries to secure future volumes



Chinese companies are investing in several key mining projects globally in each of the critical minerals.

- <u>Lithium (5):</u>
  - *Argentina, (2) Chile, DRC-Congo & Mexico*
- <u>Nickel (4):</u>
  - *(4) Indonesia (mining & processing)*
- <u>Cobalt (5):</u>
  - *(4) DRC-Congo and (1) Indonesia*
- <u>Graphite (4):</u>
  - *(2) Mozambique & (2) Madagascar*
- <u>Copper (4):</u>
  - *(2) DRC-Congo, Pakistan, Peru*
- <u>Rare Earth/REO (4):</u>
  - *(2) Australia, Tanzania & Greenland*

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**Source: PlusMining, Inc. and Martec analysis.*

Lack of Investment in US Mining Industry

The US has abundant resources but restrictions and a lack of an efficient regulatory framework to support mining investment is a deterrent

US mining restrictions pose a severe threat to a secure supply chain for critical minerals.

- Martec's findings show the US has one of the longest permit approval application processes, especially compared to countries such as China, Australia, Chile, and Canada
  - *Can take 50% to 2 times longer in US from exploration to discovery and development before you get to actual commercial production out of a mine*
  - *Findings show it takes approximately 10 – 20+ years for a mine site to become commercially operational in the US*
- US does not have the regulatory framework in place to attract investment in exploration and discovery of mineral deposits as compared to other nations globally
  - *Requires both federal and local level approval processes*
  - *Individual state authoritative framework creates inconsistencies thus longer lead times/delays for approval process*
- US has an immense amount of geological potential, but the environmental regulations and community issues are perceived as big barriers in attracting mining companies to invest in the US
  - *Mining community views the US as favoring an approach to preserving its natural resources rather than exploiting their potential*

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Lack of Investment in US Mining Industry (*continued*)

Timeline can vary significantly from exploratory to actual commercial production for a mine*

Timeline can range from ~10 to 20+ years before production

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Time Range	~1 – 10+ years	~2 – 5 years	~2 – 7 years	~10 – 40 years	~2 – 10+ years
Avg. Time by Stage	~2 - 5 years	~3 – 5 years	~2 – 3 years	~20 years	3 – 5+ years
Comments	• China and Australia 1 – 3 years • US 5 – 10+ years • Many times, started by smaller companies and then acquired later	• China, Australia and Canada have more expedited processes • US process varies by state and legal challenges	• 2 – 3 years is the norm unless legal challenges or unplanned issues arise • REO mines can take longer due to extraction & mkt. risk	• Some mines have gone beyond 50 years • Mining companies prefer not to design mine to be <10 years due to poor ROI	• Varying req. by country • If radioactive materials will be longer • China, Russia, SE Asia and South American countries tend to have lower standards
Key Steps by Stage	• Prospecting • Reconnaissance • Survey mapping • Sampling • Geochemical analysis • Resource estimation • Permitting	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation • Planning & investment • Final permitting	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase • Construction	• Ore extraction • Milling / Ore separation • Processing • Grade control • Waste rock/tailings & wastewater mgmt. • Near mine exploration • Expansion life of mine	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

**Note: Timing and cost will vary significantly by material and country/region globally.*

Lack of Investment in US Mining Industry *(continued)*

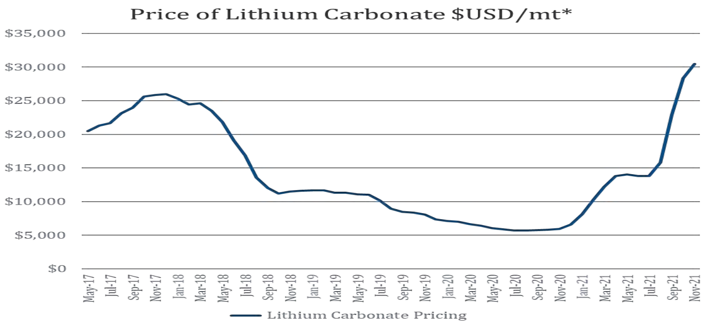
Future uncertainty of which chemistry or chemistries will be the wining solution over the long-term adds complexity to the investment decision process

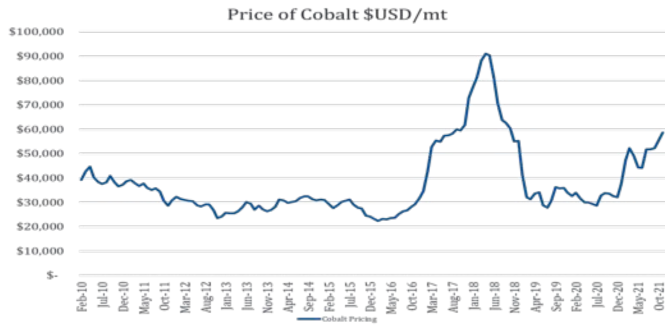
The mining and refining industry has concerns over making significant investments with capital when the auto industry has not fully committed to a chemistry, while historical delays in mining deposits continue to plague the US.

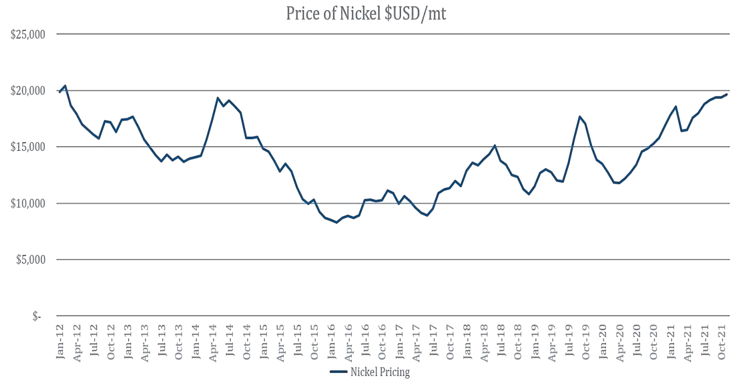
- 10+ battery chemistries exist today across the globe with a high mix of mineral variations (LFP, NCA, NCM) and some are still in R&D/pilot stage (Solid-State Lithium, Sodium-ion, Zinc-ion, etc.)
- Countless US deposits exist with activity to get approval, but several continue to have delays or stoppages ordered
- Investing in US mineral deposits or mines makes it difficult to determine a reliable ROI and payback period for the mining and financial/lending community

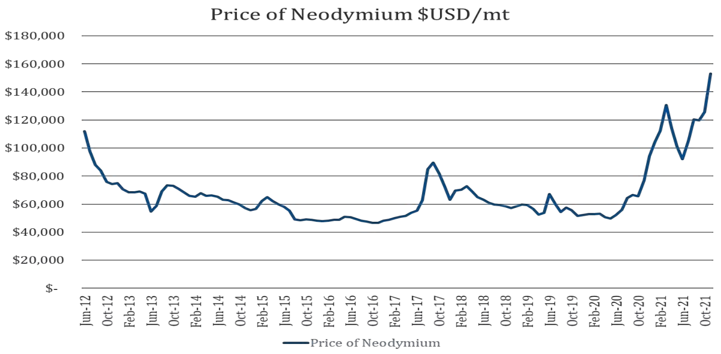
Mineral Pricing Trends Overview

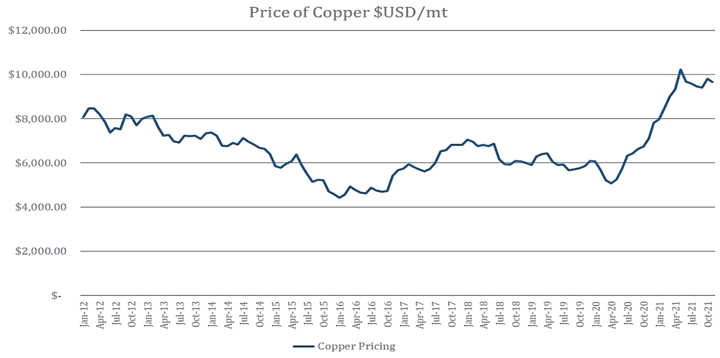
Pricing pressure on the mineral market is already occurring over the last 12 months

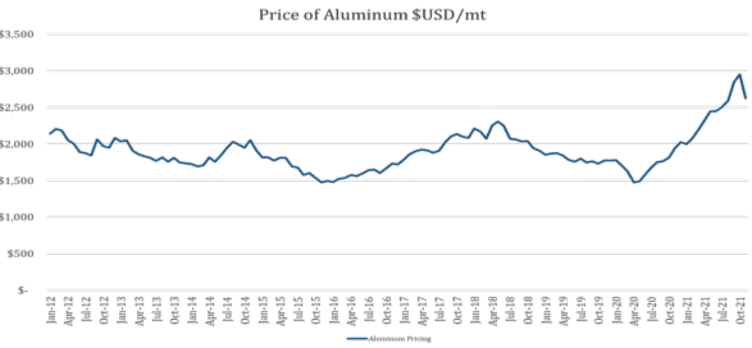












Price Change over Last 12 Months:

Mineral	% Price Increase over last 12 Months*
Lithium Carbonate	414%
Nickel	24%
Cobalt	80%
REE – Neodymium (Nd)	99%
Copper	36%
Aluminum	35%

**Note: % price increases are reflective of the date period from November 2020 to November 2021.*

The increase in demand for the critical minerals necessary for battery production could put upward pressure on the price of materials for electric vehicles—which could ultimately be transferred to consumers. Over the past year, the price of each key mineral has experienced significant increases with lithium carbonate leading the way at greater than 4 times the price it was 12 months ago.

**Note: Lithium carbonate is the underlying raw material of lithium hydroxide which is utilized in EV batteries.*

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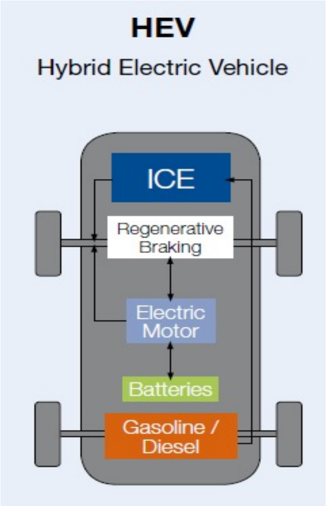
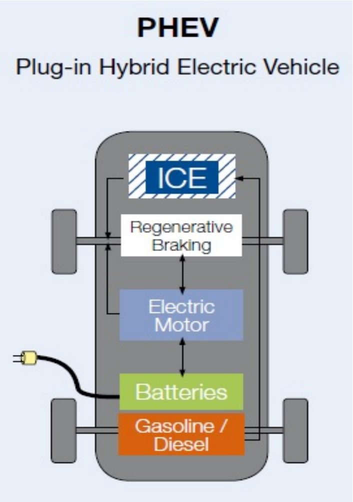
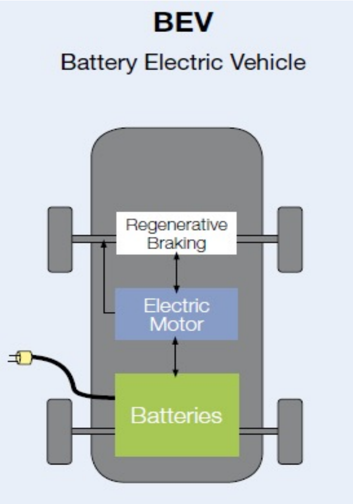
BEV materials supply chain assessment

MATERIALS MODEL & FORECASTS

Automotive BEV Supply Chain Analysis Project Definitions & Descriptions

Different Types of Electrified Vehicles

Explanation of the types of electrified vehicles included in the analysis

	HEV *(Full Hybrids)*	PHEV *(Plug-in Hybrids)*	BEV *(Battery Electric Vehicles)*
Vehicle Types *(included in analysis)*			
Definition	Full hybrids are capable of travelling (really) short distances on electric power only. The hybrid system cuts the ICE in & out as required, reducing fuel consumption where possible and providing more power when required	Plug-in hybrid runs primarily using its electric motor, powered by the battery. A plug-in hybrid won't tap into the ICE until the battery runs out of power	A battery electric vehicle (BEV), pure electric vehicle, exclusively uses energy stored in rechargeable battery packs, with no secondary source of propulsion
Global kWh Power Range	0.6 – 2.4 kWh	6 – 38 kWh	30 – 180 kWh
Global Avg. kWh	~1.2 kWh	~12 kWh	~60 kWh

Source: EPA Population and Activity of On-road Vehicles in MOVES2014 EPA-420-D-15-001, Martec Analysis

Battery Chemistry Types – Li Battery Construction

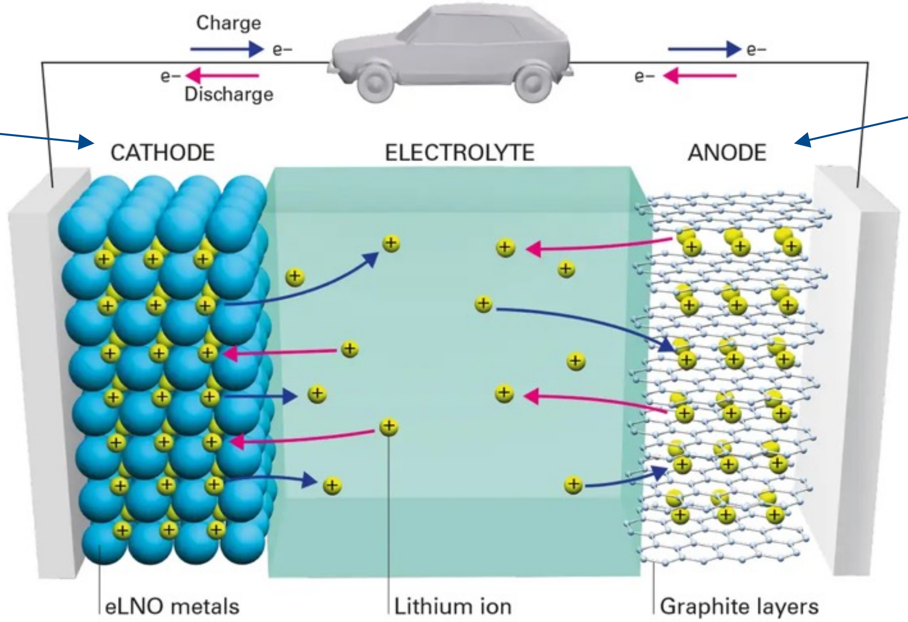
Explanation of the different types of battery chemistry

Below is a description of the different materials in a Li-Ion battery for the Cathode & Anode:

Cathode Materials:

Cathode materials are dependent on Li battery type in the crystal structure forming a multi-metal oxide material to which lithium is added:

- LFP: Lithium, Iron, Phosphate
- NCM/NCA: Nickel, Cobalt, Manganese (or Aluminum)



Anode Materials:

The anode (or negative electrode) in Lithium-ion battery is typically made up of Graphite, coated on Copper Foil

- Graphite, Copper and some Silicon

Source: DOIO: 10.1016/j.ssi.2017.12.023 (photo).

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Battery Chemistry Types

Explanation of the different types of battery chemistry acronyms

Lithium-ion batteries contain a lithium-metal oxide with a mix of other minerals.

- Other minerals utilized on the cathode besides Lithium are commonly Nickel, Manganese, and Cobalt
- Cobalt is primarily utilized as a stabilizer
- Trend is to move away from reliance on the scarce and more expensive materials such as Cobalt and move more towards higher-grade Nickel concentrations.

Multiple Lithium-ion chemistries have been developed and are being utilized to-date or will be introduced in the very near future to increase/optimize efficiencies in vehicle range & charge time, reduce reliance on multiple key materials and/or reduce cost.

- Ultra-low Cobalt Li-ion batteries, Solid-State Lithium, and Sodium-Ion are primary examples of technologies with significant activity

The mix of other key minerals besides Lithium utilized in the cathode are described in a ratio of mass.

- Examples of this would be NCM-523, NCM-622, and NCM-811
- Each number after Nickel-Cobalt-Manganese are representative of the mix ratio of those three materials combined

NCM-523:

- Ni = 0.521 kg (50%) = 5
- Co = 0.210 kg (20%) = 2
- Mn = 0.293 kg (30%) = 3

NCM-622:

- Ni = 0.547 kg (60%) = 6
- Co = 0.183 kg (20%) = 2
- Mn = 0.171 kg (20%) = 2

NCM-811:

- Ni = 0.665 kg (80%) = 8
- Co = 0.083 kg (10%) = 1
- Mn = 0.078 kg (10%) = 1

Battery Chemistry Types *(continued)*

Positives & Negatives by Technology

Battery Acronym	Full Name/Cathode	Vehicle Range	Charge Time	Cost	Other Comments
Na-Ion	Sodium-Ion	– –	–	+ +	• CATL (leading Li battery mfr. in China) recently announced plans to commercially introduce first Na-Ion battery for automotive applications • Allows ability to hedge against potential future shortages in Li availability or cost • Sodium more plentiful • Questions with reliability & durability
LFP	Lithium-Iron-Potassium	–	–	+ +	• Slight safety advantage over NCA/NCM • Challenges with both vehicle range & charge time • Currently lowest cost technology at commercial scale
NCM	Li-Nickel-Cobalt-Manganese	O	O	O	• Currently most common technology for BEV batteries • Superior range & charge time over LFP • Most common configuration NCM523 and NCM622
NCA/ NCM811 & NCM955	LI-Nickel-Cobalt-Aluminum/ Li-Nickel-Low Cobalt-Manganese	+	+	+	• Tesla phasing out NCA technology and moving toward ultra-low Cobalt NCM955 • Helps reduce reliance on Cobalt but increases need for high grade Nickel
Solid-State	Solid-State Lithium	+ +	+ +	+ or ++	• Not in commercial-scale production for LD automotive applications • Cold temp. performance challenges • Superior vehicle range & reduced charge time • Eliminates usage of Cobalt & Nickel • Potential to be lower cost solution

Automotive Battery Equivalents

Putting the scale of automotive battery demand in context

iPhone 13 - 12.4Wh

iPad (9th Gen) - 32.4Wh

MacBook Pro 14 - 70Wh

Tesla Model 3/Y – 75,000Wh

Why is this important?

One Tesla Model Y/3 with a 75kWh battery is roughly equivalent to:

- ~6,000 cellphones
- ~2,300 tablets
- ~1,100 laptops

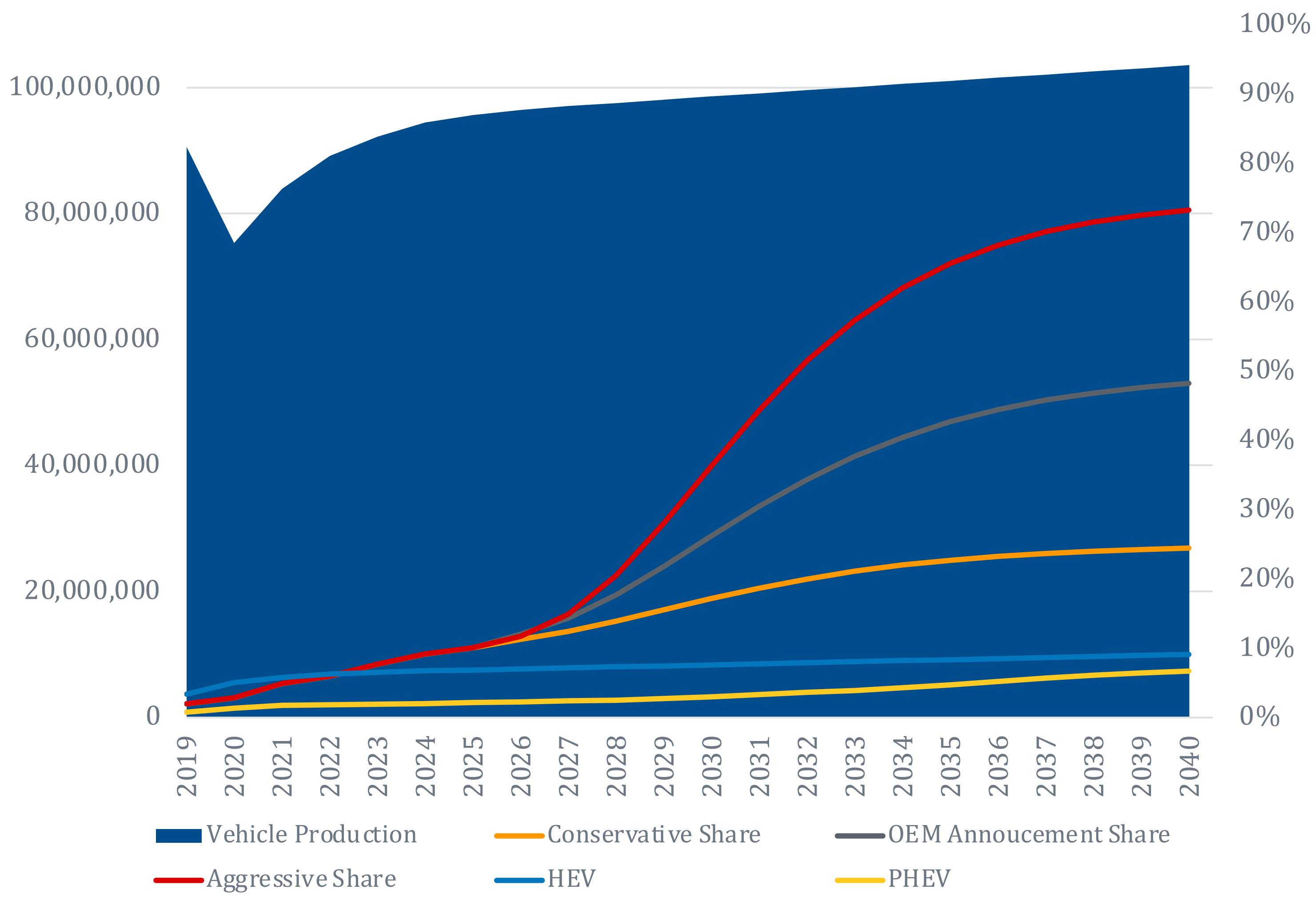
Given the total annual sales for these battery-operated devices globally (1.5B cellphones, 164M tablets, 277M laptops) the total material demand is roughly equivalent to 575,000 Tesla Model 3/Y vehicles.

- For point of reference, the 2020 sales for all Tesla vehicles was ~500,000
- Tesla is nearly at the same level of battery material demand as the entire mobile electronics industry today

Global Automotive Production & Forecast

Global LD Auto xEV Production Forecast*

Primary Scenarios



Source: Martec Analysis

Scenario Logic:

- All scenarios follow expected vehicle OEM launch programs through 2025 as these programs are already in scheduled production plans.

Conservative

- Global demand peak of ~25% by 2040

OEM Announcements

- Follows announcements of all global OEM's expectations for EV penetration
- Global demand peak of ~50% by 2040

Aggressive

- Rapid acceptance of BEVs in all markets during the next 2-3 vehicle cycles
- Global demand peak of ~75% by 2040

PHEV

- Consistent forecast for each scenario (same %)
- Optional OEM compliance solution

HEV

- Full Hybrids will continue to be an alternative in electrification, but growth will be limited due to push towards BEVs

**Note: Forecast is inclusive of both residential & commercial fleet for LD automotive vehicles (passenger cars, SUVs and LD trucks). Excludes MD & HD vehicles.*

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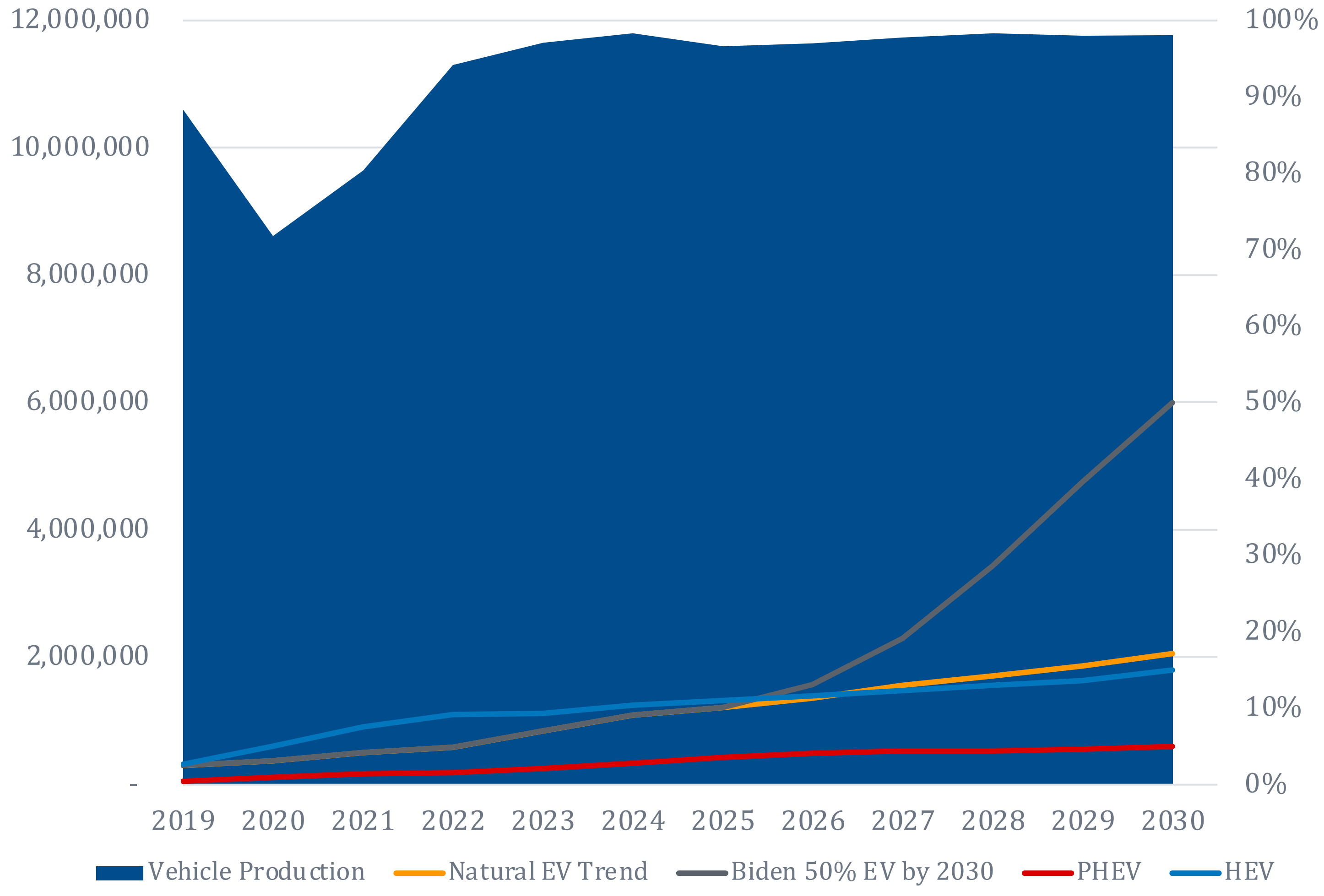
US-Only LD Auto xEV Production Forecast*

Primary Scenarios



Source: Martec Analysis
**Note: Forecast is inclusive of both residential & commercial fleet for LD automotive vehicles (passenger cars, SUVs and LD trucks). Excludes MD & HD vehicles.*

Scenario Logic:

- All scenarios follow expected vehicle OEM launch programs through 2025 as these programs are already in scheduled production plans.

Natural EV Introduction

- Peak of ~17% by 2030

Biden 50% EV by 2030

- Market adoption consistent with Biden administration target of 50% EV penetration by 2030

PHEV and HEV

- PHEV and HEV introductions consistent in both scenarios (no change)
- Optional OEM compliance solution favored by some OEMs in the market
  - *Provides an alternative solution in order to meet potential different compliance standards*

US vehicle production was used in this analysis to support the labor analysis and US material demand scenarios. Sales values include imported vehicles that leverage production of vehicles and batteries from ex-US countries.

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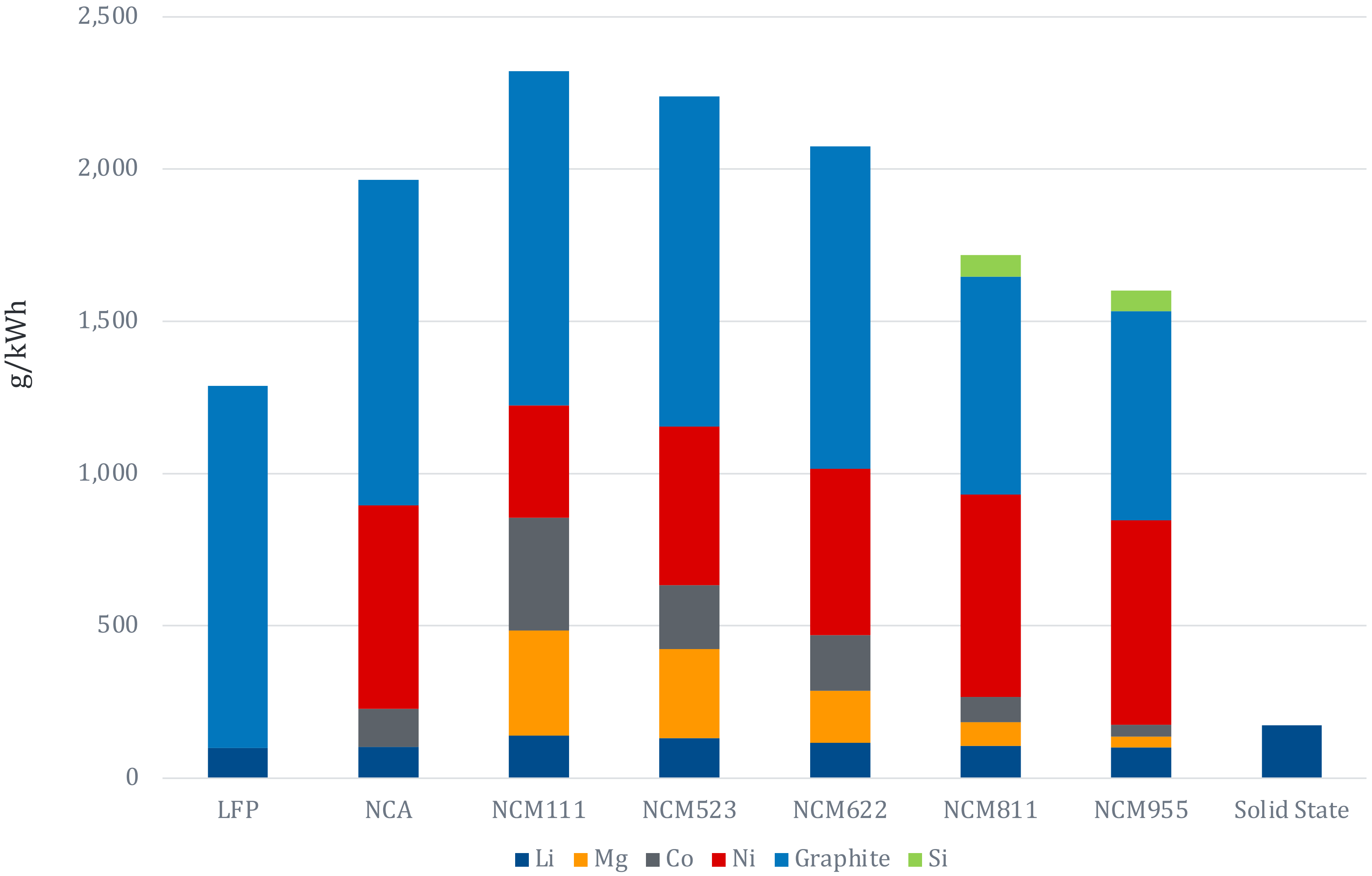
Electrified Vehicle Battery Technologies Overview

Key Battery Material Content (g/kWh)

Target Battery Chemistries

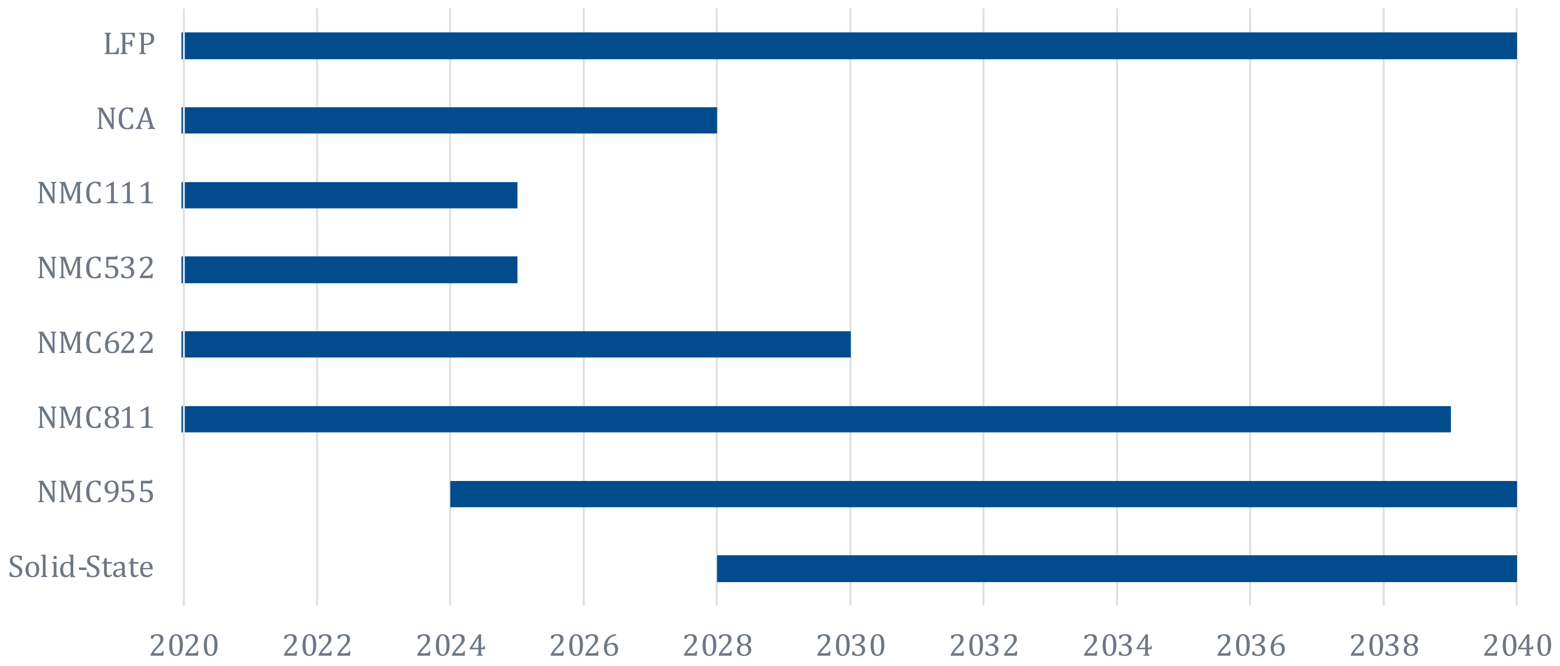


- Battery manufacturers are focusing on reducing the amount of cobalt in their batteries with each new chemistry
  - *Cobalt is the largest cost driver of battery cathodes*
- Automakers and battery manufacturers are quickly moving to NCM batteries with 811 and 955 formulations
  - *Lower cost than other NCM chemistries*
- LFP and Solid-state batteries have no nickel or cobalt in their cathodes
- Solid-state technology being targeted for its longer range and quicker charge time potential

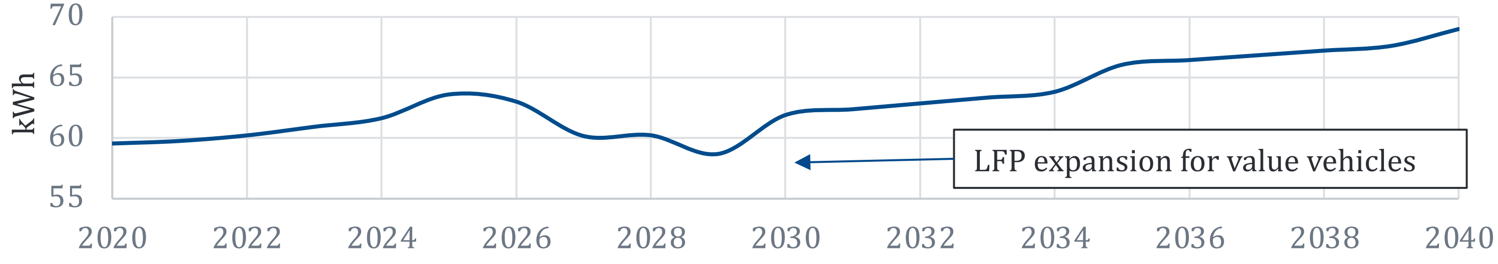
Sources: Institute of Environmental Sciences (CML), Leiden University, Roland Berger Analysis

Battery Chemistry Introduction Timeline

Major Available Chemistries



Global Average BEV Battery Pack Capacity (kWh)



- LFP is a low-cost battery solution for vehicles not requiring long range
  - *Smaller European and Chinese market vehicles*
  - *Tesla "low-cost" EV offering*
- NCA is a chemistry that is exclusive to Tesla/Panasonic
  - *This is being phased out so Tesla can align more with the global chemistry solutions*
- NMC 111 and 532 are already phasing out of production
  - *622 not far behind*
- NMC 811 and 955 are the current benchmarks for performance and cost
  - *Lower cobalt usage means lower cost, higher nickel means more energy*
- Solid-state is still in development and is expected for LD automotive production in the next 6 – 7 years
- Drop in avg. kWh power density will be driven by growth of LFP in low-cost vehicle applications primarily in China

Source: Martec Analysis

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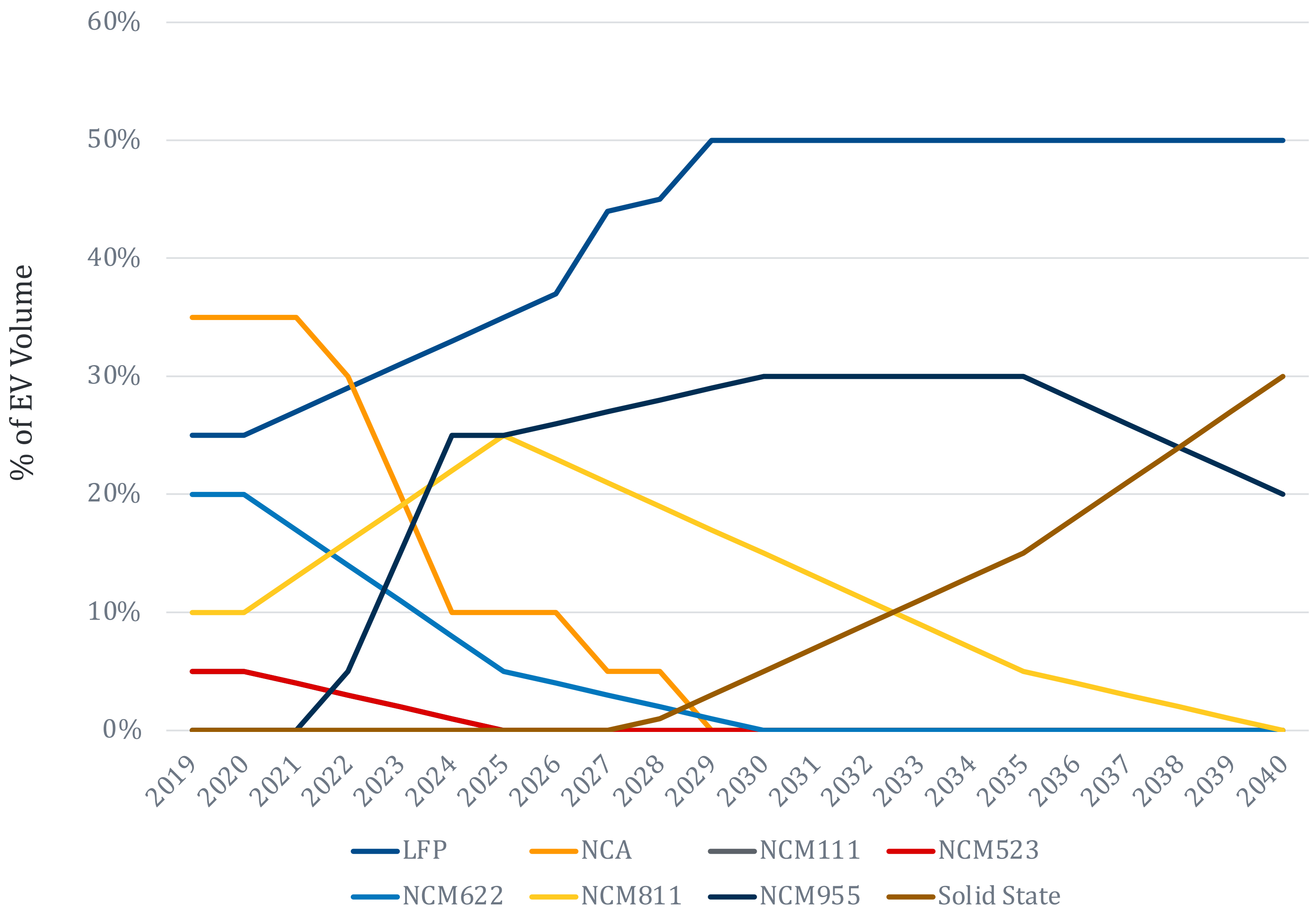
Share of BEV Battery Chemistry Mix

Global Automotive Forecast 2019 – 2040(F)*



- Long-term LD auto battery trends:
  - *LFP for value*
  - *Solid-state for premium powertrain offering (longer range & shorter charge time)*
- NCM 111, 523, and 622 chemistries are short-lived
  - *NCM 811 and 955 chemistries have lower cell costs and higher performance*
- Tesla moving away from NCA batteries
  - *NCM 955 for 4680 cells*
- Solid-state future is assumed to begin ~2028
  - *Many companies active with this solution*
  - *Limitations in real-world performance, dealing with cold climates and commercial scale processing still a challenge*
- Solid-state batteries have very low raw material usage compared to other solutions
  - *Best cost/performance characteristics of all known battery chemistries*

**Note: Martec forecast based on proprietary Martec research and analysis.*

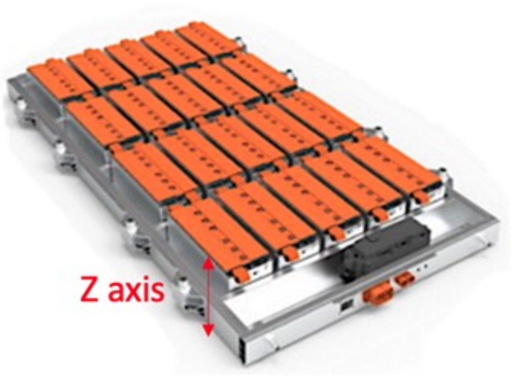
Source: Martec Analysis

Cell-to-Pack Overview & Impact

Shift from modular battery pack design to cell-to-pack

- Current EVs typically use a battery pack structure that is built on modules
  - *These modules can be arranged to fit the space and capacity requirements for several different vehicles*
- The cell-to-pack concept removes the modules to increase the number of cells packaged in a specific volume
  - *This packaging does not impact the chemistry or efficiency of the individual cells*
  - *Allows for more cells to be placed within a given space by eliminating area needed for module walls/packaging, thus increasing available space*
- Cell-to-pack packaging gives OEMs the choice of increasing energy storage on the vehicle or maintaining existing storage with less space & weight
  - *Cell-to-pack could allow easier recycling with less packaging & rigor in processing*
- BYD implies a 50% increase in energy storage possibility while Tesla claims a possible 14% increase in their 2020 Battery Day presentation

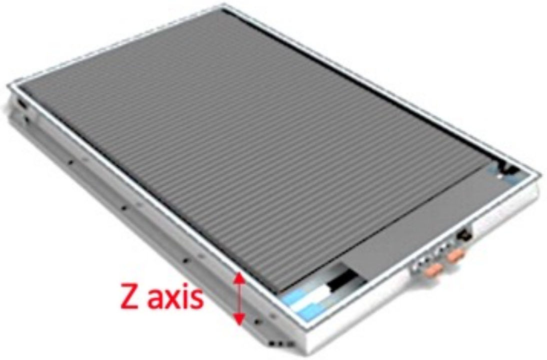
Modular Pack Design:



Low space utilization (~40% VCTP)

Battery pack with modules

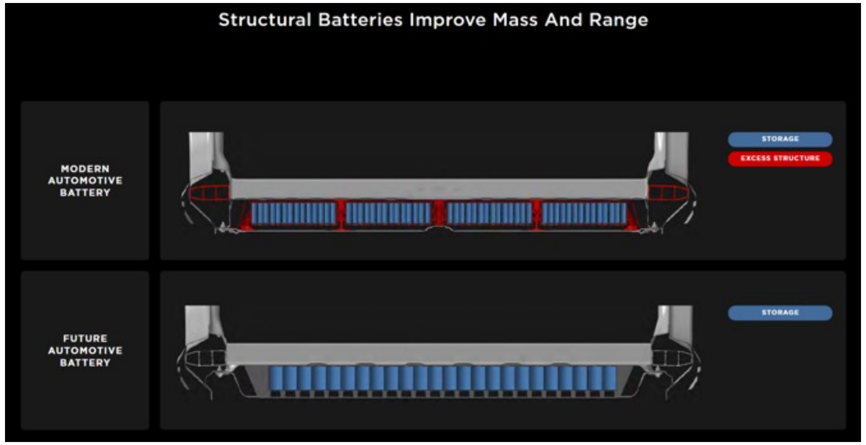
Cell-to-Pack Design:



High space utilization (~60% VCTP)

Blade Battery without modules

Source: BYD

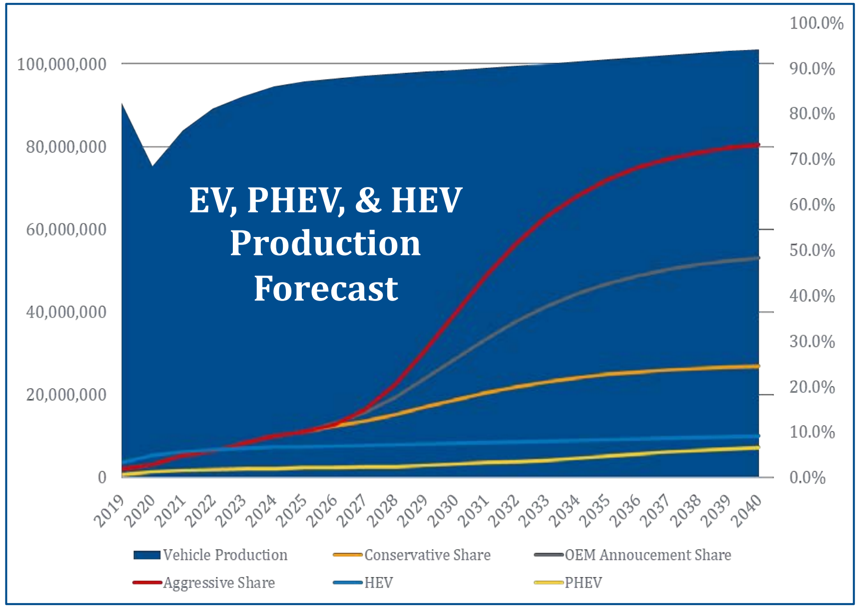


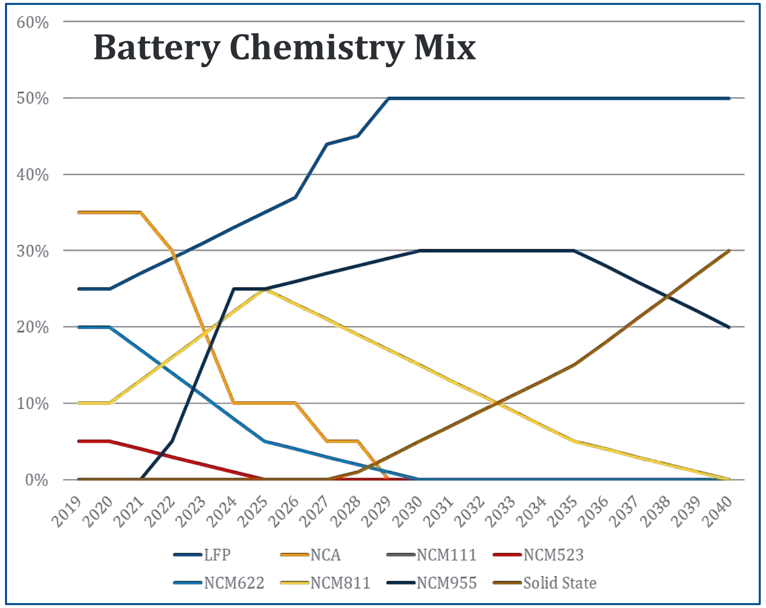
Source: Tesla

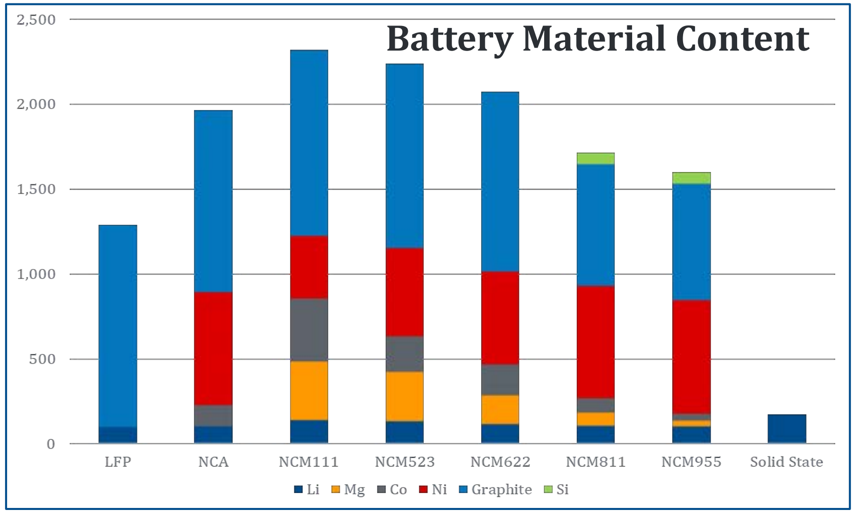
Electrified Vehicle Materials Demand - Global vs. US-Only -

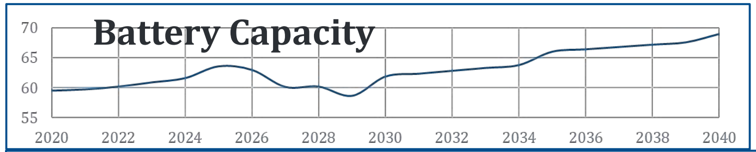
Material Demand Model

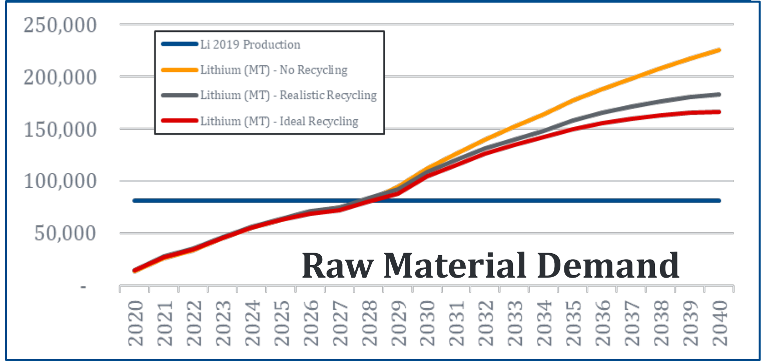
Step-by-Step Methodology











- Starting with the PHEV and EV production values for each scenario to set the topline demand for vehicles
- Next is the chemistry mix changes over time to account for chemistry improvements, new technology developments and technology phase-outs
- Then the materials segmented by chemistry
  - ➢ *Showing the critical cathode materials but also evaluating the effect of wire, magnets, and case materials as well*
- The capacity for the battery on a per vehicle basis – changing over time as new classes of vehicles are electrified
- Finally, all of these factors are added together to get to the raw material demand for each targeted resource on a global basis
  - ➢ *After this is completed, we then look at the recyclability of batteries to determine the net impact on raw material demand.*
  - ➢ *Is the scenario possible given the level of raw material production and expansion rate?*

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Recycling Model

Step-by-Step Methodology

- Retirement rate based on EPA's assessment of the US market (MOVES Survival Rate)
  - *This yields the potential recyclable battery volume*
- Martec is using USA as an average vehicle age (12 Years*) which is in the middle compared to other key areas (China ~14.5 years** and Europe ~10.7 years***)
- Each year's volume is treated separately to account for the different battery chemistries produced in that specific year
- A recycling efficiency multiplier is then applied to account for the losses in the recycling process
  - *Realistic recycling capability of 50% to 75% of raw material recoverability and ideal 100% recycling capability are modeled separately*
- These results are then subtracted from the new demand values to create the net impact to the raw material demand

Table 7-2 MOVES survival rate by age and HPMS class

Age	Motorcycles	Light-Duty Vehicles: Passenger Cars	Light-Duty Vehicles: Passenger Trucks Light Comm. Trucks	Buses	Single Unit Trucks	Combination Trucks
0	1.000	0.997	0.991	1.000	1.000	1.000
1	0.979	0.997	0.991	1.000	1.000	1.000
2	0.940	0.997	0.991	1.000	1.000	1.000
3	0.940	0.993	0.986	1.000	1.000	1.000
4	0.940	0.990	0.981	0.990	0.990	0.990
5	0.940	0.986	0.976	0.980	0.980	0.980
6	0.940	0.981	0.970	0.980	0.980	0.980
7	0.940	0.976	0.964	0.970	0.970	0.970
8	0.940	0.971	0.958	0.970	0.970	0.970
9	0.940	0.965	0.952	0.970	0.970	0.970
10	0.940	0.959	0.946	0.960	0.960	0.960
11	0.940	0.953	0.940	0.960	0.960	0.960
12	0.940	0.912	0.935	0.950	0.950	0.950
13	0.940	0.854	0.929	0.950	0.950	0.950
14	0.940	0.832	0.913	0.950	0.950	0.950
15	0.940	0.813	0.908	0.940	0.940	0.940
16	0.940	0.799	0.903	0.940	0.940	0.940
17	0.940	0.787	0.898	0.930	0.930	0.930
18	0.940	0.779	0.894	0.930	0.930	0.930
19	0.940	0.772	0.891	0.920	0.920	0.920
20	0.940	0.767	0.888	0.920	0.920	0.920
21	0.940	0.763	0.885	0.920	0.920	0.920
22	0.940	0.760	0.883	0.910	0.910	0.910
23	0.940	0.757	0.880	0.910	0.910	0.910
24	0.940	0.757	0.879	0.910	0.910	0.910
25	0.940	0.754	0.877	0.900	0.900	0.900
26	0.940	0.754	0.875	0.900	0.900	0.900
27	0.940	0.567	0.875	0.900	0.900	0.900
28	0.940	0.752	0.873	0.890	0.890	0.890
29	0.940	0.752	0.872	0.890	0.890	0.890
30	0.300	0.300	0.300	0.300	0.300	0.300

	Retirement Year							
Production Year	2019	2020	2021	2022	2023	2024	2025	2026
2019	12,706	12,615	12,524	20,550	27,813	35,249	43,875	51,820
2020		15,459	15,348	15,237	25,003	33,840	42,887	53,382
2021			29,551	29,339	29,127	47,795	64,687	81,981
2022				37,974	37,701	37,429	61,417	83,125
2023					50,699	50,334	49,971	81,997
2024						62,168	61,721	61,276
2025							69,258	68,760
2026								78,355
2027								
2028								
2029								
2030								
2031								
2032								
2033								
2034								
2035								
2036								
2037								
2038								
2039								
2040								
Total	**12,706**	**28,074**	**57,423**	**103,100**	**170,343**	**266,814**	**393,816**	**560,696**

Net Demand	2019	2020	2021	2022	2023	2024
Li Ion	11,725,599	14,783,290	27,618,318	35,097,701	46,427,292	56,486,089
Li Metal	-	-	-	-	-	-
Ni	57,948,346	73,517,163	138,789,789	178,478,839	239,614,002	295,734,079
Co	13,706,989	17,285,739	30,801,486	35,279,518	38,997,792	38,071,153
Mn	7,526,631	9,248,303	15,572,538	18,391,674	23,501,069	27,602,876
Al	138,134,311	174,262,719	327,847,353	418,080,424	552,795,786	672,283,572
Cu	86,728,739	109,448,969	206,219,346	264,178,964	352,033,106	431,450,073
Graphite	112,833,958	142,580,681	265,196,596	327,235,261	408,803,741	467,966,502

**Note: Source – Bureau of Transportation Statistics "Average Age of Automobiles and Trucks in Operation in the United States."*

***Note: Source – SpringerLink – Vehicle survival patterns in China.*

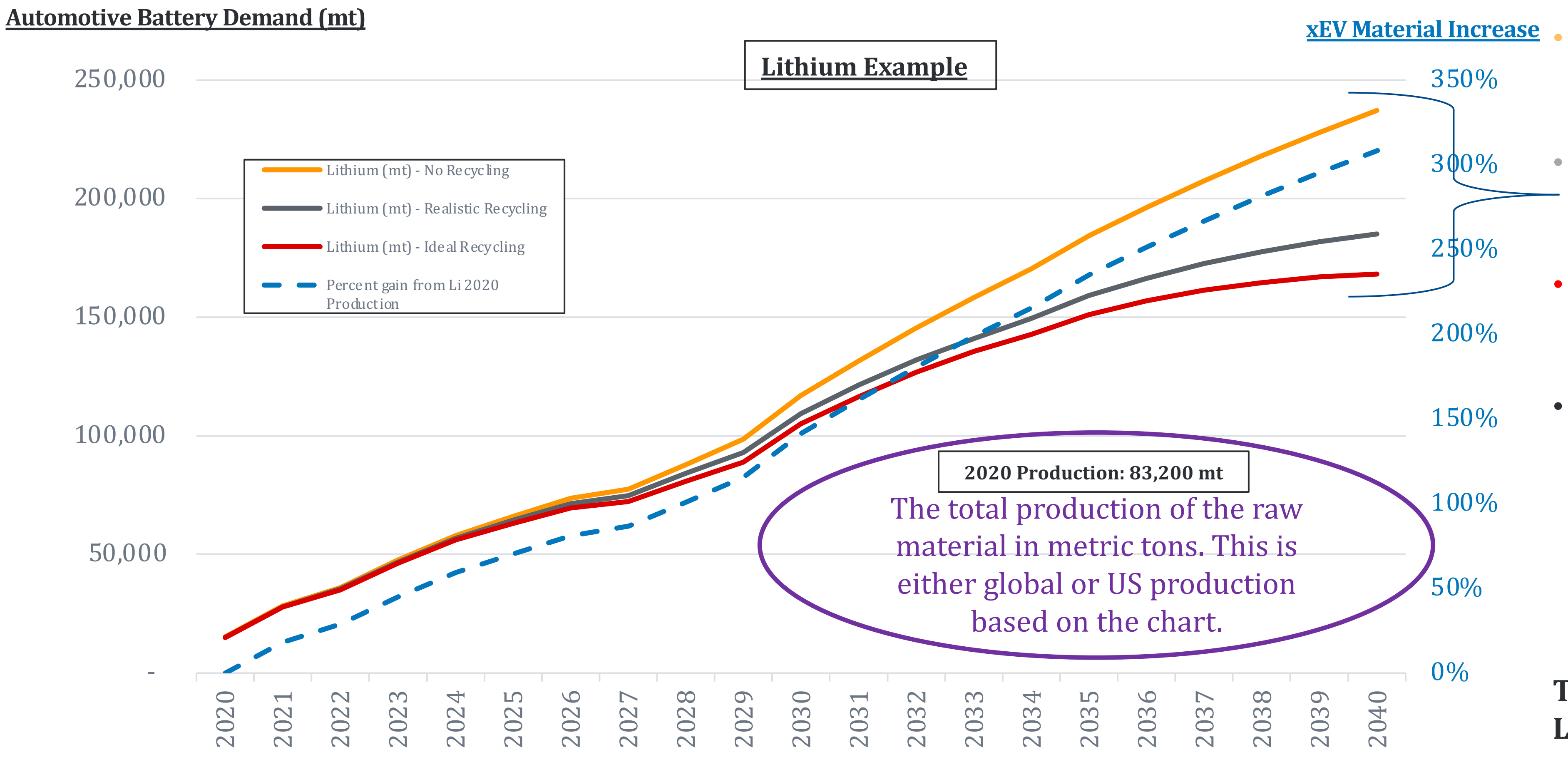
****Note: Source – Autoalan Tiedotuskeskus "Average age of passenger cars in European countries."*

Source: EPA Population and Activity of On-road Vehicles in MOVES2014 EPA-420-D-15-001 and Martec Analysis

Materials Demand
- *Conservative Global Scenario* -

Material Demand Chart Explained

Material Demand Global Scenario: X% BEV by 2040



Note: xEV = Industry term standing for electrified vehicles (BEV, HEV, and PHEV combined).

These lines are the model outputs for various scenarios:

- Orange line is if none of the materials are from recycled sources
- Gray line is if we assume a reasonable recycling rate of 50% - 70%
- Red line is if we assume that all of the material that can be recycled is returned to the market
- The dashed line (-----) is the increase in total production needed to supply the demand in the orange line assuming the current demand of the material for other uses is maintained

This example would indicate that Lithium would have to increase >300% (or 3 times) 2020 levels just to support automotive growth alone in Lithium.

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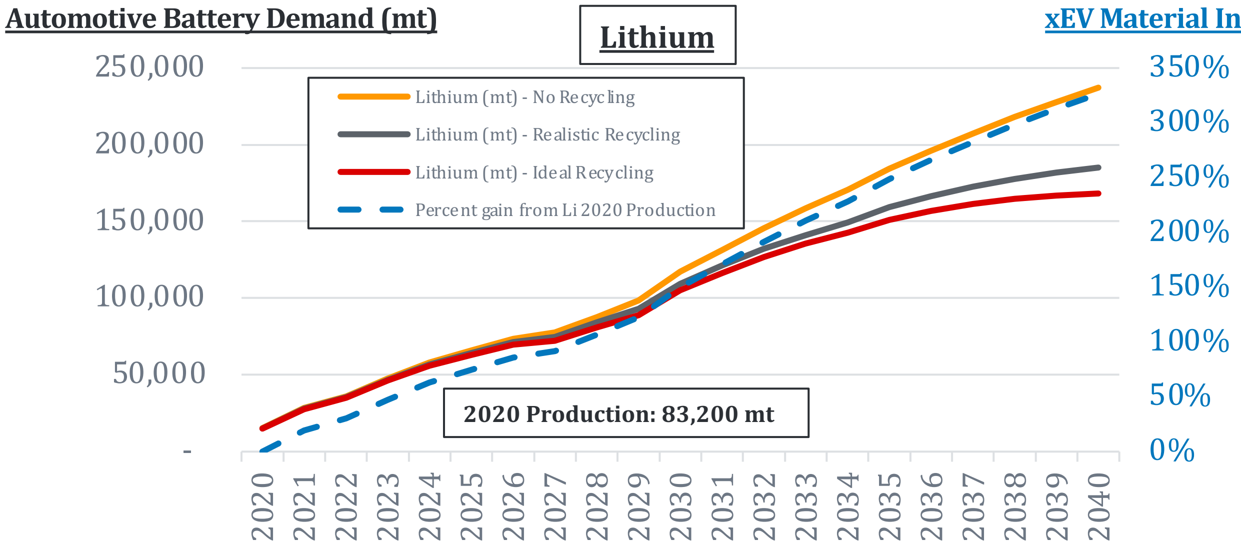
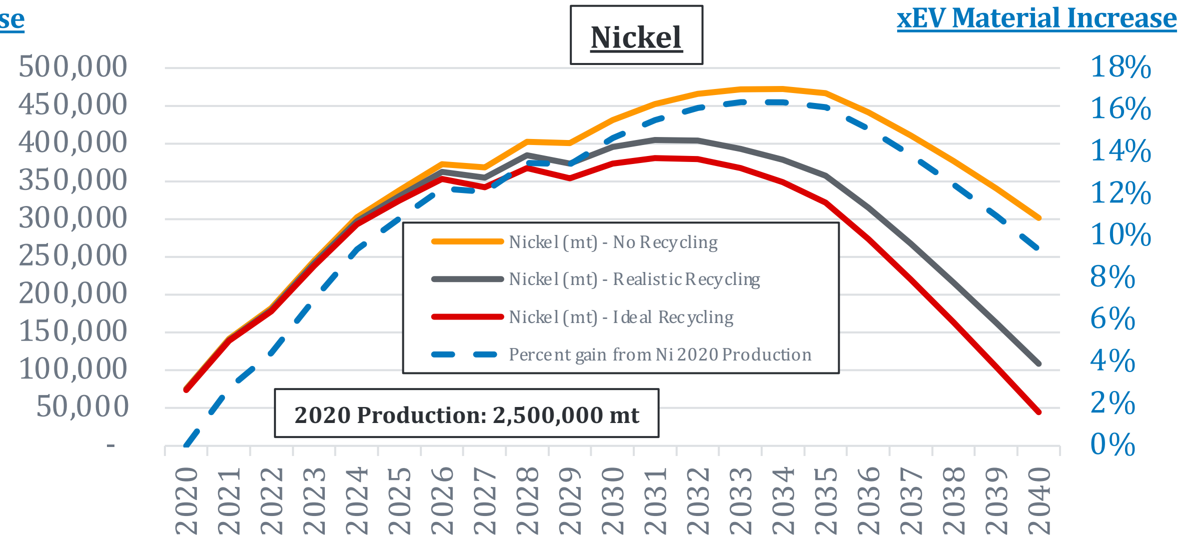
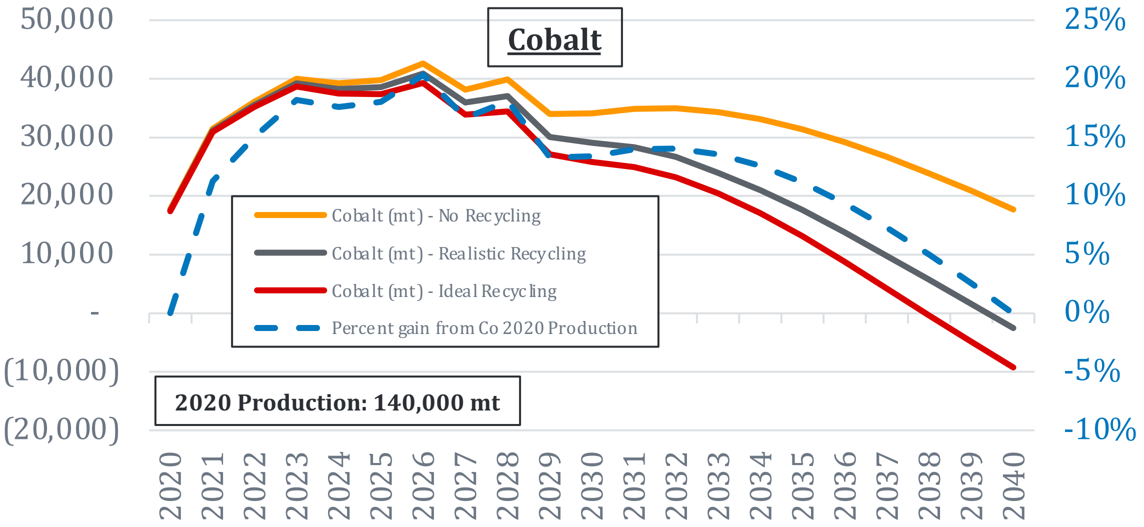
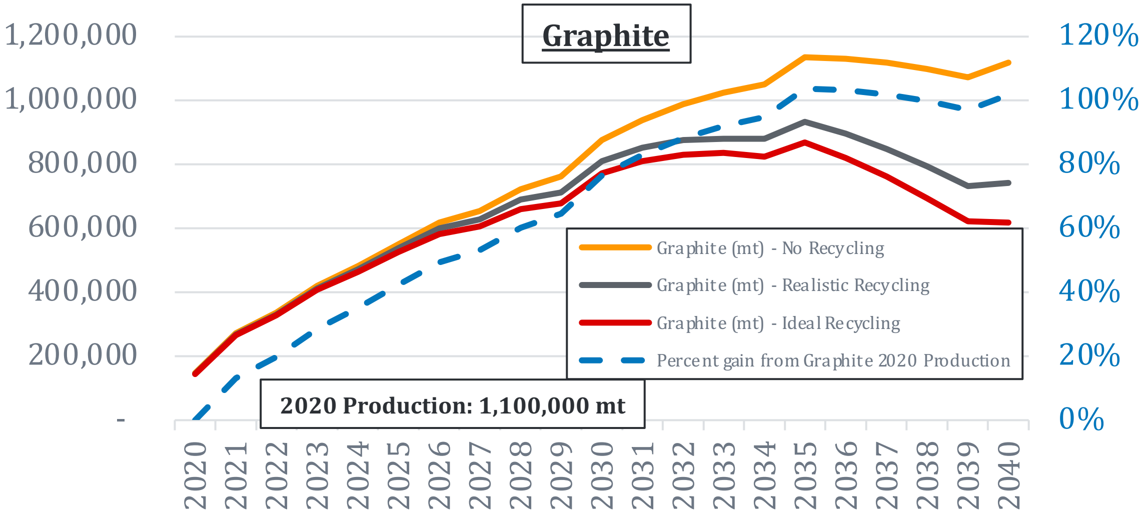
Material Demand for BEV, PHEV, & HEV: 2020 – 2040(F)

Conservative Global Scenario: ~25% BEV by 2040







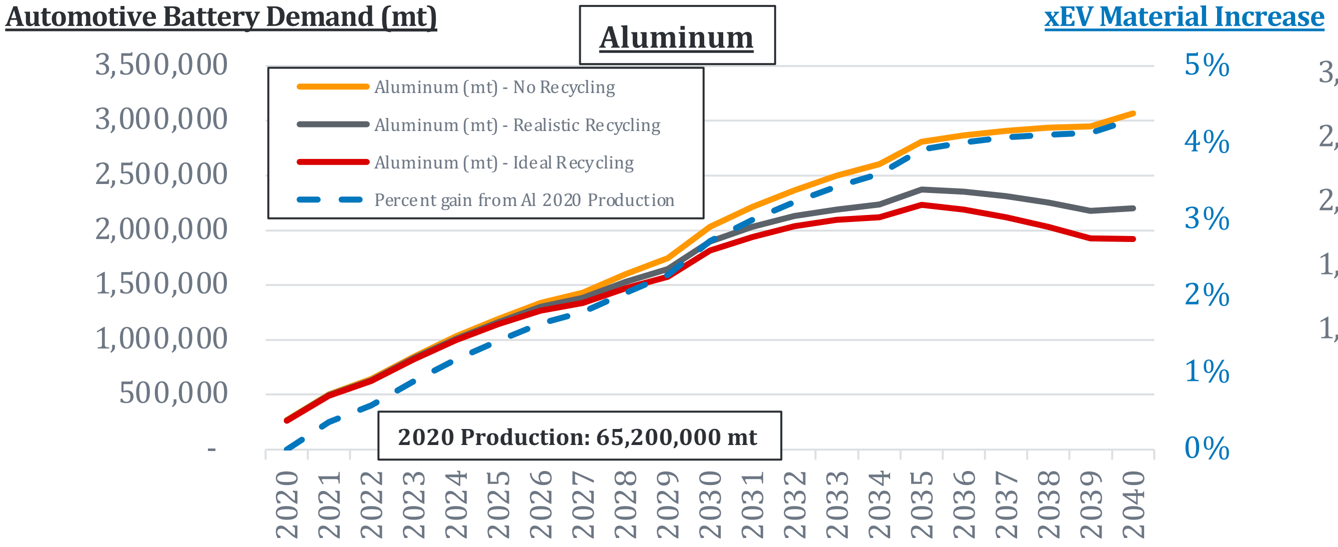


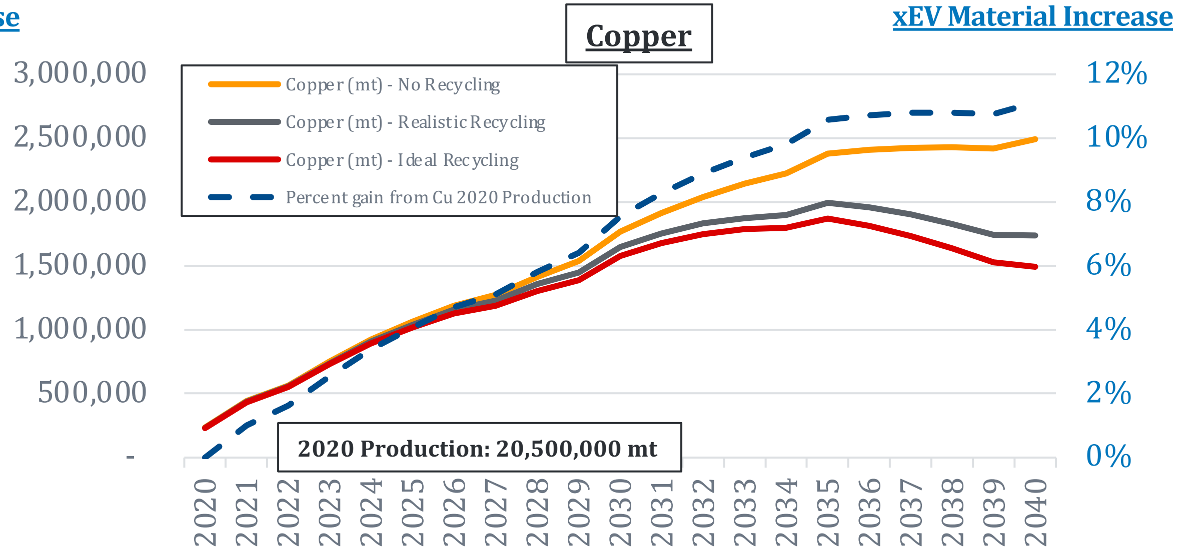
Note: 2020 production is higher than xEV Automotive Demand due to use in other end applications (e.g., building and construction, consumer electronics, etc.).

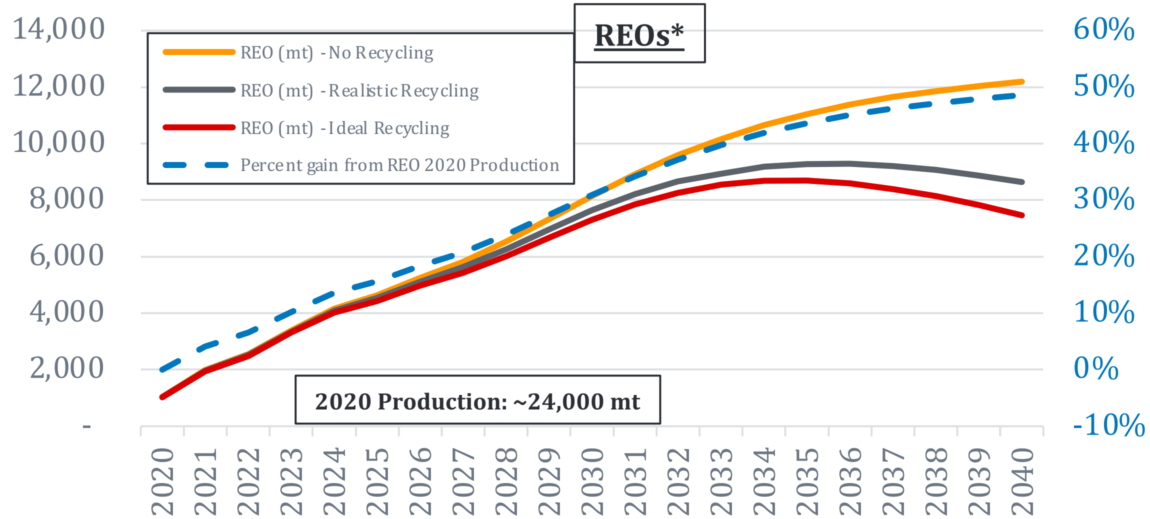
Source: Martec Analysis

Material Demand for BEV, PHEV, & HEV: 2020 – 2040(F)

Conservative Global Scenario: ~25% BEV by 2040







Note: *2020 production is higher than xEV Automotive Demand due to use in other end applications (e.g., building and construction, consumer electronics, etc.).*

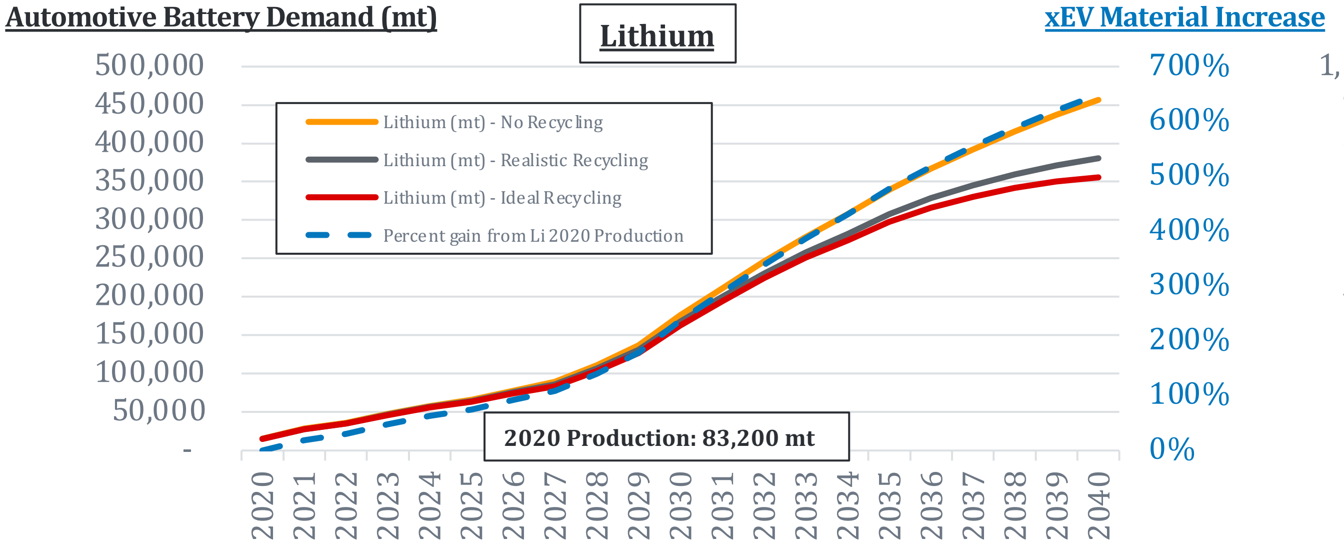
Source: Martec Analysis

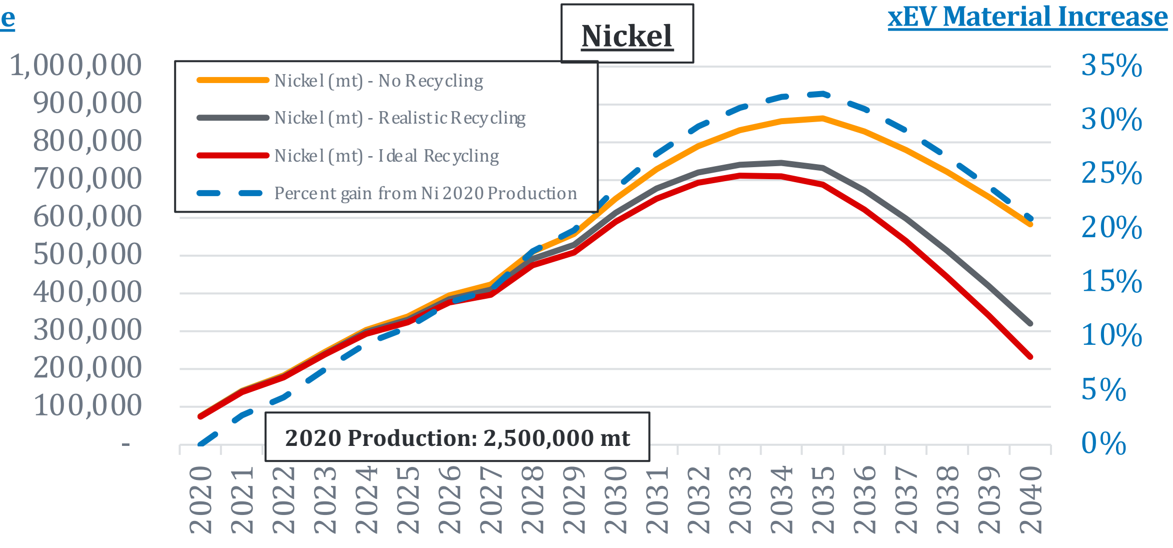
**Note: REOs are primarily utilized in xEV motors vs. batteries.*

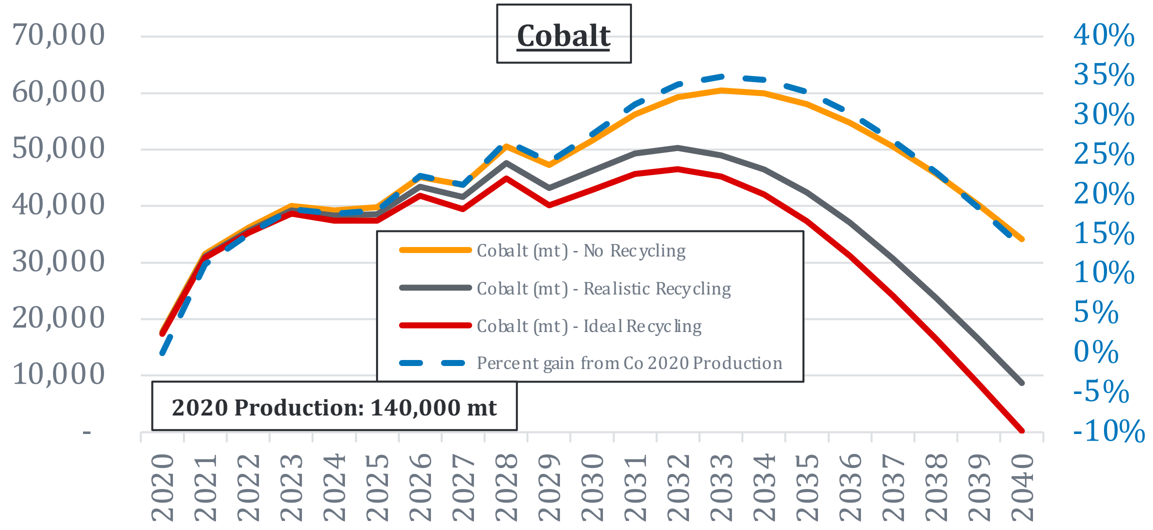
Materials Demand
- *OEM Announcements Global Scenario* -

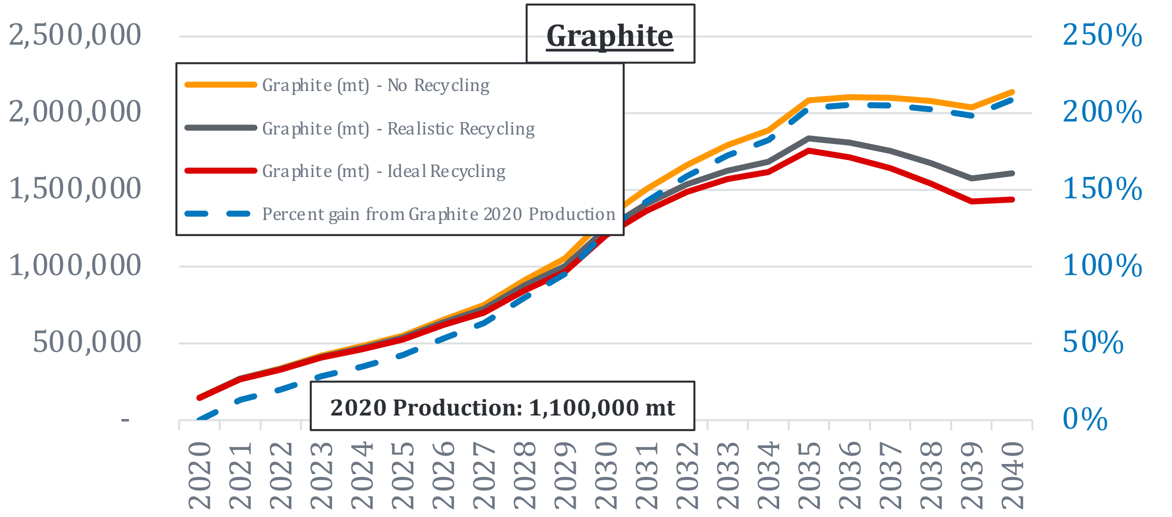
Material Demand for BEV, PHEV, & HEV: 2020 – 2040(F)

OEM Announcements Global Scenario: ~50% BEV by 2040







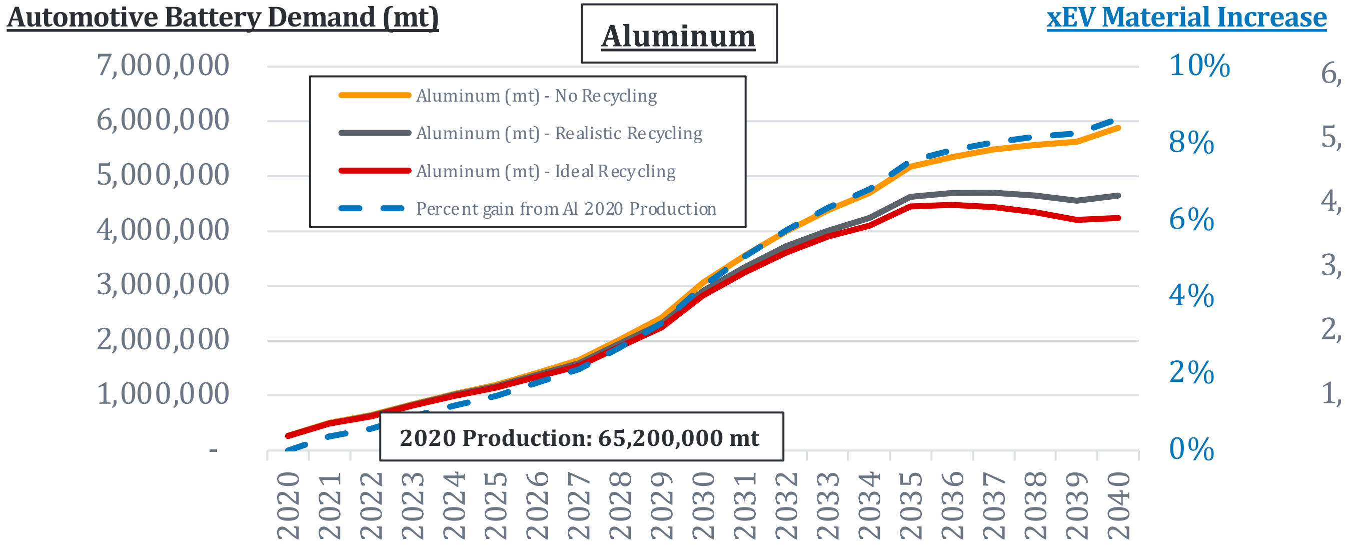


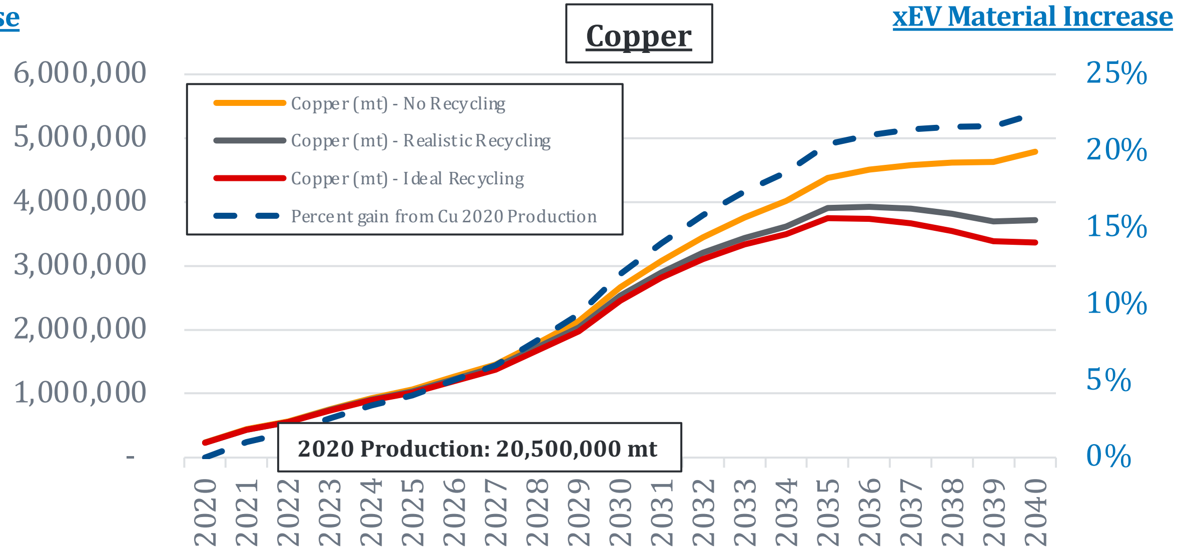
Source: Martec Analysis

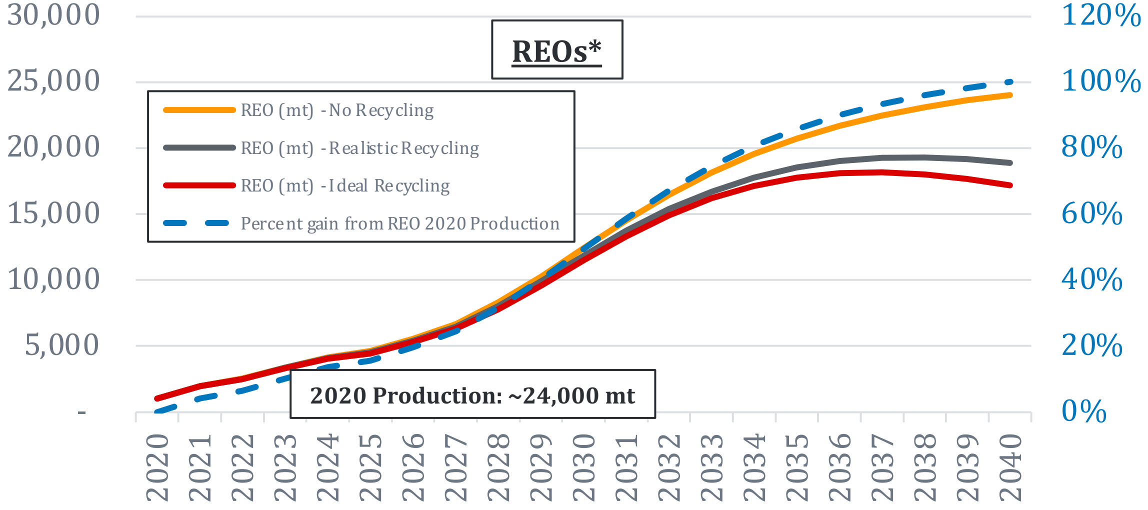
***Note:** 2020 production is higher than xEV Automotive Demand due to use in other end applications (e.g., building and construction, consumer electronics, etc.).*

Material Demand for BEV, PHEV, & HEV: 2020 – 2040(F)

OEM Announcements Global Scenario: ~50% BEV by 2040







Source: Martec Analysis

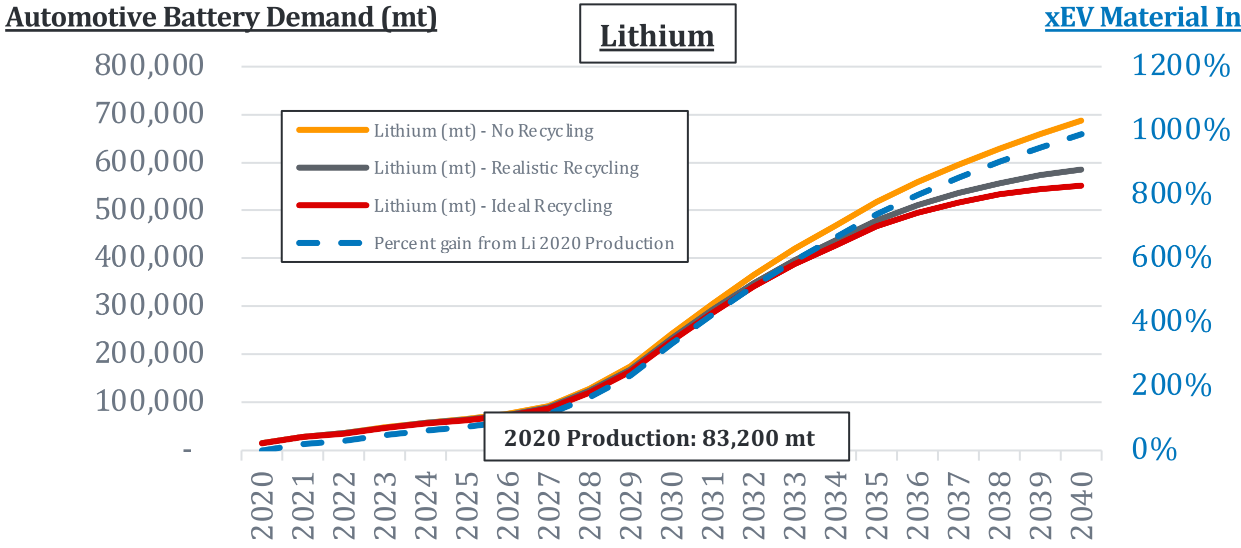
Note: *2020 production is higher than xEV Automotive Demand due to use in other end applications (e.g., building and construction, consumer electronics, etc.).*

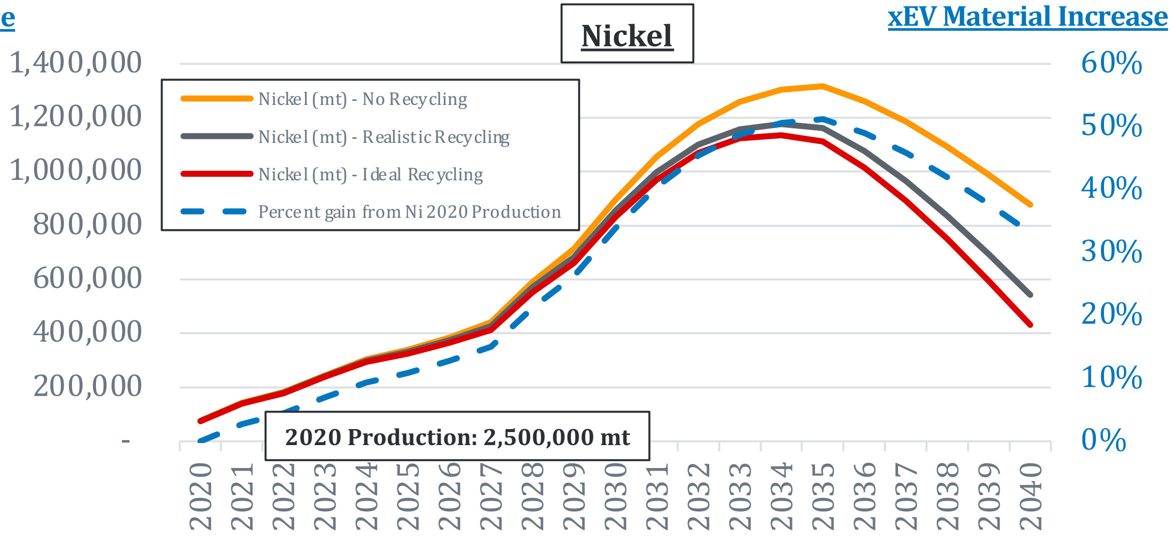
**Note: REOs are primarily utilized in xEV motors vs. batteries.*

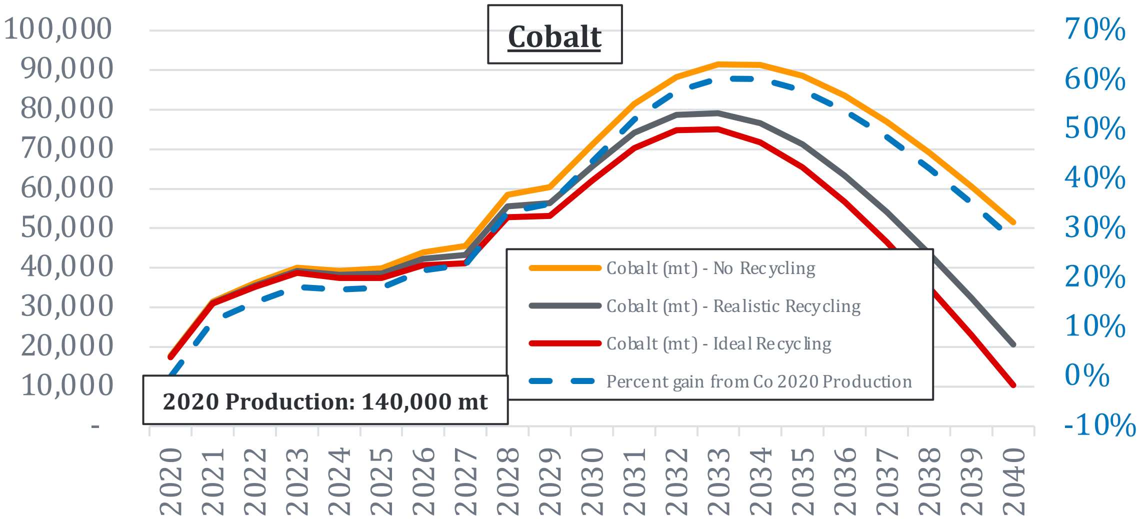
Materials Demand
- *Aggressive Global Scenario* -

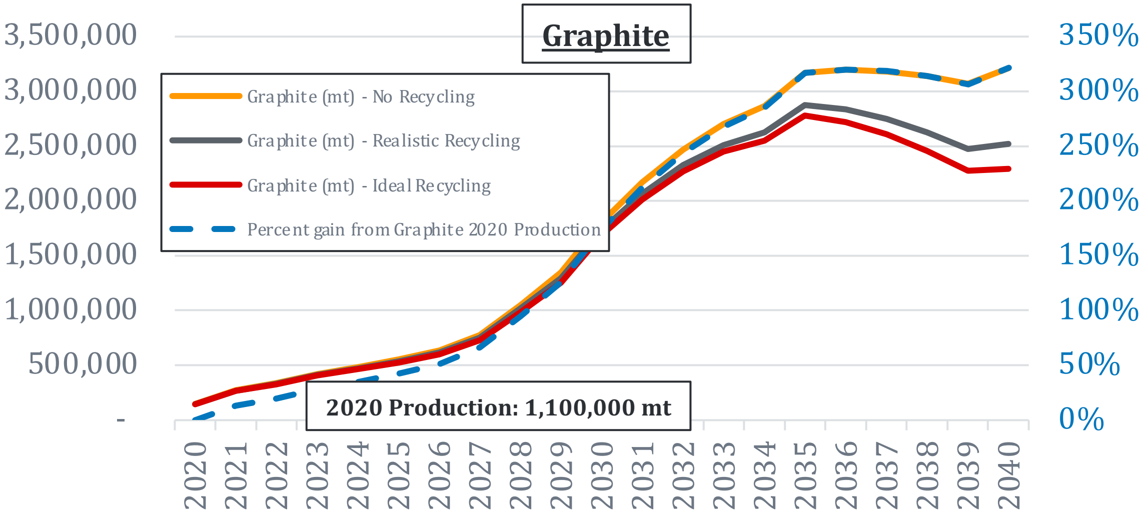
Material Demand for BEV, PHEV, & HEV: 2020 – 2040(F)

Aggressive Global Scenario: ~75% BEV by 2040









Source: Martec Analysis

***Note:** 2020 production is higher than xEV Automotive Demand due to use in other end applications (e.g., building and construction, consumer electronics, etc.).*

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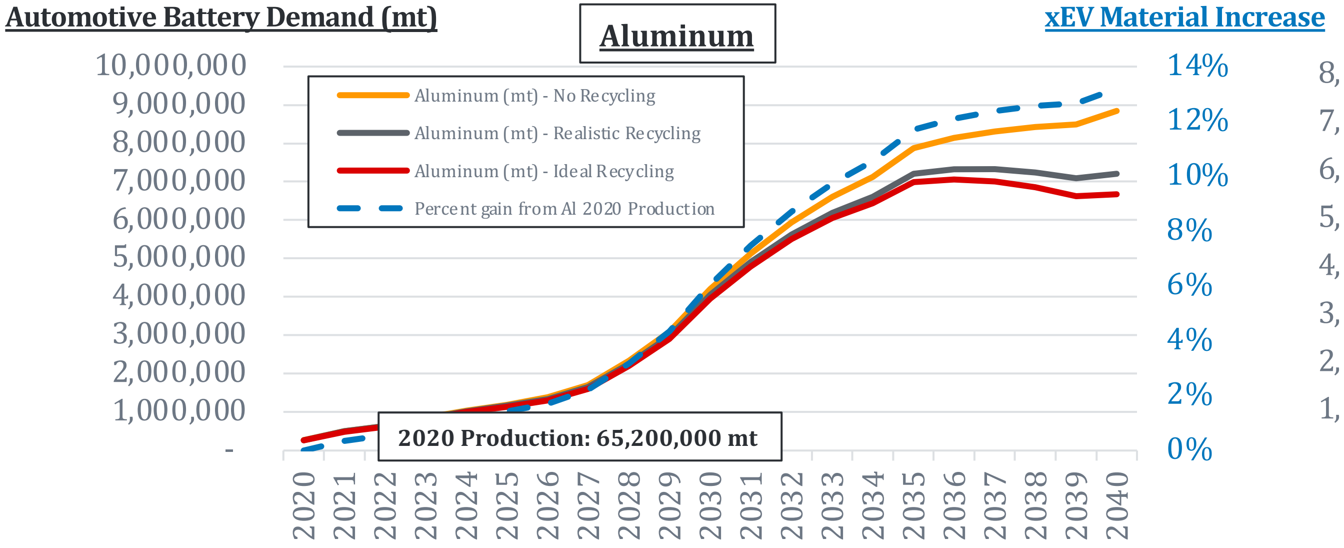
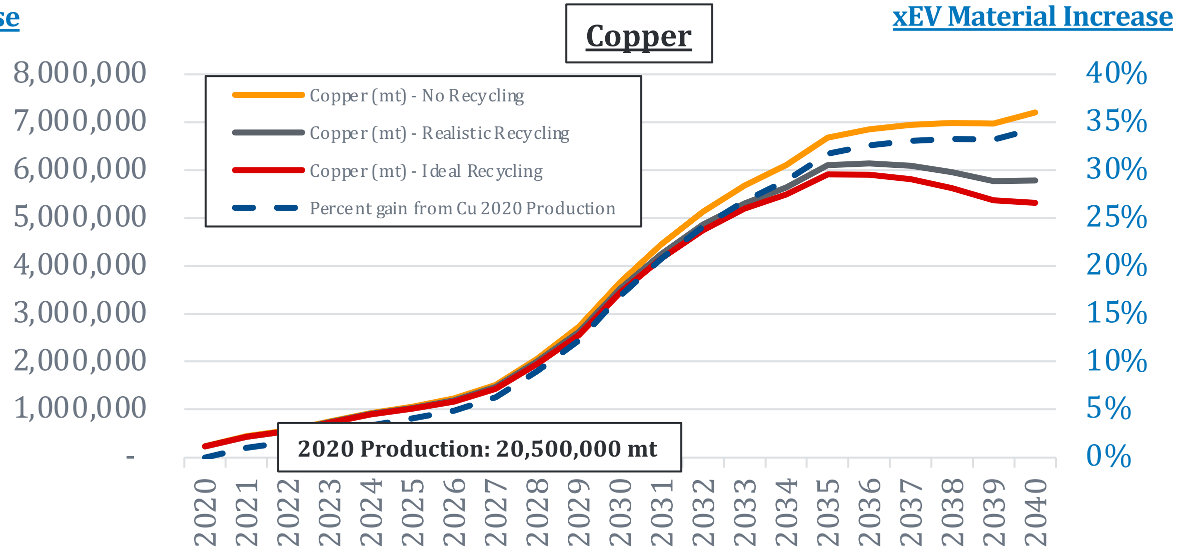
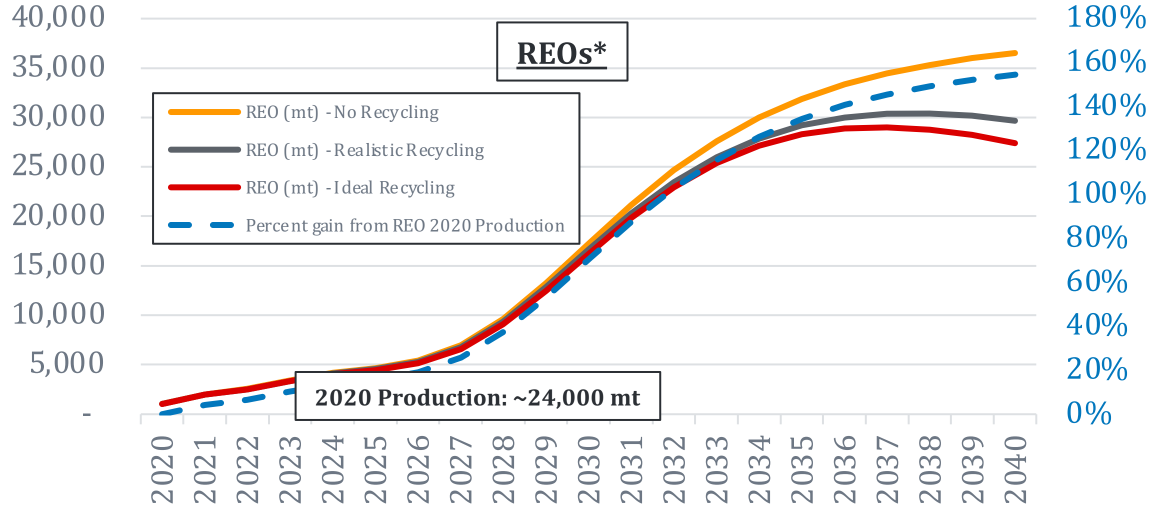
Material Demand for BEV, PHEV, & HEV: 2020 – 2040(F)

Aggressive Global Scenario: ~75% BEV by 2040







Source: Martec Analysis

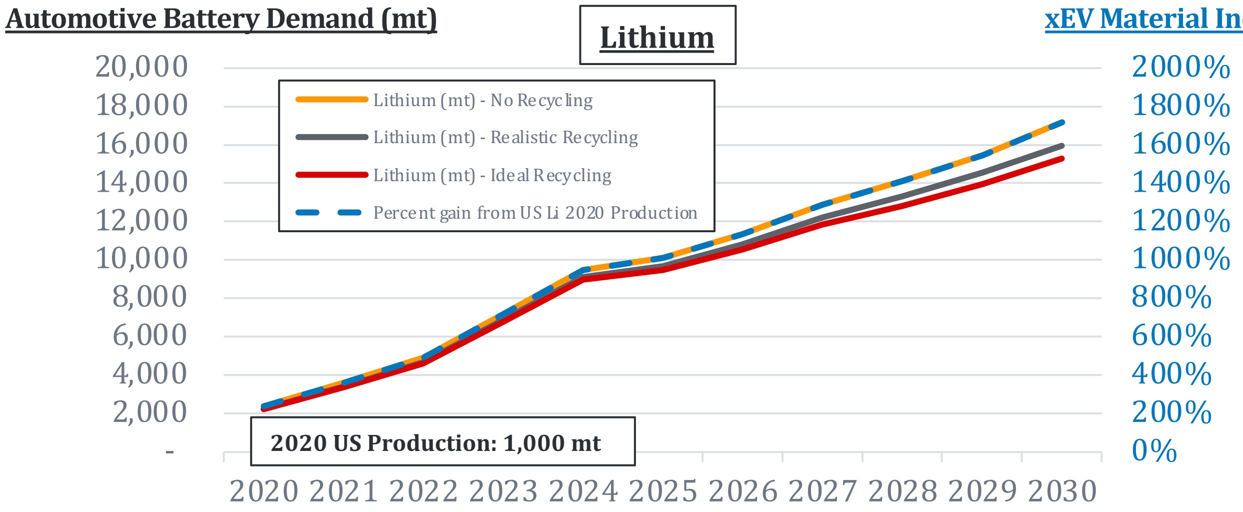
Note: *2020 production is higher than xEV Automotive Demand due to use in other end applications (e.g., building and construction, consumer electronics, etc.).*

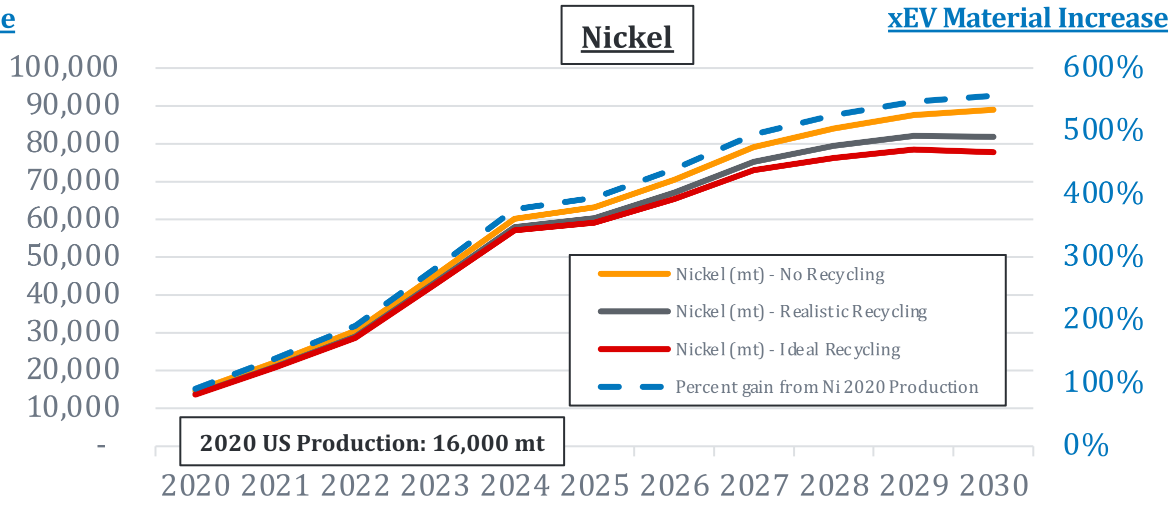
**Note: REOs are primarily utilized in xEV motors vs. batteries.*

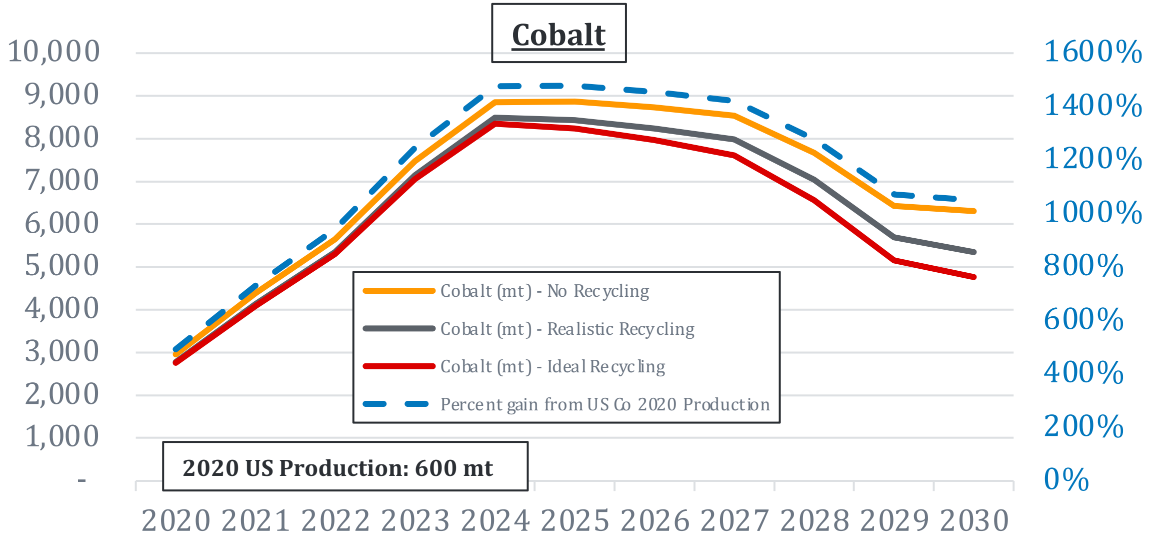
Materials Demand
- US-Only Natural EV Progression Scenario -

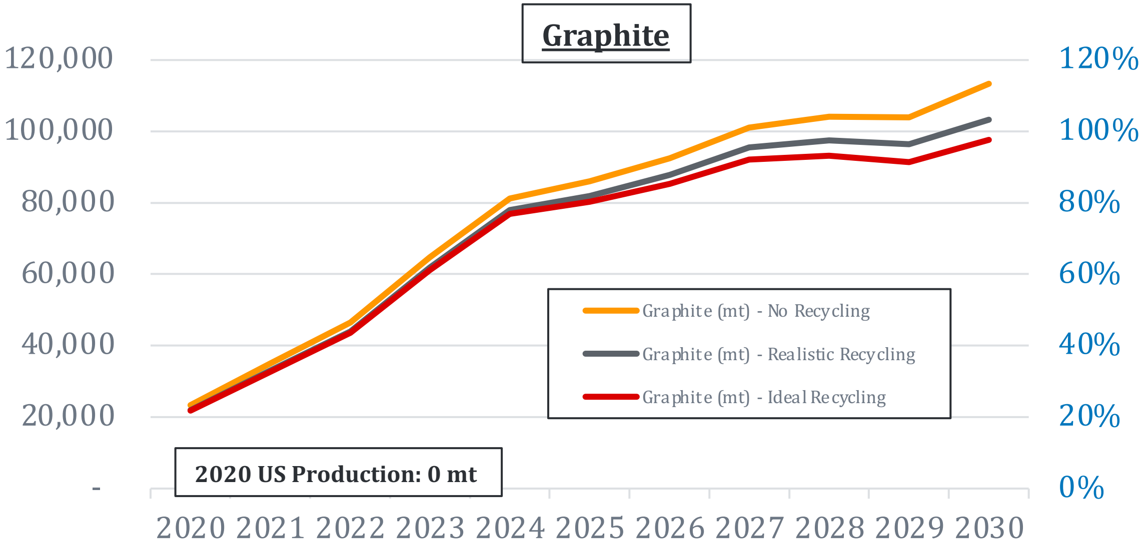
Material Demand for BEV, PHEV, & HEV: 2020 – 2030(F)

US-Only Natural EV Progression Scenario: ~17% BEV by 2030





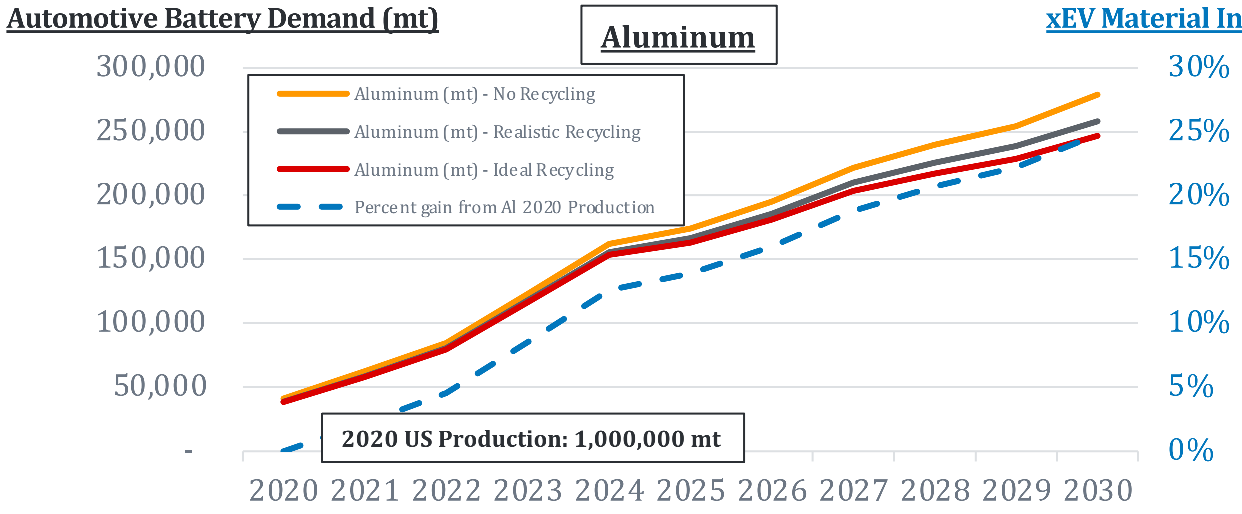


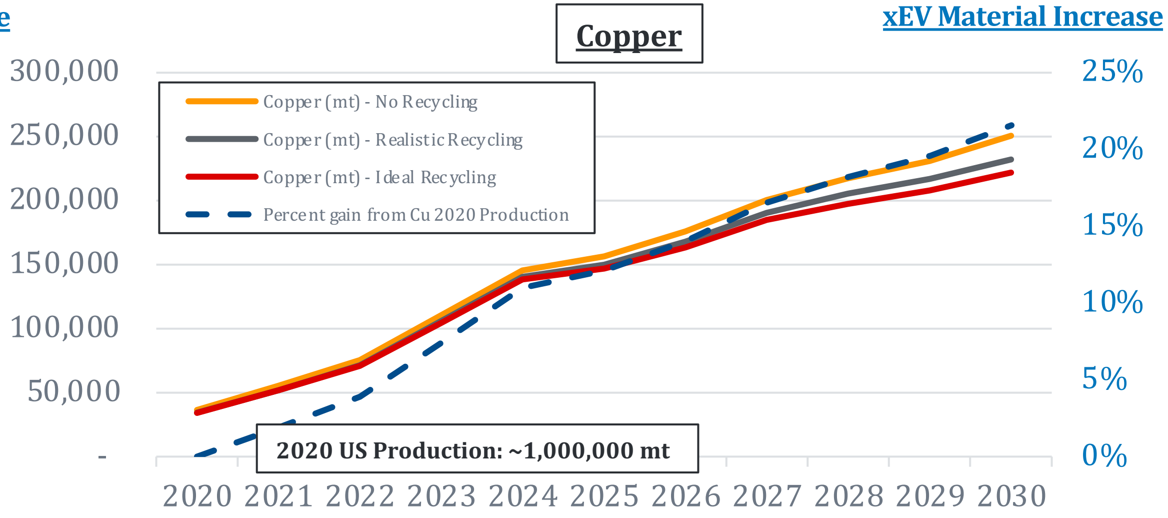


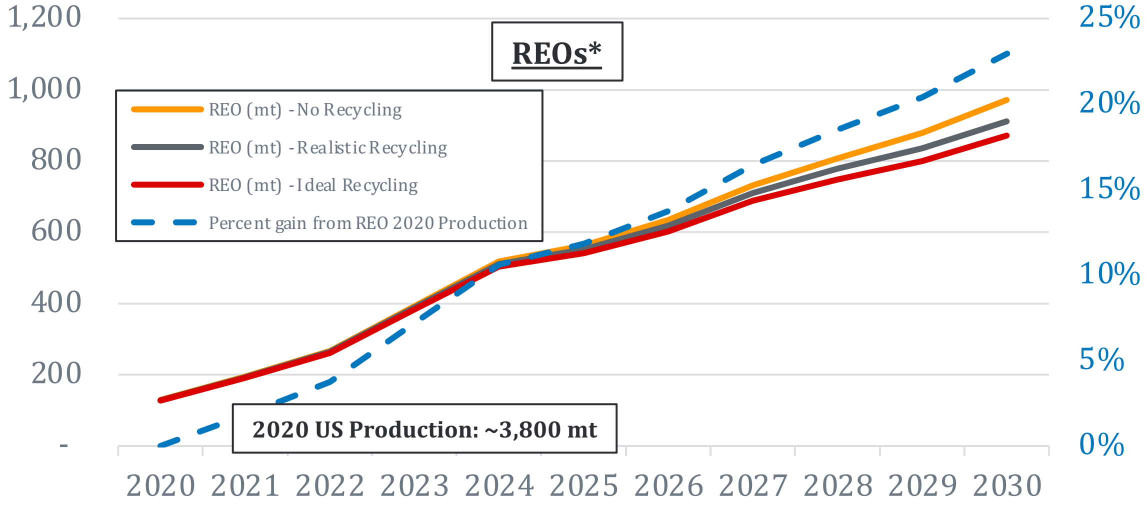
Source: Martec Analysis

Material Demand for BEV, PHEV, & HEV: 2020 – 2030(F)

US-Only Natural EV Progression Scenario: ~17% BEV by 2030







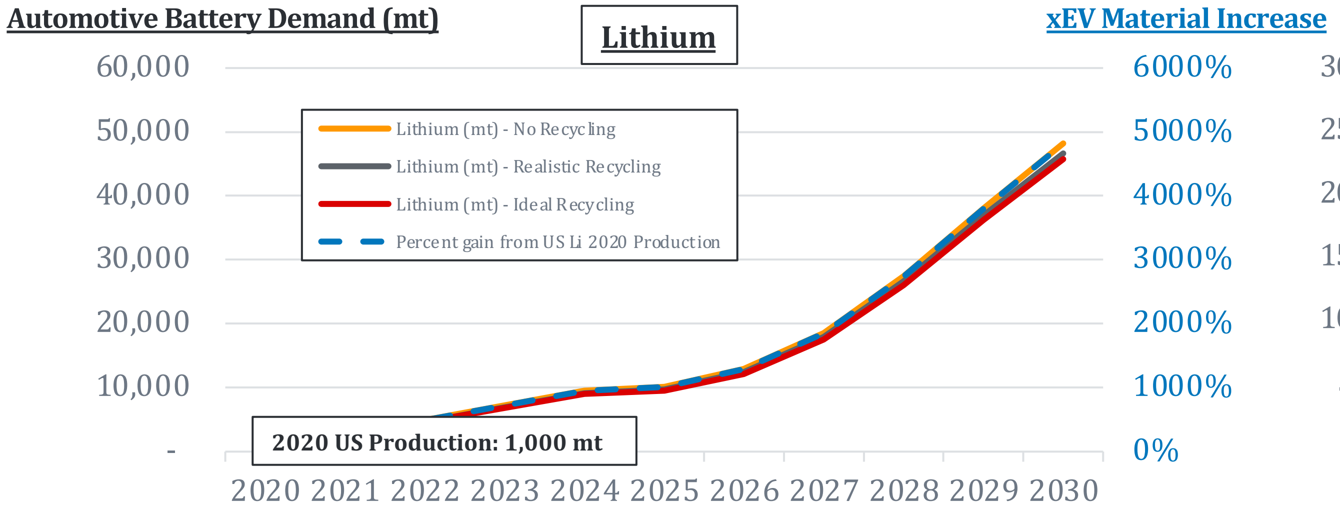
Source: Martec Analysis

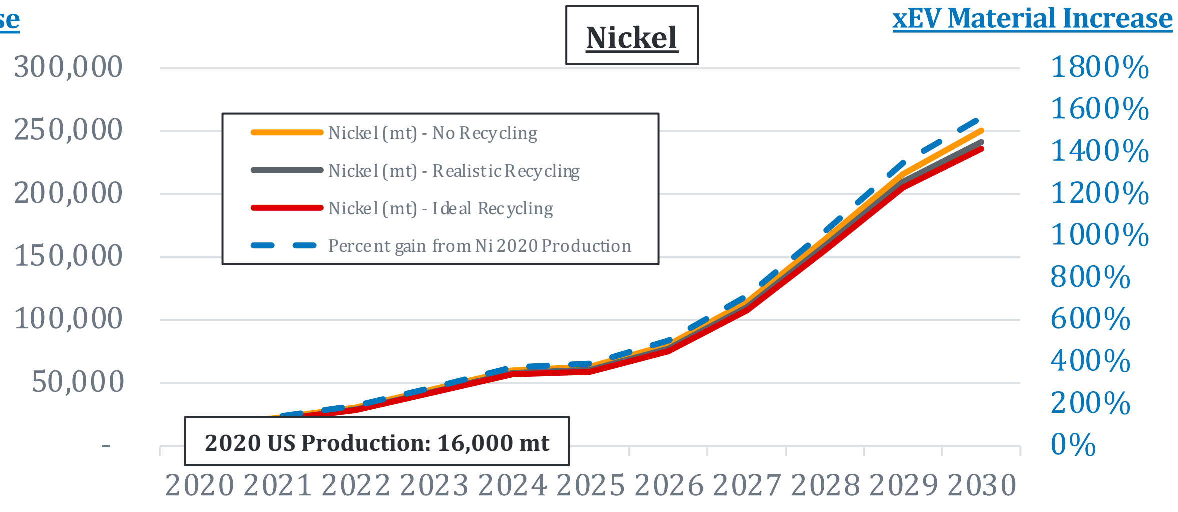
**Note: REOs are primarily utilized in xEV motors vs. batteries.*

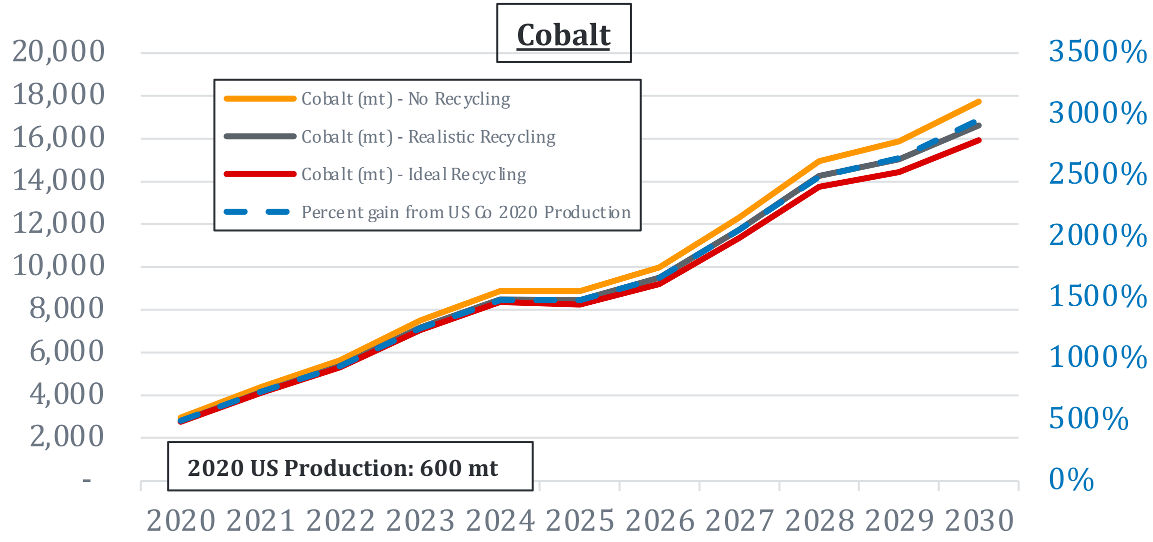
Materials Demand
- *US-Only Biden EV Scenario* -

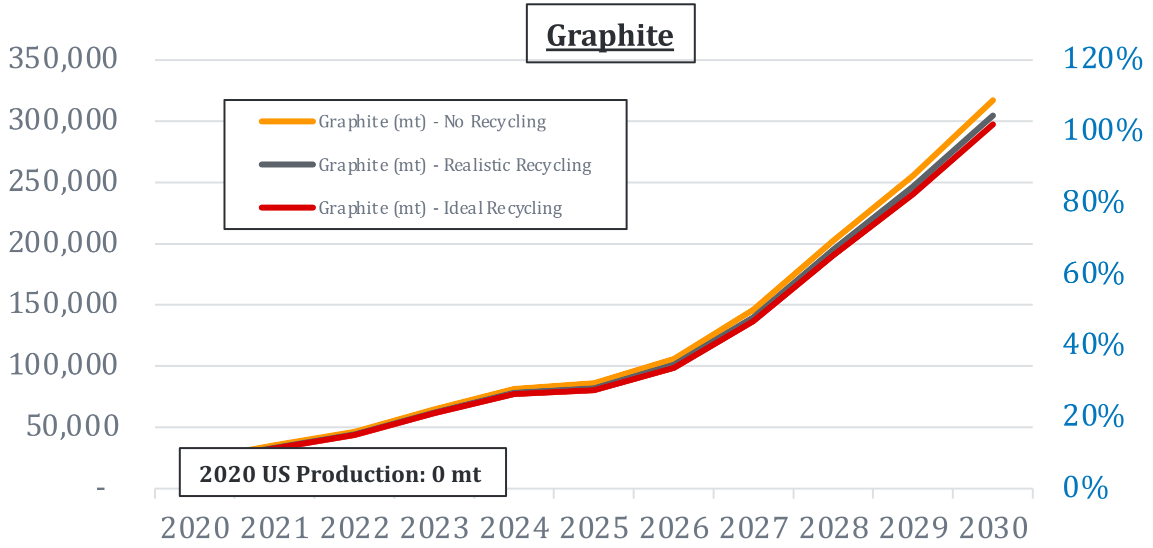
Material Demand for BEV, PHEV, & HEV: 2020 – 2030(F)

US-Only Biden EV Scenario: 50% BEV by 2030









Source: Martec Analysis

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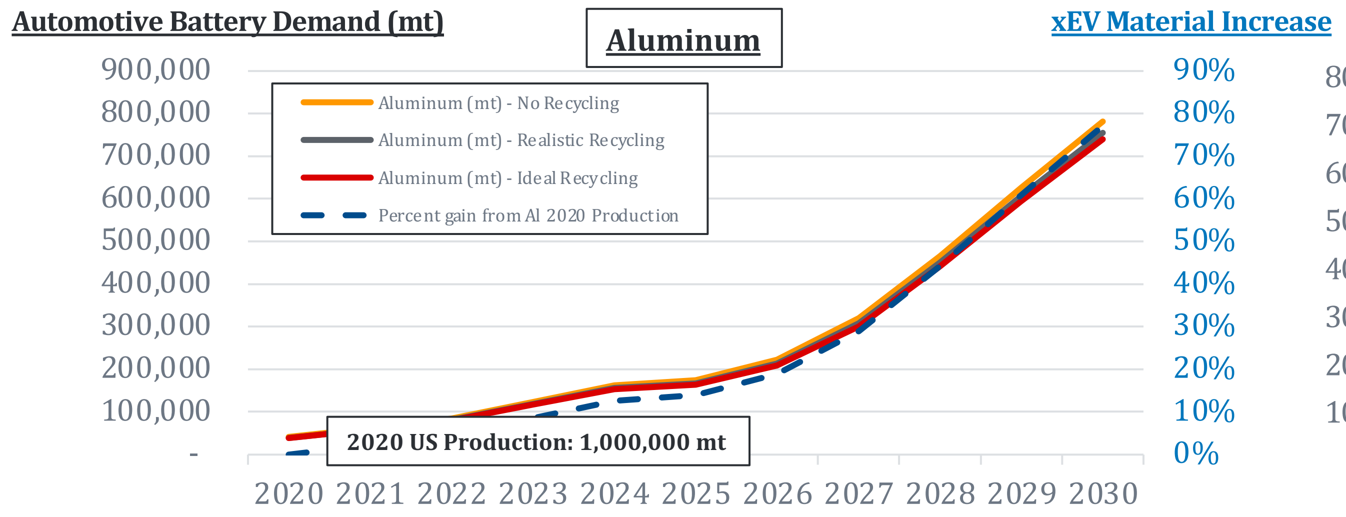
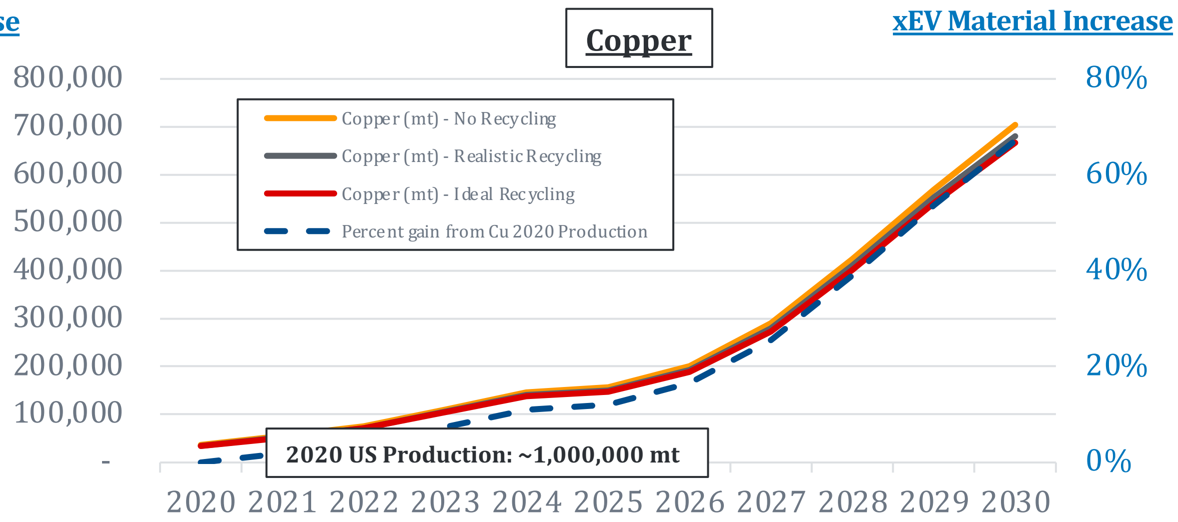
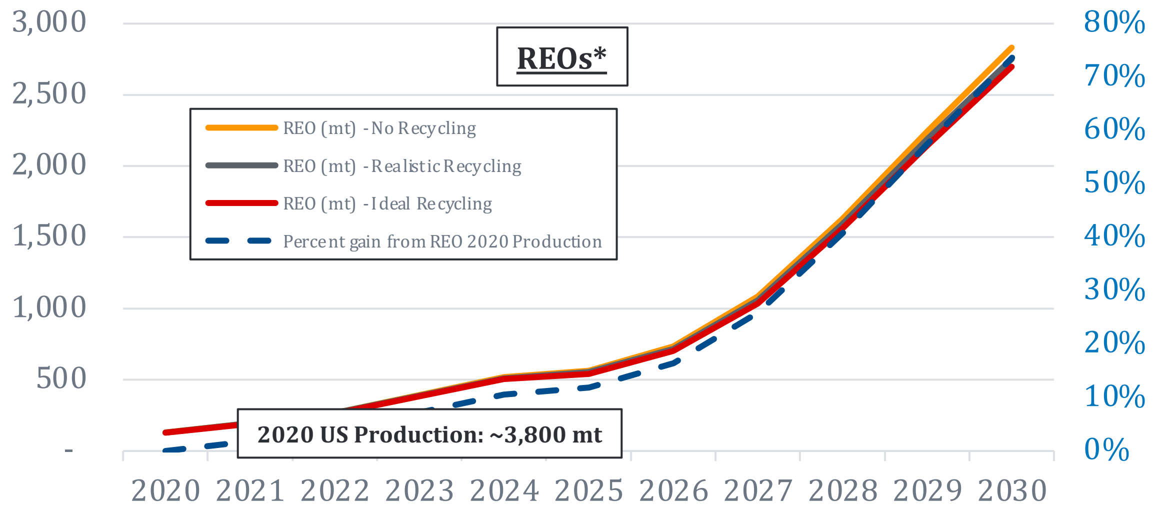
Material Demand for BEV, PHEV, & HEV: 2020 – 2030(F)

US-Only Biden EV Scenario: 50% BEV by 2030







Source: Martec Analysis

**Note: REOs are primarily utilized in xEV motors vs. batteries.*

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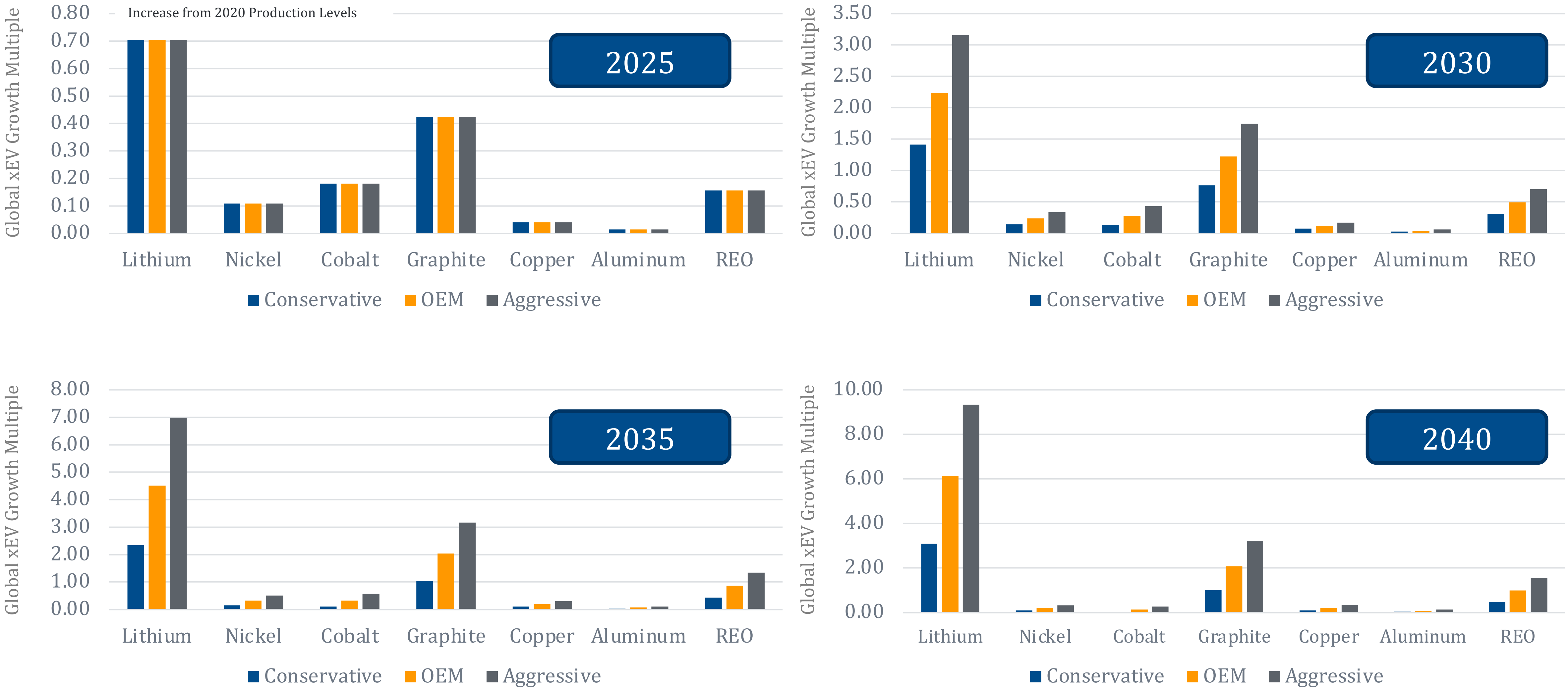
Materials Demand Analysis

- Key Takeaways -

Summary of Global Material Demand Scenarios from xEV Growth*

Lithium, Cobalt, and REOs are expected to have the largest increase in production from 2020 levels



**NOTE: 2025 material demand does not change based on the different scenarios as production plans from vehicle OEMs are already in place. The different scenario plans have a bigger impact when looking at materials needed by 2030 and beyond. This analysis assumes no recycling takes place.*

Material Supply Chain Summary Analysis

Key Takeaways

- Significant production & investment required both domestically and globally
    - ➢ *Global scenarios studied indicate the requirements for significant expansion in the production of raw materials in order to meet demand from the automotive industry*
    - ➢ *Lithium, Graphite and REOs (Neodymium) are the raw key materials with the most significant expansion in production requirements*
        - – The most aggressive EV scenario studied requires 9X the lithium, 3X graphite, and 1.5X REO by 2040 to meet automotive battery demand
    - ➢ *Nickel is potentially also at risk of short supply as the specific type nickel used for batteries is <30% of the total global production of the raw material*
    - ➢ *Special downstream processing is required to achieve battery grade Nickel*
        - – Raw material processors can use general types of Ni (Lateritic) but must use higher cost processes
            - ○ *Challenges also exist with quality from using these types of Ni*
        - – Newer downstream processing being installed globally (HPAL - High Pressure Acid Leaching) for battery grade Ni creates significant amount of CO_2 emissions

Material Supply Chain Summary Analysis *(continued)*

Key Takeaways

- Lack of recycling infrastructure & economics
    - *Recycling can have a huge impact on the demand for several critical raw materials*
    - *Cobalt and Nickel see the largest benefit*
        - The shift in technology choices (ultra-low Cobalt batteries and Solid-State Li) also help the supply issues with these two materials
        - Recycling these key materials from EV batteries is still in its infancy stage globally and will take time to get batteries back due to existing vehicle lifespans being ~12 years in the US
            - *Recycling batteries also competes with companies repurposing batteries into the energy storage sector*

- Being self-sufficient will be a significant challenge
    - *For the US to become self sufficient in the supply of battery raw materials, there needs to be a massive increase in local production of all the key materials studied*
        - No US production of graphite and very limited production of cobalt are significant hurdles to achieve US only production of automotive batteries
        - Continued litigation challenges delaying expansion in mining preventing US production of key materials (Li, Co, Ni, REOs)
        - US has abundant resources to support high volume battery manufacturing but lacks the mining capacity and cost position to achieve this goal

BEV materials supply chain assessment

MATERIAL MAPPING & SUMMARIES

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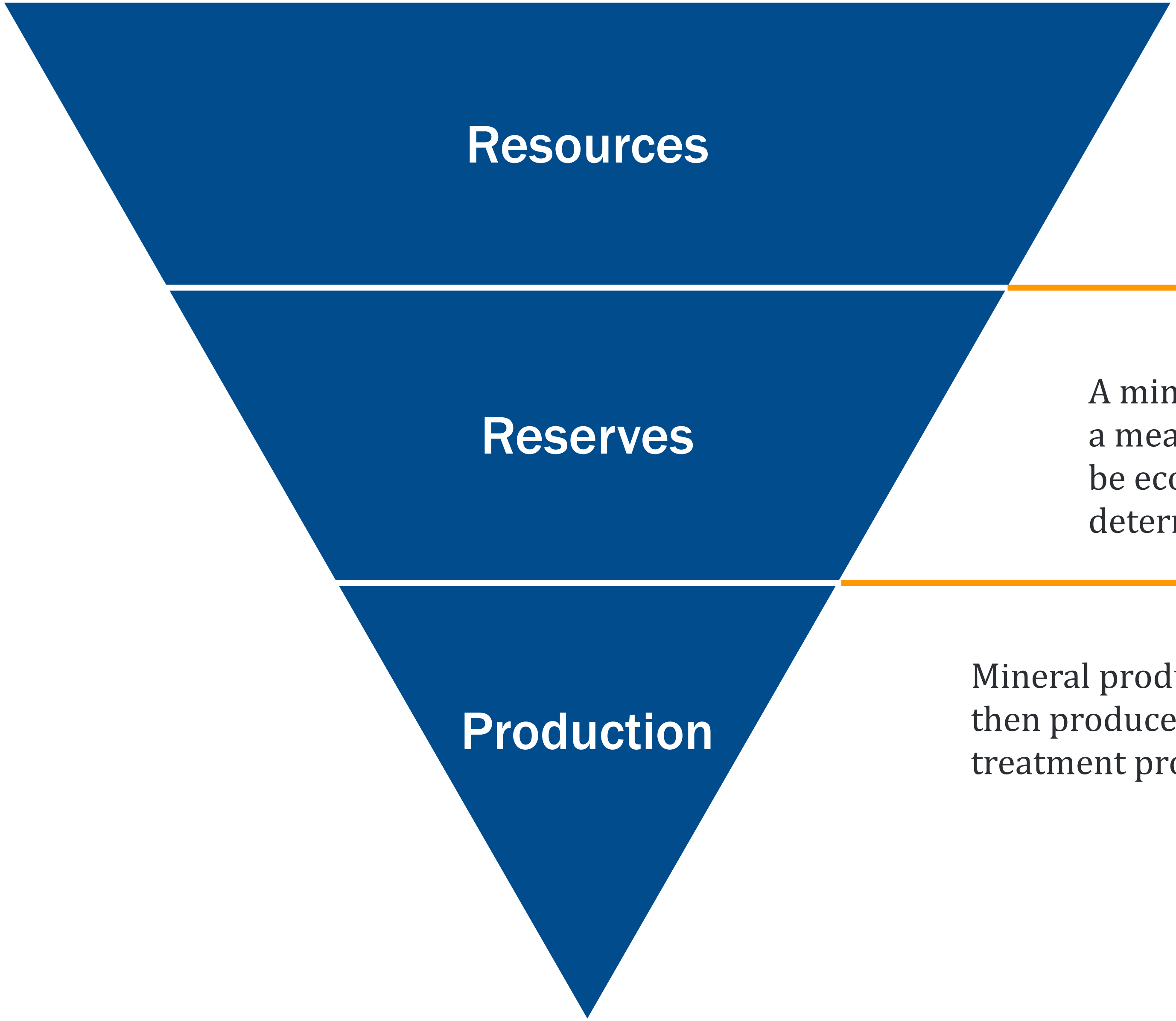
Definitions



A mineral **resource** is a concentration or occurrence of solid material in or on the Earth's crust. Resources can be either inferred or identified. In such form, grade, or quality and quantity that there are reasonable prospects for eventual economic extraction.

A mineral **reserve** is the economically mineable part of a measured and/or indicated mineral resource that can be economically and legally extracted. Amount is determined by a feasibility study.

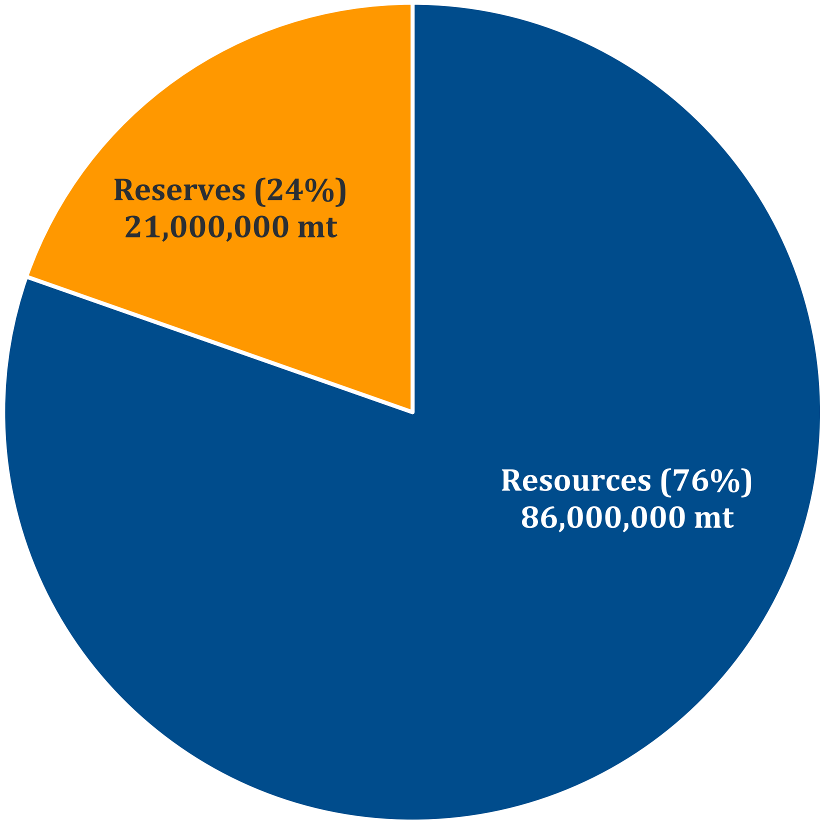
Mineral production is when a mineral is extracted from a mine then produced and prepared in a marketable state by a simple treatment process.

lithium

Lithium Production, Reserves, & Resources

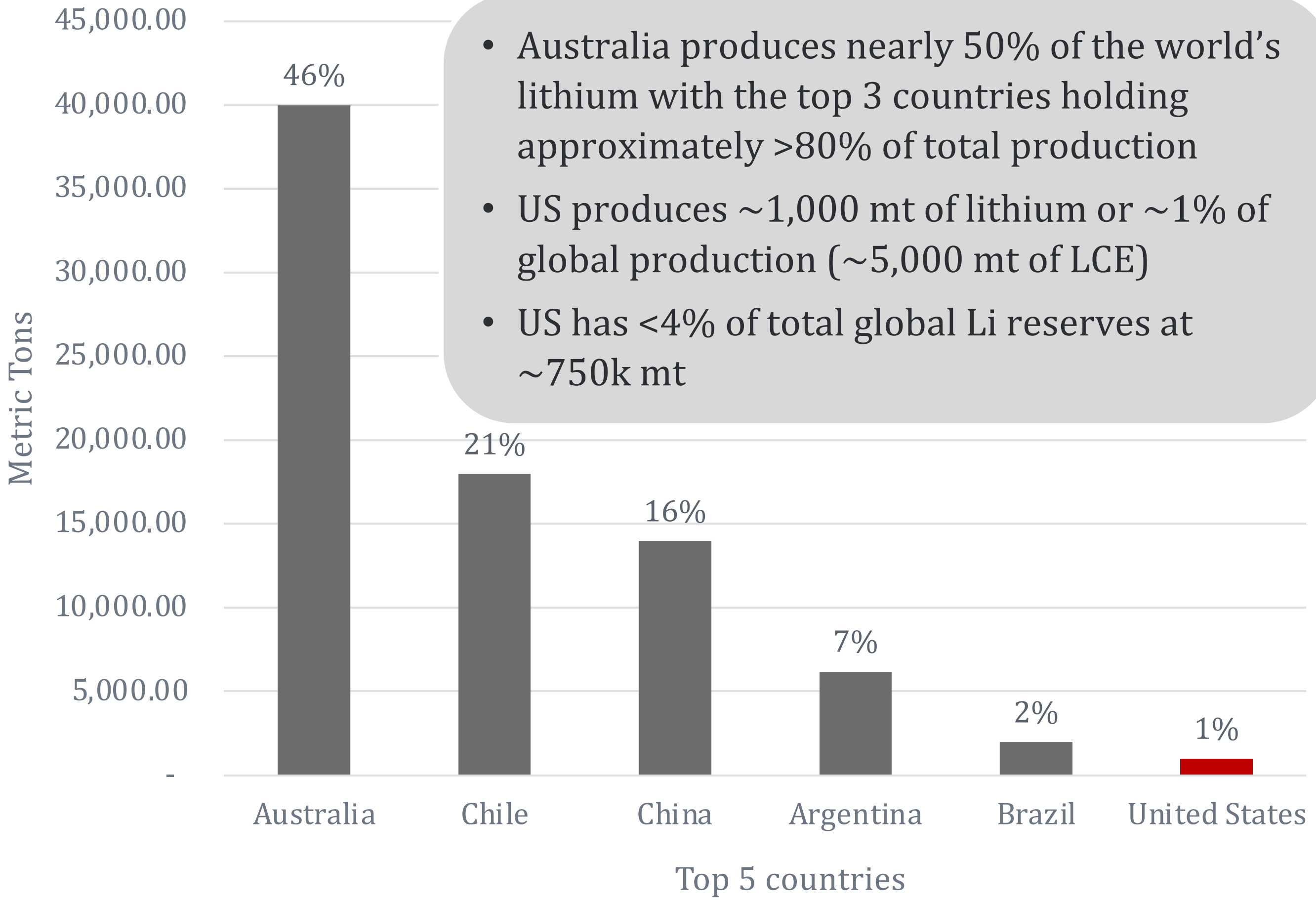
Approximately 3/4 of the world’s Lithium resources remains unexplored.
Majority of the world’s lithium production is mined out of Australia representing >45% of global production.

2020 Lithium Resource vs. Reserves



Note: *Resources include identified and inferred resource totals.*

2020 Global Lithium Production
(Global Production = 83,200 mt)

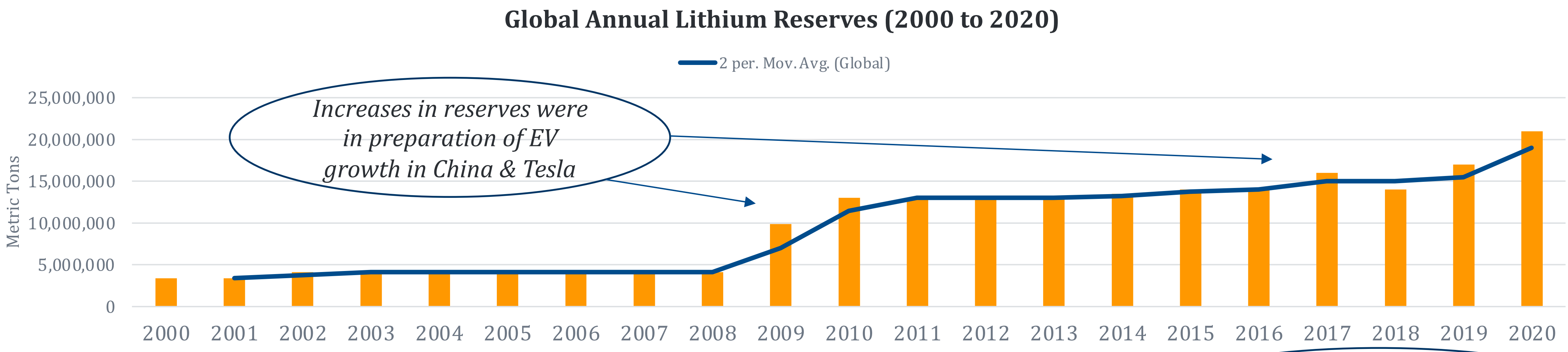


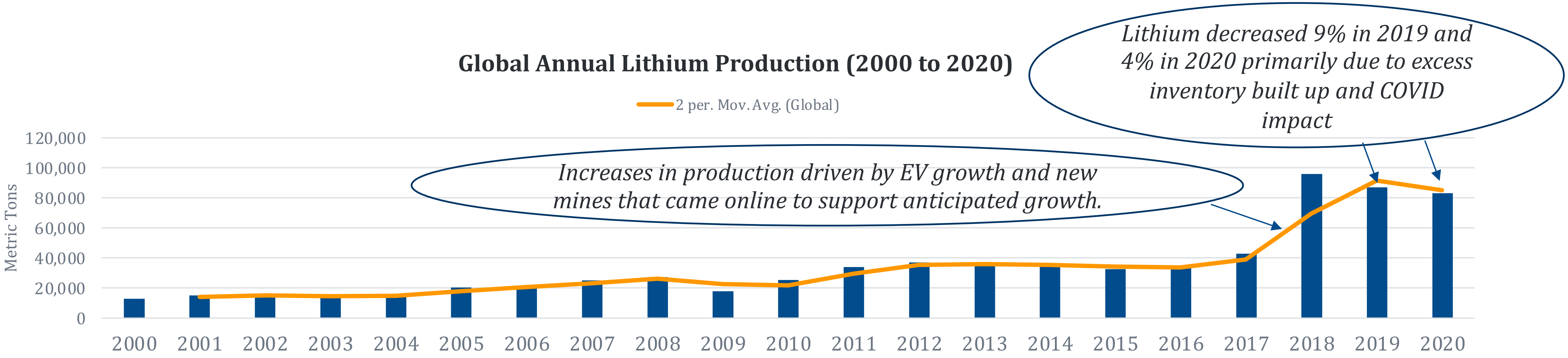
- Australia produces nearly 50% of the world’s lithium with the top 3 countries holding approximately >80% of total production
- US produces ~1,000 mt of lithium or ~1% of global production (~5,000 mt of LCE)
- US has <4% of total global Li reserves at ~750k mt

Source: 2020 Lithium USGS Report + Estimated USA production of ~5,000 mt of Lithium Carbonate Equivalent (LCE); USGS withholds US production.

Lithium Historical Production vs. Reserves

Global lithium reserves grew approximately 250% from 2009 to 2010 with a spike in production in 2018





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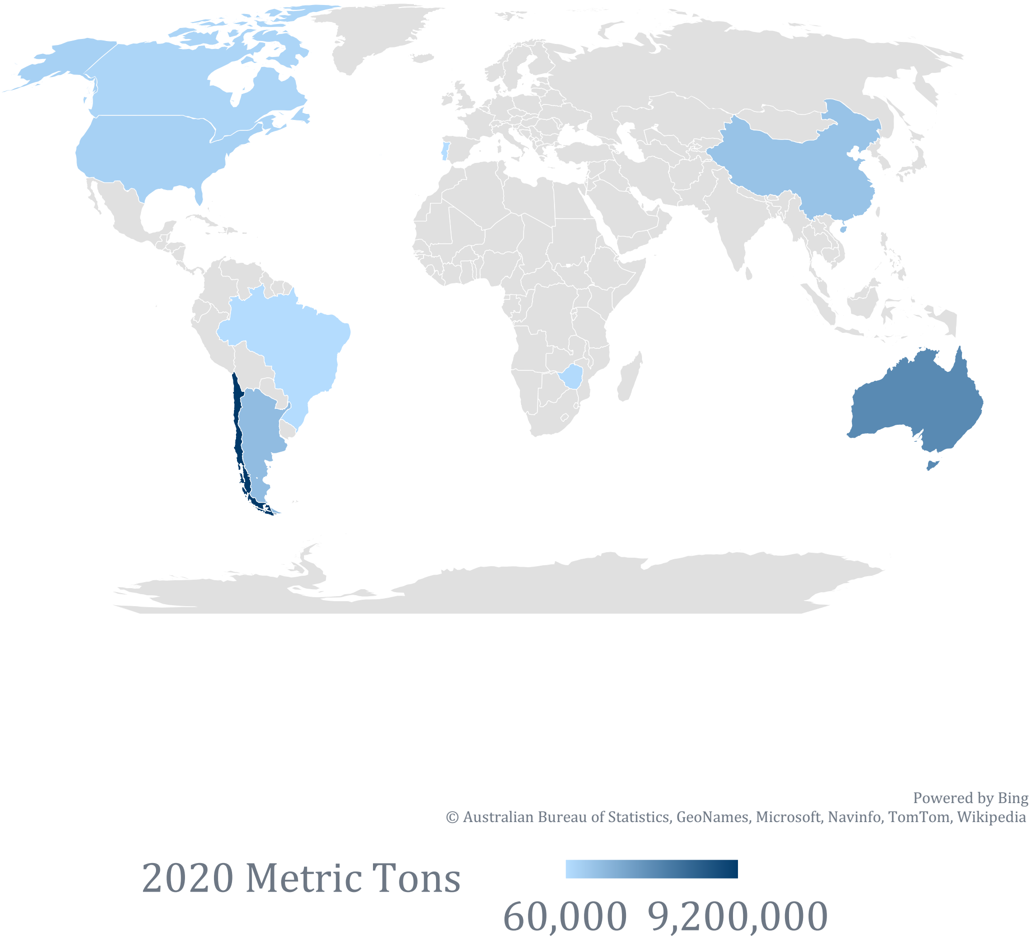
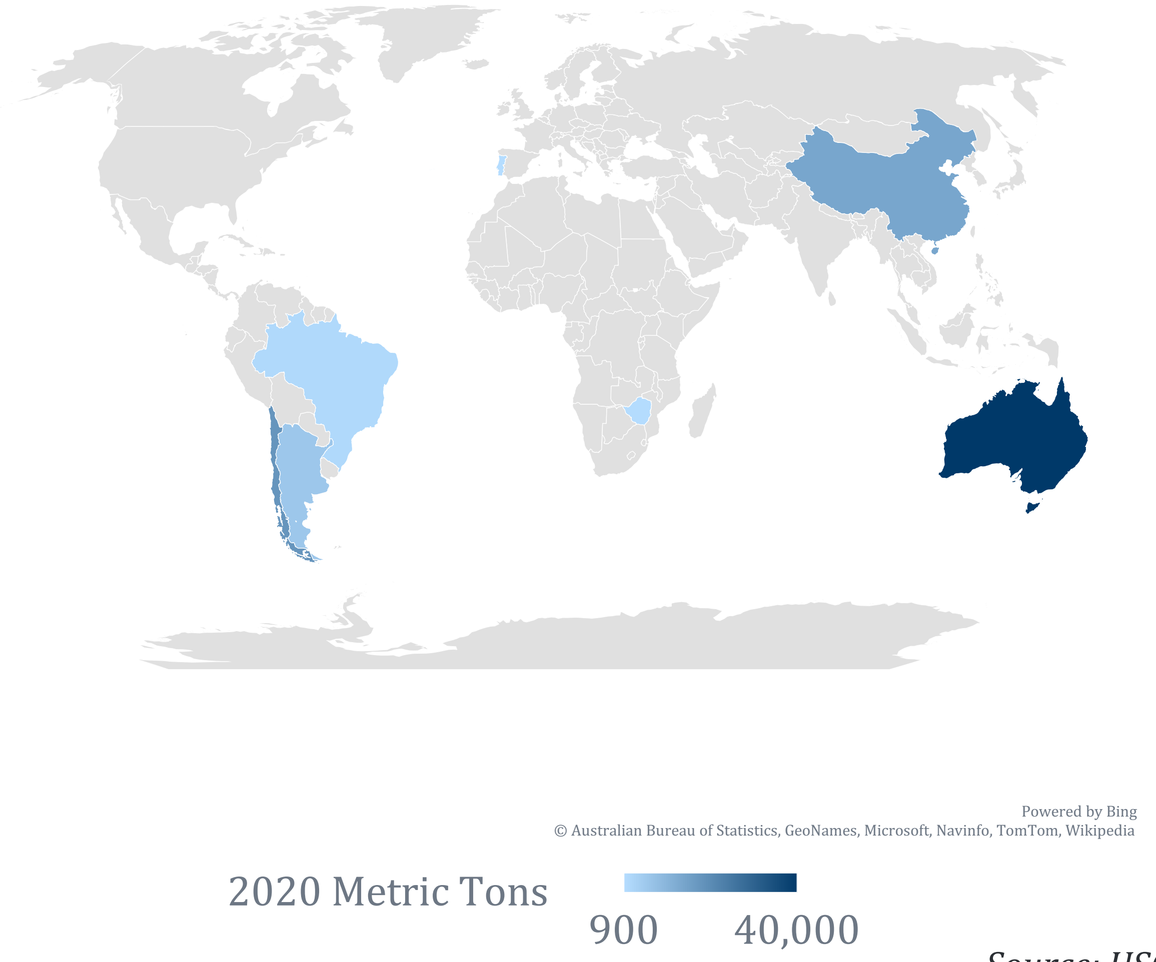
Source: 2000-2020 Lithium USGS Report

2020 Lithium Reserves vs. Production

Reserves



Production



Source: USGS

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Mining Timeline General Overview for Lithium

Timeline can vary significantly from exploratory to actual commercial production for a mine

Timeline can range from 7 – 14+ years before production

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Time Range	2 - 5+ years	2 - 4 years	3 - 5 years	10 - 20 years	Highly subjective to the jurisdiction and size
Avg. Time by Stage	~3.5 years	~3 years	~4 years	>15 years	N/A
Low to High Invmt. Cost	$6M - $25M+	$40M - $100M+	$300M - $1,500M	$50M - $250M/yr.	Min. $20M - $50M+
Avg. Investment Cost by Stage	$20M+	$50M+	$500M+	$60M/year *(high variance)*	-$35M+
Key Steps by Stage	• Permitting time for exploration is growing due to communities' opposition (US tends to be longer than 5 years) • Approx. 1 year to initiate exploration	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation • Planning & investment	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase • Construction	• Ore extraction • Milling / Ore separation • Processing • Waste rock/tailings & wastewater mgmt. • Near mine exploration • Expansion life of mine	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

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Mining Timeline Overview by Key Country/Region for Lithium

Timeline can vary significantly from exploratory to actual commercial production for a mine

Question ↓		Region: United States	Region: China	Region: Chile/Peru/Rest of LATAM	Region: Australia
Compared to average numbers, how much longer/more investment does it take to start a new mining project in this region and what are the core reasons explaining these differences?	Value [month/%]	50-100% more	30-50% less	50-100% more	Considered the market benchmark (average)
	Reasons	• Projects are predominantly more challenging brine/other unproven technologies (clay, geothermal, etc.) • Environmental permitting is more complex • Higher degree/risk of legal & environmental challenges compared to other countries	• Simpler permitting process • Investment and times are simpler because demand is strongly driven by consolidated refining plant district	• Projects in this region are predominantly brine, which has a more complicated development & mining process	• Predominantly rock projects (spodumene) that are operationally simpler and environmentally less challenged
	Value [$M/%]	50% more	50% less	50% more	Considered the market benchmark (average)
	Reasons	• Same reasons as above • Labor is cheaper than in Australia • Brine/other untested projects require more investment with a much longer/higher risk approval process	• Same reasons as above • Labor is cheaper than in Australia • Operational standards with more slack	• Longer more complex process compared spodumene/open pit deposits • Labor is cheaper than in Australia	• Rock projects are generally less investment intensive Workmanship is more demanding comparatively

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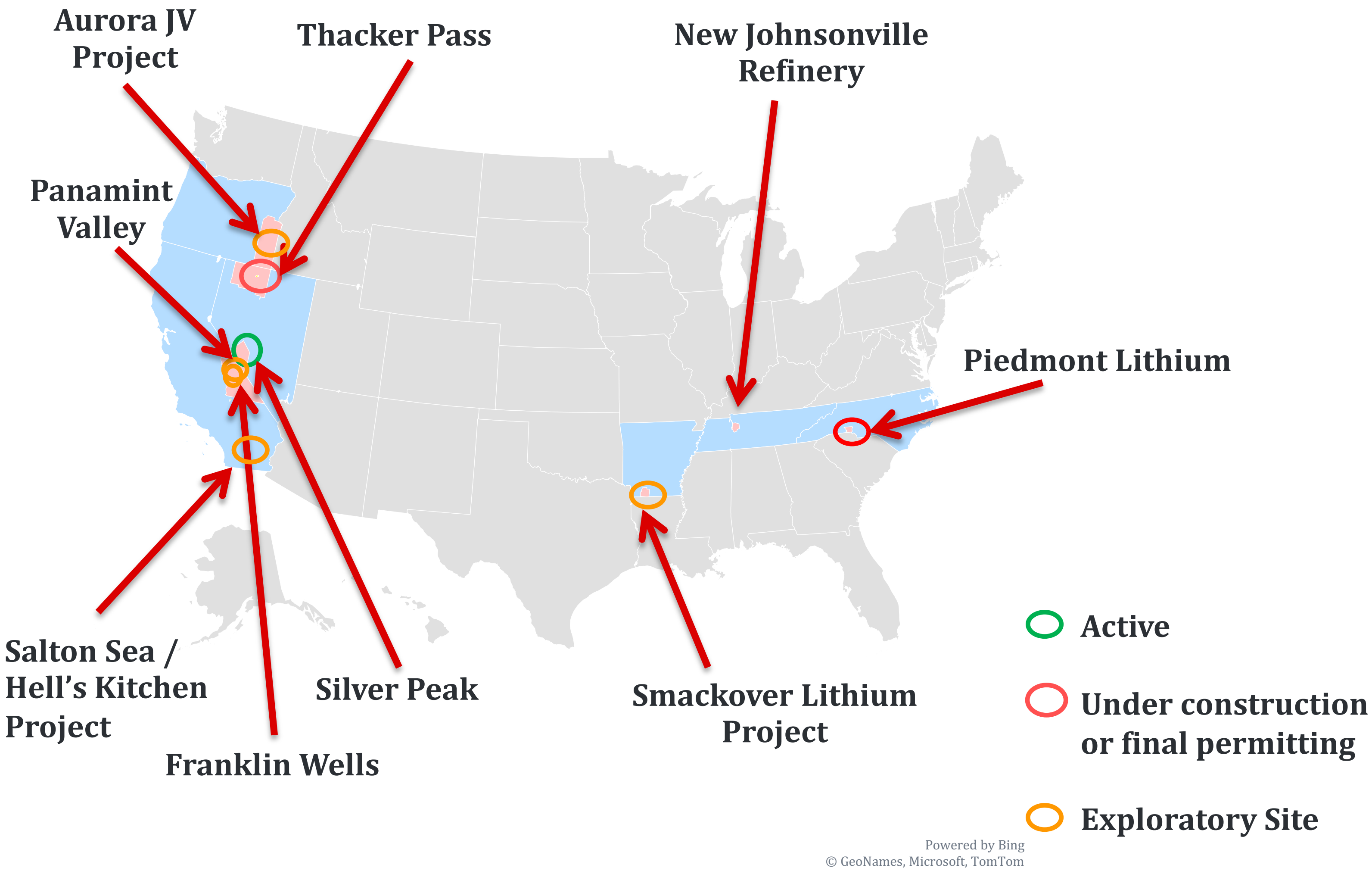
Lithium Mines in the United States



- Lithium is commercially being mined at only one location in the US
  - *Produced in Nevada at Silver Peak and soon to be at Thacker Pass*
- Thacker Pass, first phase is in final construction and will be operational by early-2022
  - *Operated by Lithium Americas*
- Multiple exploratory and some small active production sites exist in central region of US
  - *Piedmont Lithium site in North Carolina permit is delayed due to litigation*
  - *Multiple companies including Albemarle are fighting over a point of interest in southern Arkansas*
    - Timeline is uncertain
- Albemarle's New Johnsonville, TN location is a downstream Li processing/refinery site

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Silver Peak

US Lithium Mine

- Owned by US-based Albemarle which is publicly traded on the NYSE

- Total size is 33,900 acres with Albemarle's site occupying 15,020 acres

- Current output is estimated at ~1,000 mt of elemental lithium annually (or ~5,000 mt of LCE)
    - *Utilizes a heavy brine extraction process*
    - *Specific production details are not released to the public and are deemed confidential*

- In 2021 Albemarle is expected to invest ~$30M - $50M to double the current lithium production by 2025
    - *Goal is to help provide as much aid to the domestic support for the growing EV market*
    - *This investment would bring annual production capacity to ~2,000 mt of elemental Lithium (or ~10,000 mt of LCE)*
    - *Investment will add 200+ jobs from the expansion*

Thacker Pass

US Lithium Mine

- Total site is 5,545 acres and is believed the largest deposit of lithium in the US
  - *Open pit will encompass a 2-square mile area*

- Mine life is ~46 years with production scheduled to begin by mid-2022
  - *Thacker Pass will be an open pit mining operation*
  - *Phase I investment is reported at $581M*

- Annual elemental Lithium production will start out at ~5,600-6,500 mt/yr.* (for initial 3 – 4 years) and escalate up to ~11,300 mt/yr.*
  - *Phase I production figures is based on 30,000 – 35,000 mt/yr. of LCE**
  - *Final phase will escalate to 60,000 mt/yr. of LCE**
  - *Lithium reserves of ~0.58M mt (or ~3.1M mt of LCE)**

- Lithium Americas is a Canadian-based company and is the sole owner of Thacker Pass via Lithium Nevada, a subsidiary of Lithium Americas
  - *Lithium Americas is publicly held company and actively traded on NYSE (LAC) and TSX*
  - *Major shareholders include Invesco, Van Eck Associates, Global X Lithium & Battery Tech and Susquehanna International to name a few*

**Note: Figures are based on reported Lithium Carbonate Equivalent (LCE) conversion of 0.188 to derive elemental lithium.*

Details on Other Lithium Mines in the United States

Several USA Lithium deposits are in the exploratory stage

Item	Piedmont Lithium Project	Salton Sea / Hell's Kitchen	Panamint Valley & Franklin Wells	Smackover Lithium Project	Aurora JV Project	New Johnsonville
Location	North Carolina	California	California	Arkansas	Oregon	Tennessee
Size	1,199 acres	~7,300 acres	~56,537 acres	~27,262 acres *(total area potential is ~150,000 acres)*	N/A	100 acres
Capacity	22,700 mt/yr. of Lithium hydroxide	Targeting ~7,500 mt/yr. of elemental Lithium by 2024 (or 40k mt/yr. of LCE) ➢ *Initial investment estimate is ~$520M* ➢ *Recently increased from 34.7k mt/yr. targeted for 2025*	29.9M mt of Lithium Hectorite (resources) ➢ *Still in very early exploratory stage*	~4,000 mt/yr. of elemental Lithium (or 20,900 mt LCE) ➢ *Planned ~$750M investment*	N/A *(various materials from Lithium, Uranium & Mercury in Malheur County area)*	Downstream processing site only
Stage	Final Permitting (litigation delayed)	Exploratory	Exploratory	Exploratory	Exploratory	
Owner	Piedmont Lithium	Controlled Thermal Resources *(Australian firm; GM recently invested in site)*	Mattery Mineral Resources (BMR) *(Australian firm)*	Multiple companies *(Standard Lithium/Lanxess and TETRA Technologies*)*	Chevron Resources Co.	Albemarle

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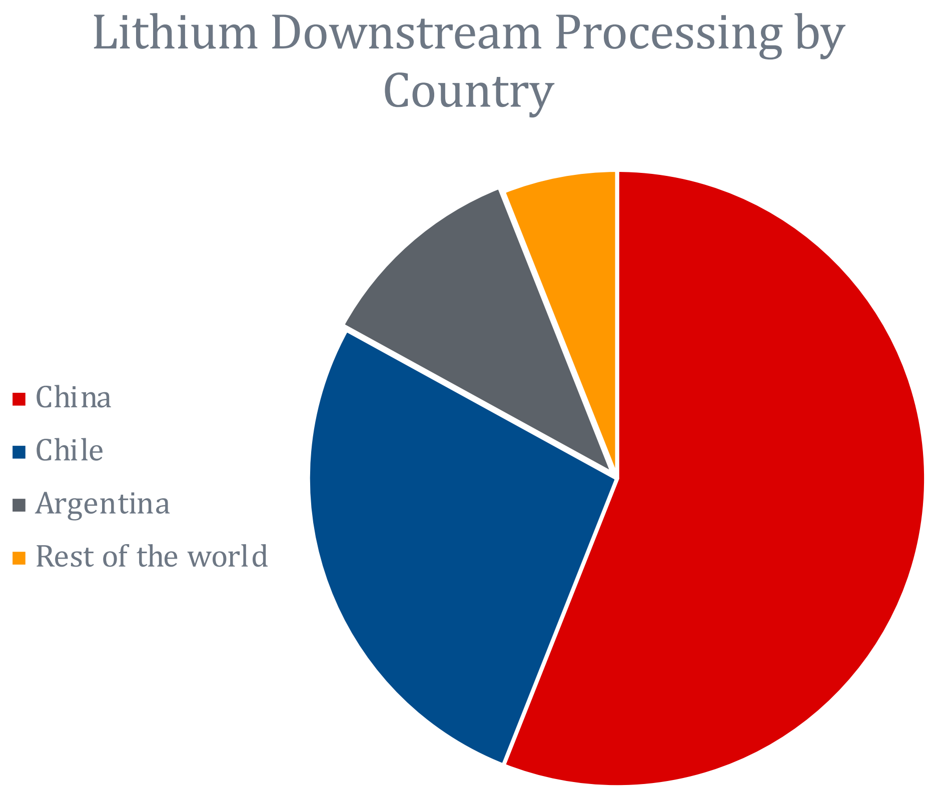
Lithium Downstream Processing

China has a dominant global position in downstream Li processing



Source: IEA – Role of Critical Minerals in Clean Energy Transitions and Martec Analysis

- China processes ~60% of the total Lithium mined globally
  - *Most countries outside of South America ship their mined Lithium to China for processing, including Lithium mined in the USA*
  - *Australia currently sends ~95% of its mined spodumene Li concentrate to China*
    - Companies are looking to do downstream refining of Lithium in Australia in the very near future
- Chile and Argentina combined process ~25% - 30% of the mined Lithium globally
- Tesla sources its Lithium from the largest producer and processor in China Ganfeng Lithium Co. who processes it into battery grade
- Significant capacity expansion in downstream processing is still needed in order to support future BEV growth

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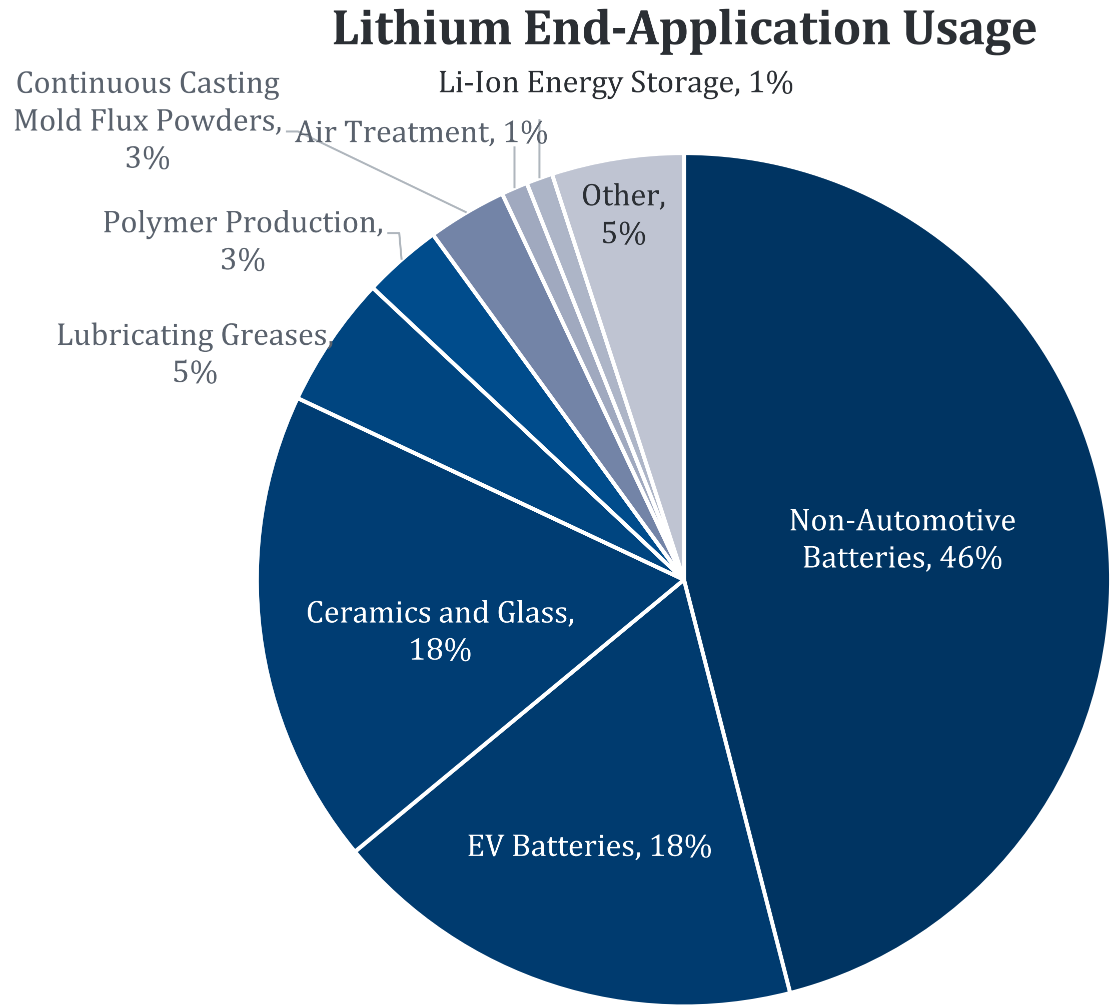
Lithium End Applications, Trends, & Events

Nearly 2/3 of Lithium's end-application is being utilized for batteries due to a rise in technological advancements



Trends & Events

- Lithium supply security has become a top priority for technology companies in the United States and Asia

- Strategic alliances and joint ventures among technology companies and exploration companies continue
  - *Albemarle & Mineral Resources Ltd. (MARBL)*
  - *Ganfeng & Bacanora (in Mexico)*
  - *Nalco, Hindustan Copper & Minerals Exploration Corp.*
  - *Companies in Australia, Chile & Argentina negotiating*

- Silver Peak, NV is the only active commercial mining site in the US extracting Lithium from brine
  - *Other states with significant resource deposits include CA, AK, TN, NC and OR, which represents a significant portion of the 6.8M mt in US resources*

- New lithium site is under development in Nevada called "Thacker Pass“, litigation delays were recently lifted
  - *Legal challenges were regarding environmental impact on local wildlife*

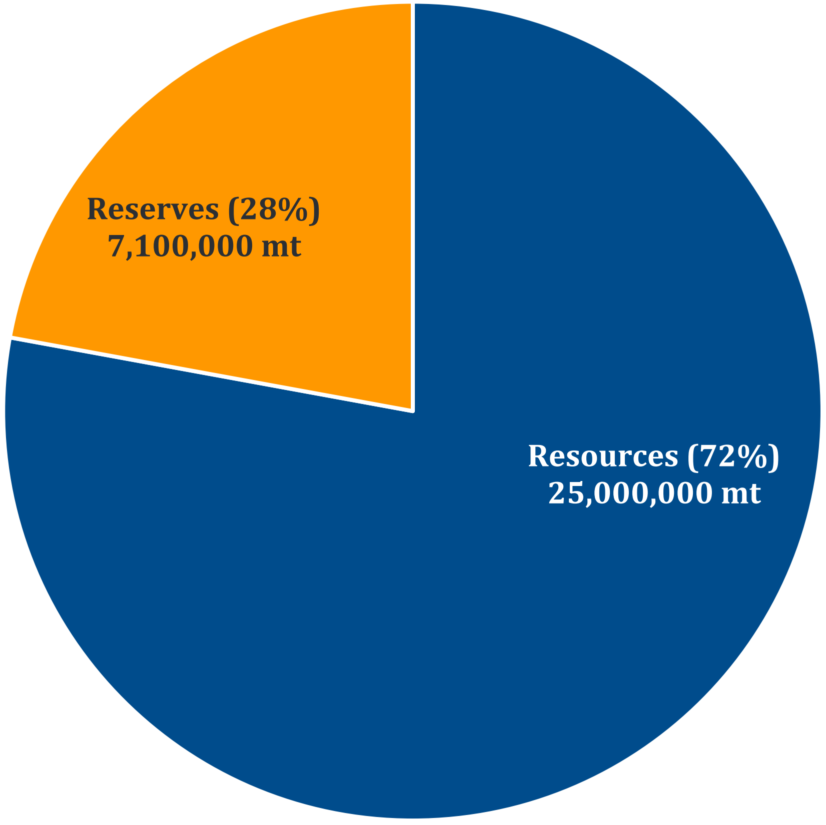
Source: 2020 Lithium USGS Report

cobalt

Cobalt Production, Reserves, & Resources

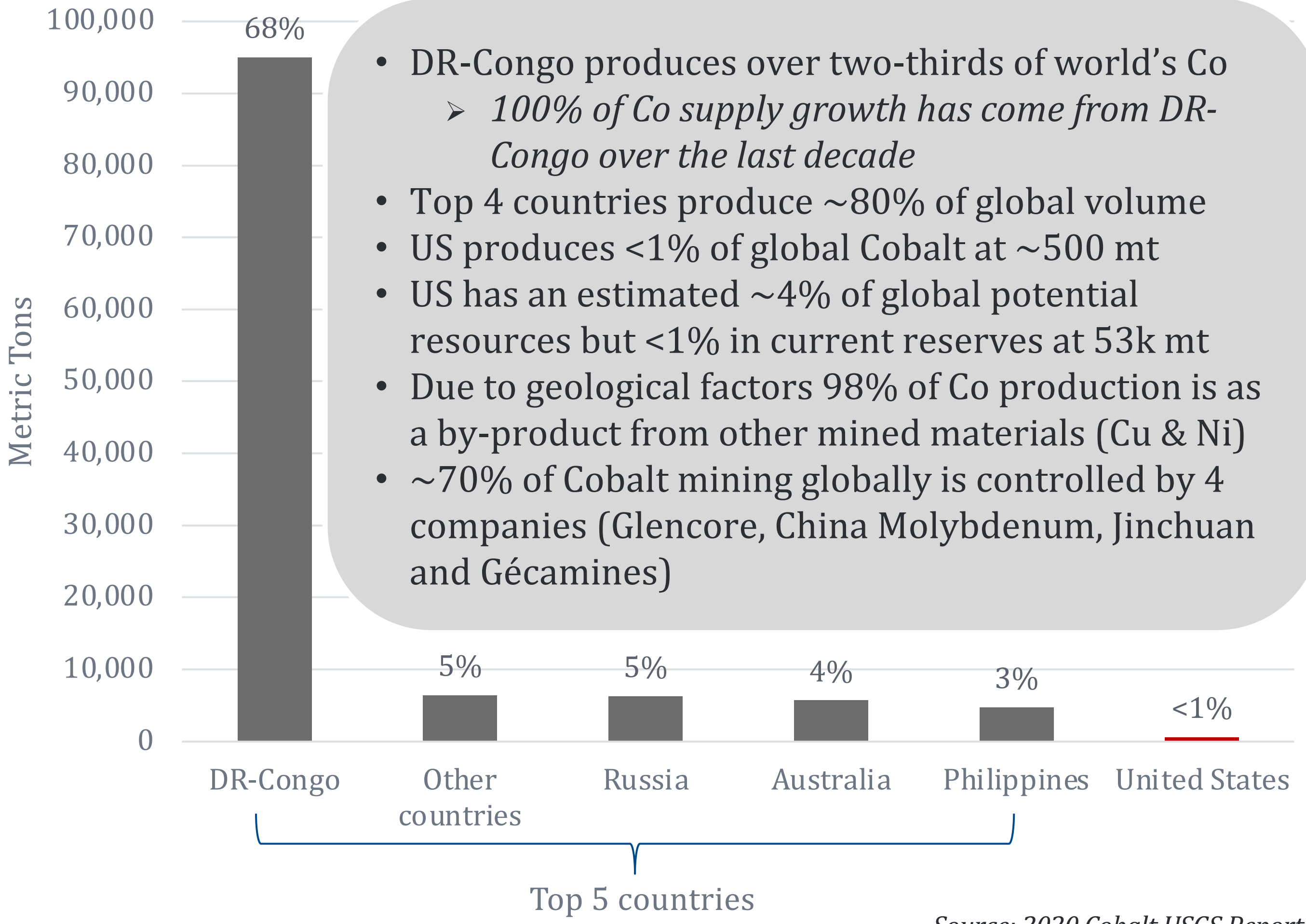
Approximately 72% of the world's Cobalt resources have not been explored.
Majority of the world's cobalt production is mined out of the Congo representing 68% of global production.

2020 Cobalt Resource vs. Reserves



Resources includes identified and inferred resource totals.

2020 Global Cobalt Production
(Global Production = 140,000 mt)



- DR-Congo produces over two-thirds of world's Co
  - *100% of Co supply growth has come from DR-Congo over the last decade*
- Top 4 countries produce ~80% of global volume
- US produces <1% of global Cobalt at ~500 mt
- US has an estimated ~4% of global potential resources but <1% in current reserves at 53k mt
- Due to geological factors 98% of Co production is as a by-product from other mined materials (Cu & Ni)
- ~70% of Cobalt mining globally is controlled by 4 companies (Glencore, China Molybdenum, Jinchuan and Gécamines)

Source: 2020 Cobalt USGS Report

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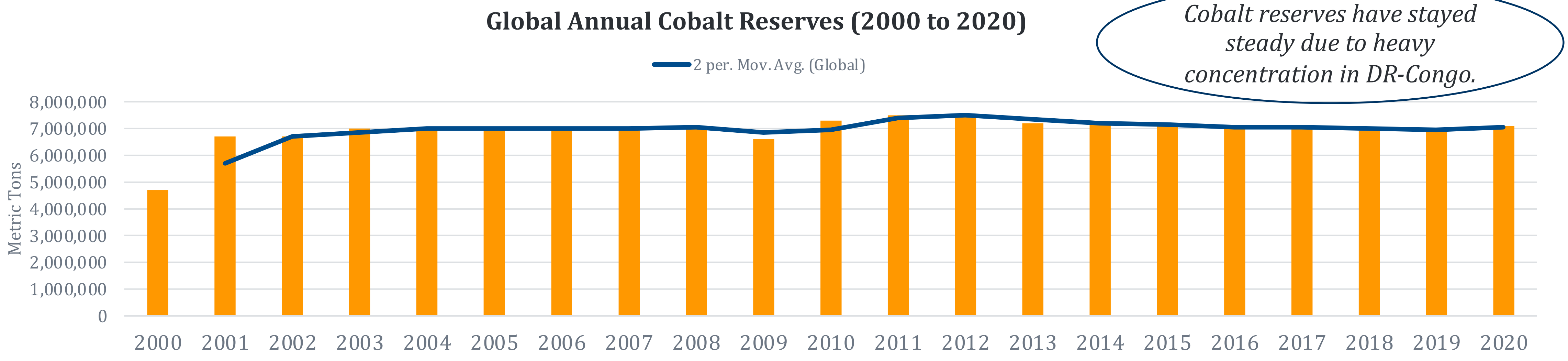
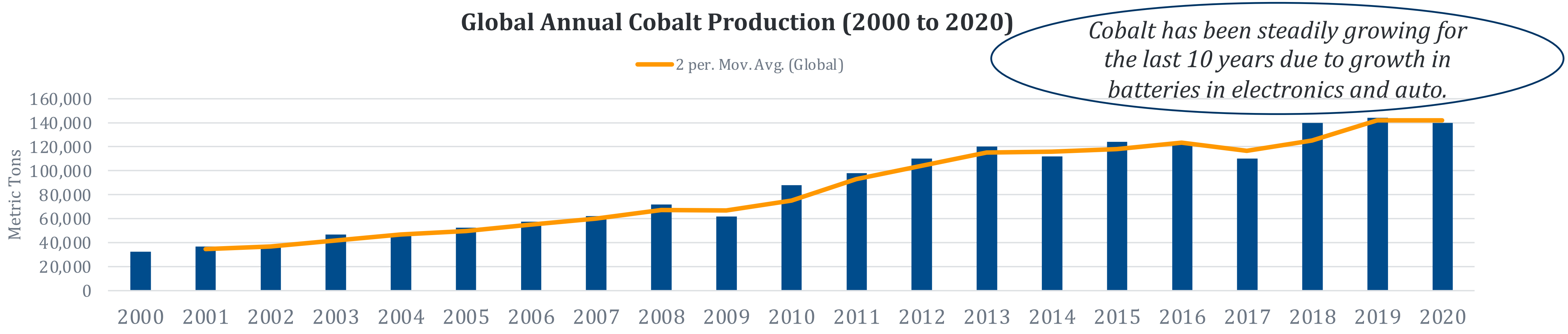
Cobalt Historical Production vs. Reserves

Global cobalt reserves remained static through the last two decades, but production grew 400% since 2000





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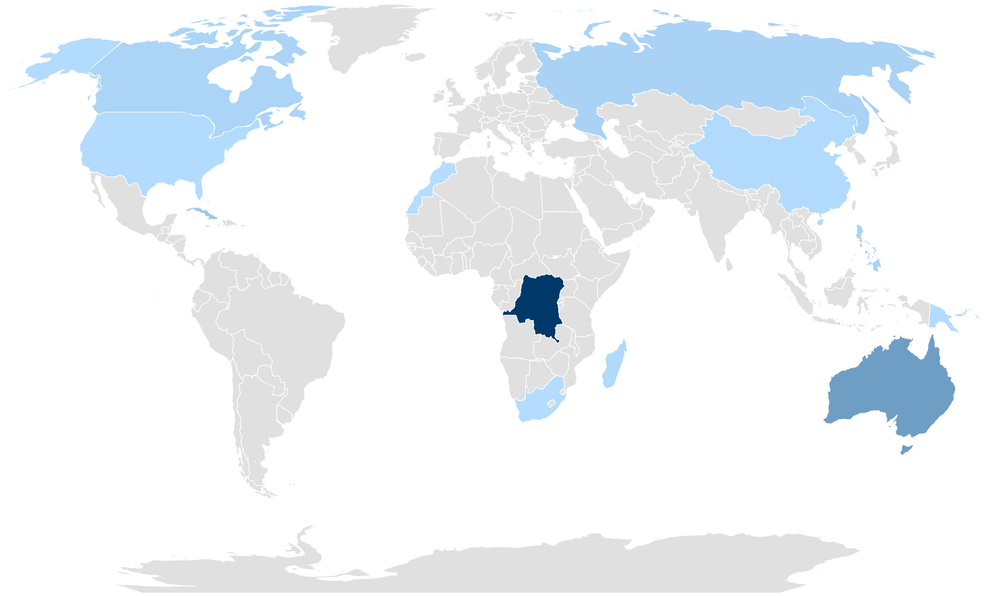
Source: 2000-2020 Cobalt USGS Report

2020 Cobalt Reserves vs. Production

Reserves



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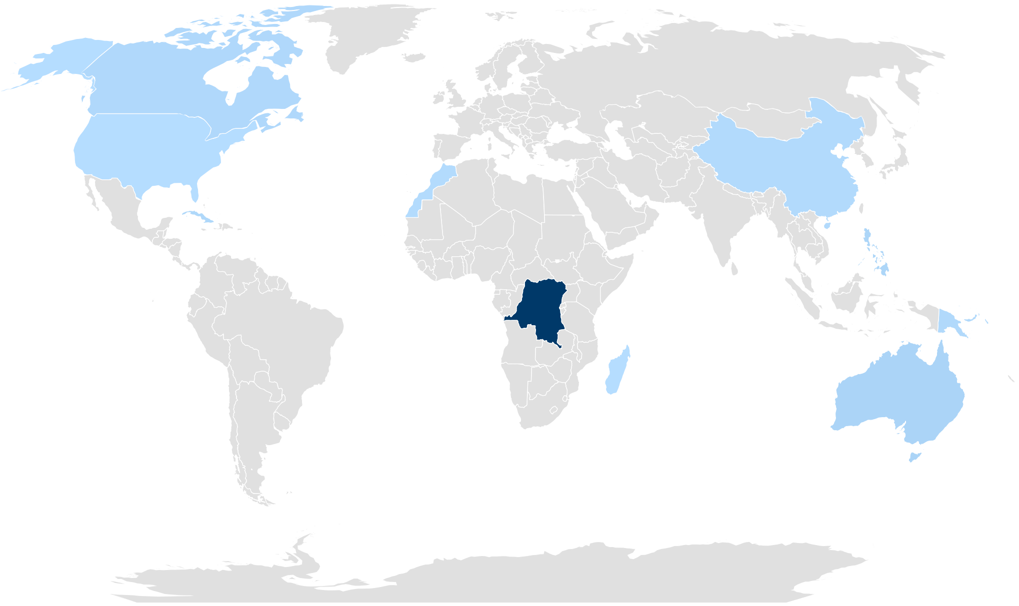
2020 Metric Tons

14,000 3,600,000

Production



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2020 Metric Tons

600 95,000

Source: USGS

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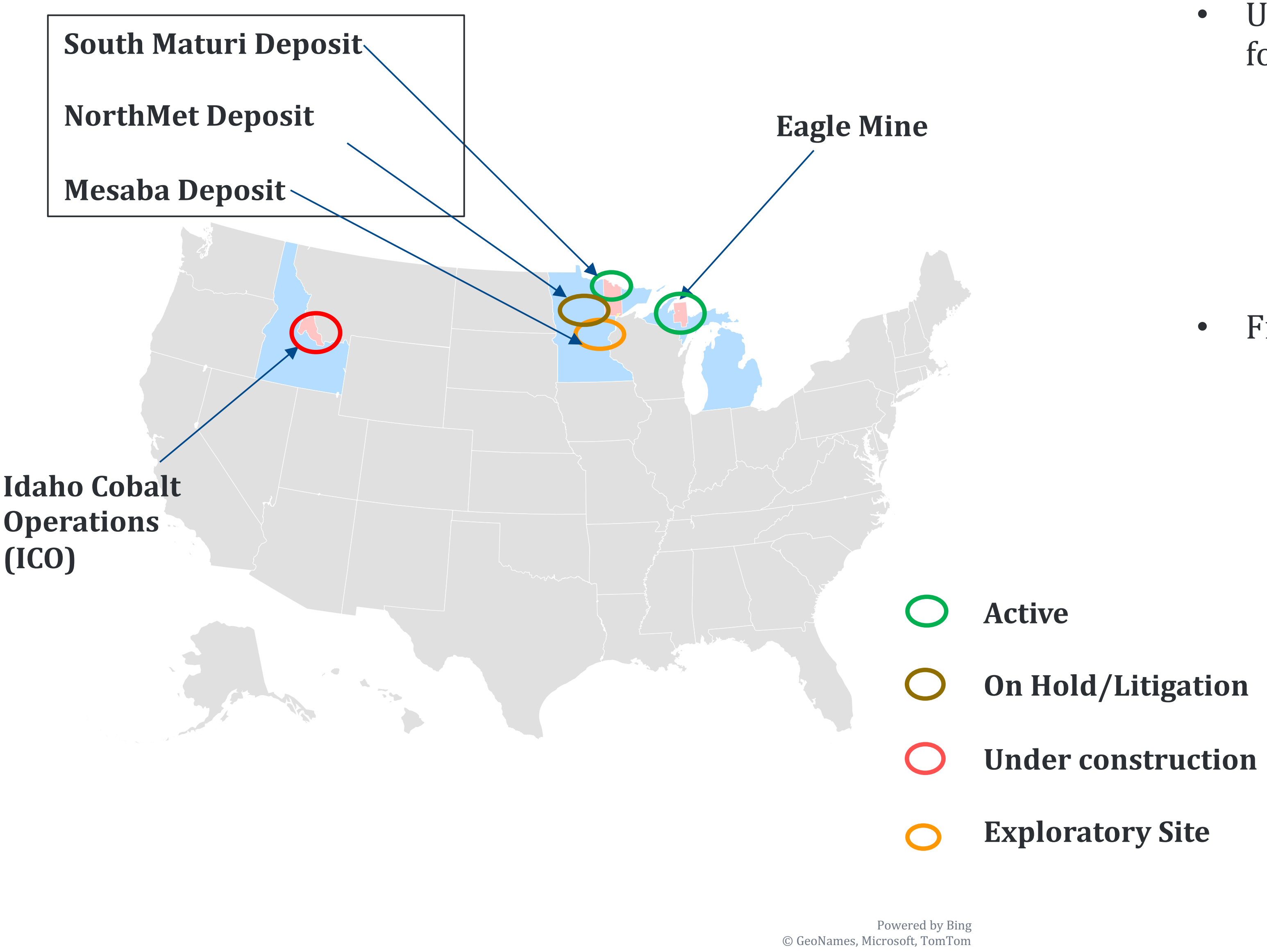
Cobalt Mines & Deposits in the US



- US is not a large producer of Cobalt over the last forty years (~600 mt in 2020)
  - *In 2014 the first exploration began after the four-decade drought*
  - *Cobalt is a secondary product at all of these US locations*

- Five total sites currently exist in US:
  - *Michigan (1):*
    - Eagle Mine owned by Lundin Mining in Marquette county
  - *Minnesota (3):*
    - All 3 sites are located within the same county
    - South Maturi (640 acres) is an active site and the NorthMet (19,000 acres) deposit is on hold due to litigation
      - *Both sites owned by PolyMet Mining*
    - Mesaba Deposit (3,200 acres) is owned by Tecks and has renewed its exploratory phase
  - *Idaho (1):*
    - ICO site is 1,698 acres
    - Production expected to start late-2022
    - Owned and operated by Jervois Mining

Eagle Mine

US Cobalt Mine

- Eagle Mine is in Marquette County and is owned by Lundin Mining based out of Toronto, Canada
  - *Lundin Mining is a publicly traded company on the Toronto Stock Exchange (XTSE)*
- Eagle Mine has been in operation since 2014
  - *Underground mine with a mile long decline tunnel*
  - *Mine is expected to be exhausted by 2025*
- Mine encompasses an area of 150 acres (approximately equivalent to an 18-hole golf course)
- Primary materials are Nickel and Copper and smaller amounts of Cobalt
  - *Total available resources were estimated as the following back in 2014 when the mine started productions:*
    - Cobalt = 165,000 mt
    - Copper = 134,000 mt

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South Maturi Mine

US Cobalt Mine

- South Maturi Deposit in Minnesota is ~640 acres in size
  - *South Maturi mine is currently active*
  - *Referred to as the Twin Metals site or TMM (Twin Metals Minnesota)*
  - *Mine is a Copper and Nickel deposit with Cobalt as a secondary material*

- Life of this mine is expected to be 25 years

- South Maturi deposit is owned by Polymet Mining based out of Toronto, Canada
  - *Polymet is a publicly traded company on the NYSE*

NorthMet Deposit

US Cobalt Mine

- NorthMet deposit is located 6 miles south of Babbitt, MN near the Mesabi Iron Range
- NorthMet Project is owned by Polymet Mining based out of Toronto, Canada
  - *Polymet is a publicly traded company on the NYSE*
- NorthMet deposit has been tied up in a variety of delays and court challenges during its permitting and construction process
  - *Open pit mine (~700 feet below surface)*
  - *Expected life of the mine is 20 – 25 years once it starts full operations*
  - *Mine is currently on hold due to recent Supreme Court ruling in April-2021 and July-2021 due to open-end on mine and environmental challenges*
- Mine encompasses an area of ~19,000 contiguous acres (mine, processing site, transportation corridor and buffer area)
- Multiple materials will be mined at the NorthMet project over its life including:
  - *Copper (~526k mt)*
  - *Nickel (~77k mt)*
  - *Cobalt (2.8k mt)*
  - *Others (smaller amounts of Palladium, Gold & Silver)*

Mesaba Deposit

US Cobalt Mine

- Mesaba deposit is also located in St. Louis County near Babbitt, MN
- Mesaba deposit is owned by Canadian mining firm Tecks
- Mesaba site is still in exploratory phase
- Mesaba site in Minnesota is set on 3,200 acres
- Mesaba deposit contains primarily Copper and Nickel Sulphide material, but also contains ~89,000 mt of Cobalt as a secondary material
- Mesaba site once promised to have over 1,200 jobs but never came through, but in 2019 began doing exploratory drilling

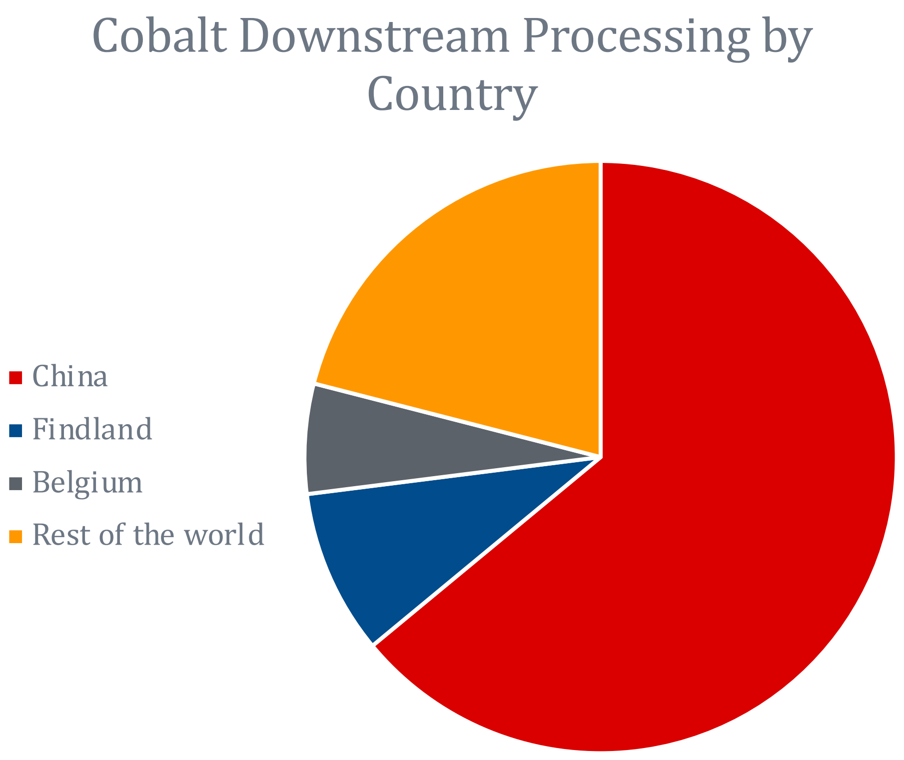
Idaho Cobalt Operation (ICO)

US Cobalt Mine

- Idaho Cobalt Operation (ICO), previously known as ICP was acquired by Jervois Mining in July-2019
- ~13,400 mt Cobalt deposit across a 1,698 acres site
  - *ICO site contains a mix of Copper, Cobalt and Gold*
- Site will have a 7-year life
- Production expected to start late-2022
  - *Recently moved forward with a $78M investment to finish construction that was started in September-2021*
- Jervois Global is an Australia-based mining and exploration company Owned
  - *Largest shareholder is Canadian Register Control (24%)*

Cobalt Downstream Processing

China has a dominant global position in downstream Cobalt processing



Source: IEA – Role of Critical Minerals in Clean Energy Transitions and Martec Analysis

- China conducts approximately two-thirds of the downstream processing of Cobalt
- Finland & Belgium process ~15% - 20% of the mined Cobalt globally into refined material for usage in end applications (i.e., battery grade, consumer electronics, etc.)
- Multiple investments in downstream processing facilities or expansions have been announced:
  - *May-2021:*
    - Zhejiang Huayou & EVE Energy (China companies) to invest in Indonesian Nickel/Cobalt project aiming to produce 15,000 mt of refined Cobalt a year
  - *November-2021:*
    - Electra a Canadian firm (formerly First Cobalt Corp.) announced $56M expansion of Toronto processing facility

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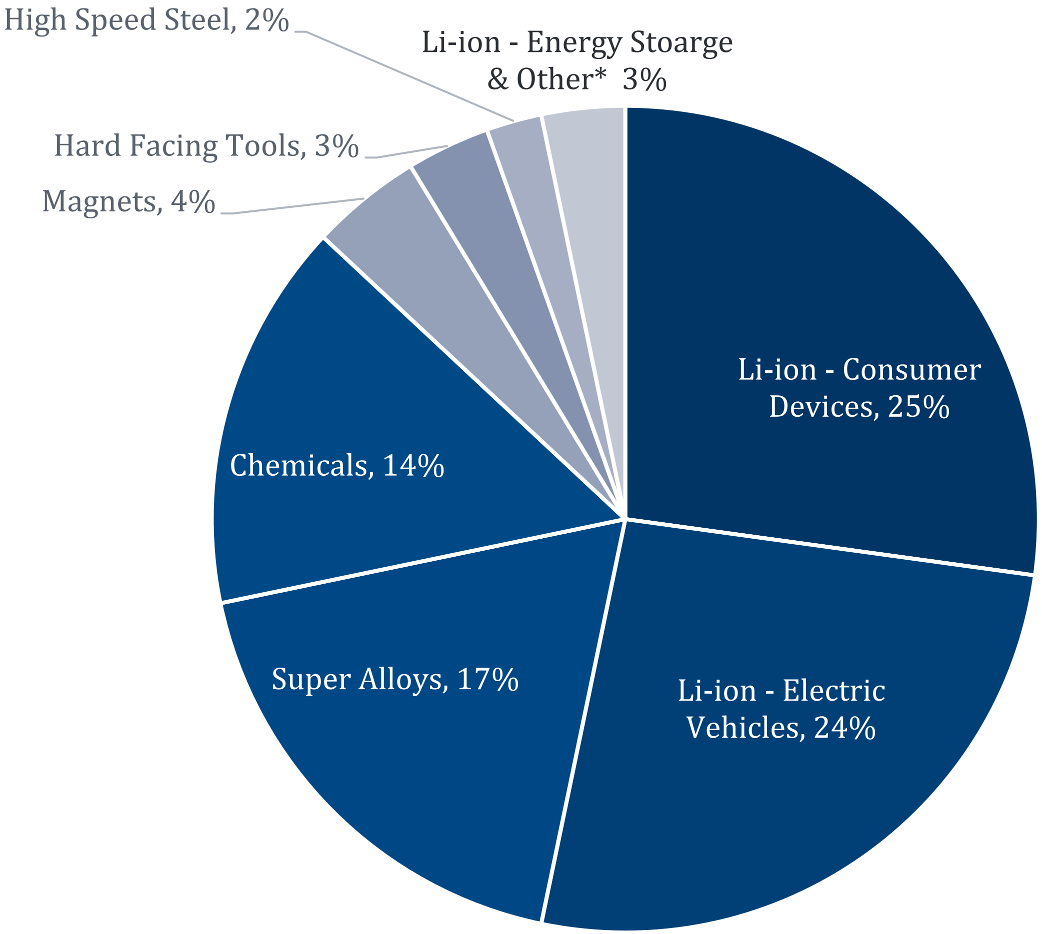
Cobalt End Applications, Trends, & Events

Cobalt contents of Li-ion batteries are expected to be reduced while high-grade nickel content will increase

Cobalt End-Application Usage*



**Note: Li-Ion Energy Storage batteries represent <1%.*

Trends & Events

- Cobalt global CAGR of 15.6% over the past 22 years
  - *Trend has been due to the increase in Li-ion batteries*
  - *Cobalt demand primarily remained unaffected by the COVID-19 pandemic with only a 2.7% decline; EV batteries grew by 5% YoY*
  - *Growth in demand for cobalt batteries helped offset a decline for cobalt in other end applications*
    - Largest declines seen in Ni-base alloys utilized in aerospace and hard facing tools in industrial applications
- China is the world's largest processor of refined cobalt and the worlds largest consumer, consuming ~80% of it going towards rechargeable batteries
- Global cobalt sulfate market is expected to reach $1.1 Billion by 2027

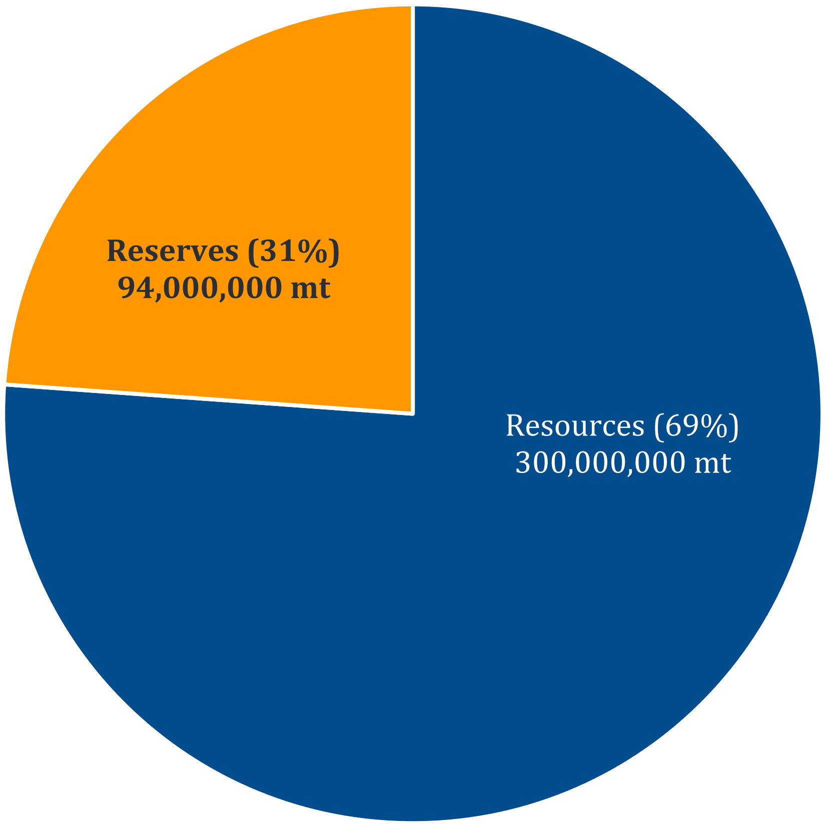
Source: 2020 Cobalt USGS Report

nickel

Nickel Production, Reserves, & Resources

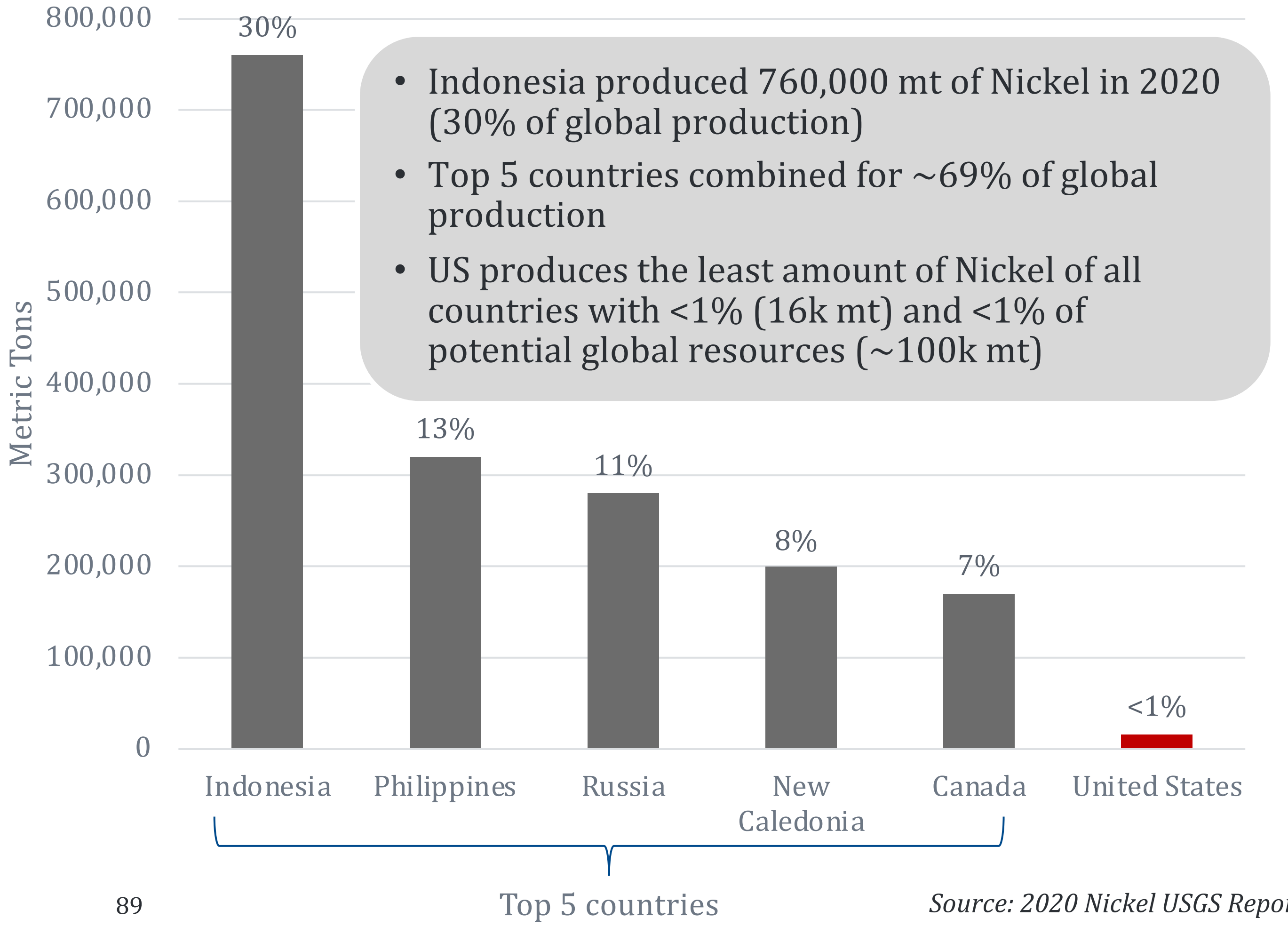
Approximately 70% of the world’s nickel resources have not been explored.
Majority of the world’s nickel production is mined out of Indonesia representing 30% of global production.

2020 Nickel Resource vs. Reserves



Resources includes identified and inferred resource totals.

2020 Global Nickel Production
(Global Production = 2,500,000 mt)



Source: 2020 Nickel USGS Report

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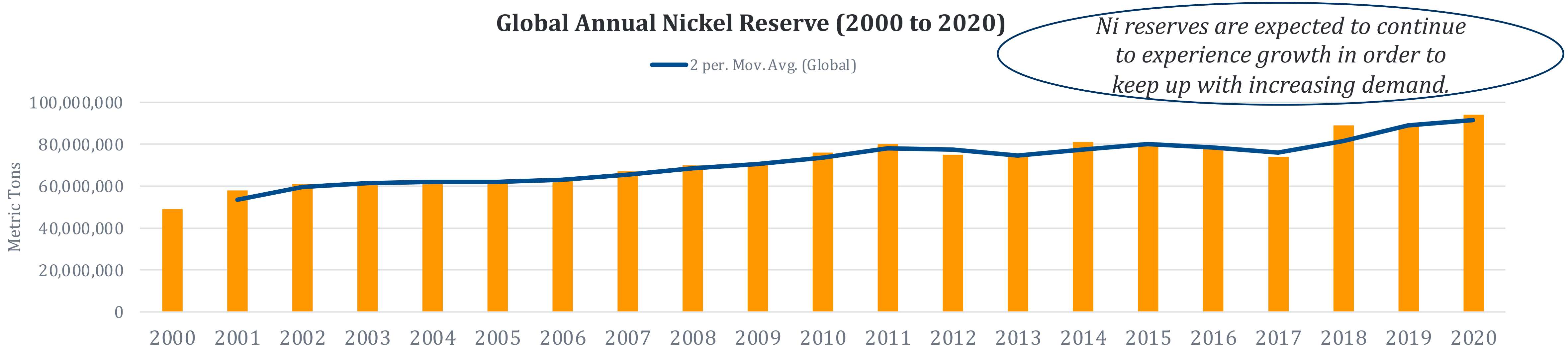
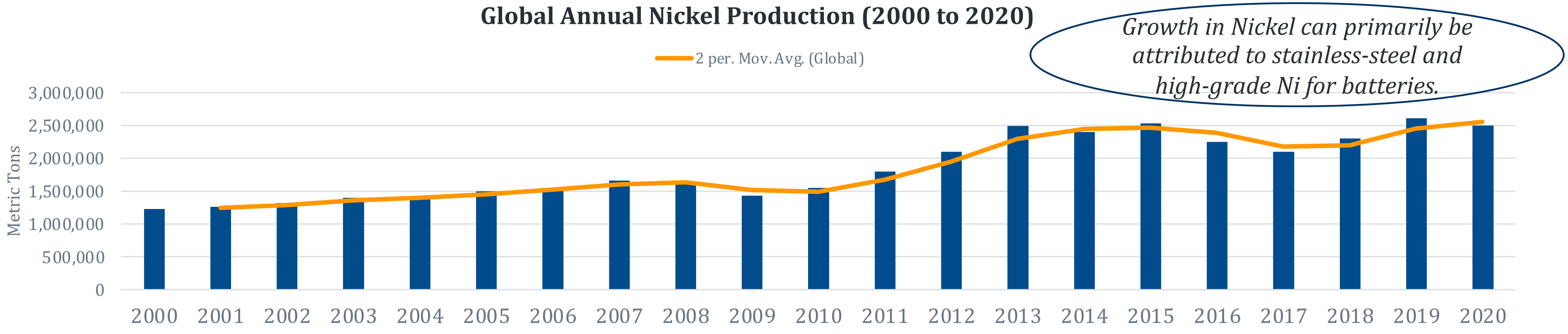
Nickel Historical Production vs. Reserve

Both global nickel reserves and production doubled since 2000, with an emphasis in production since 2010.





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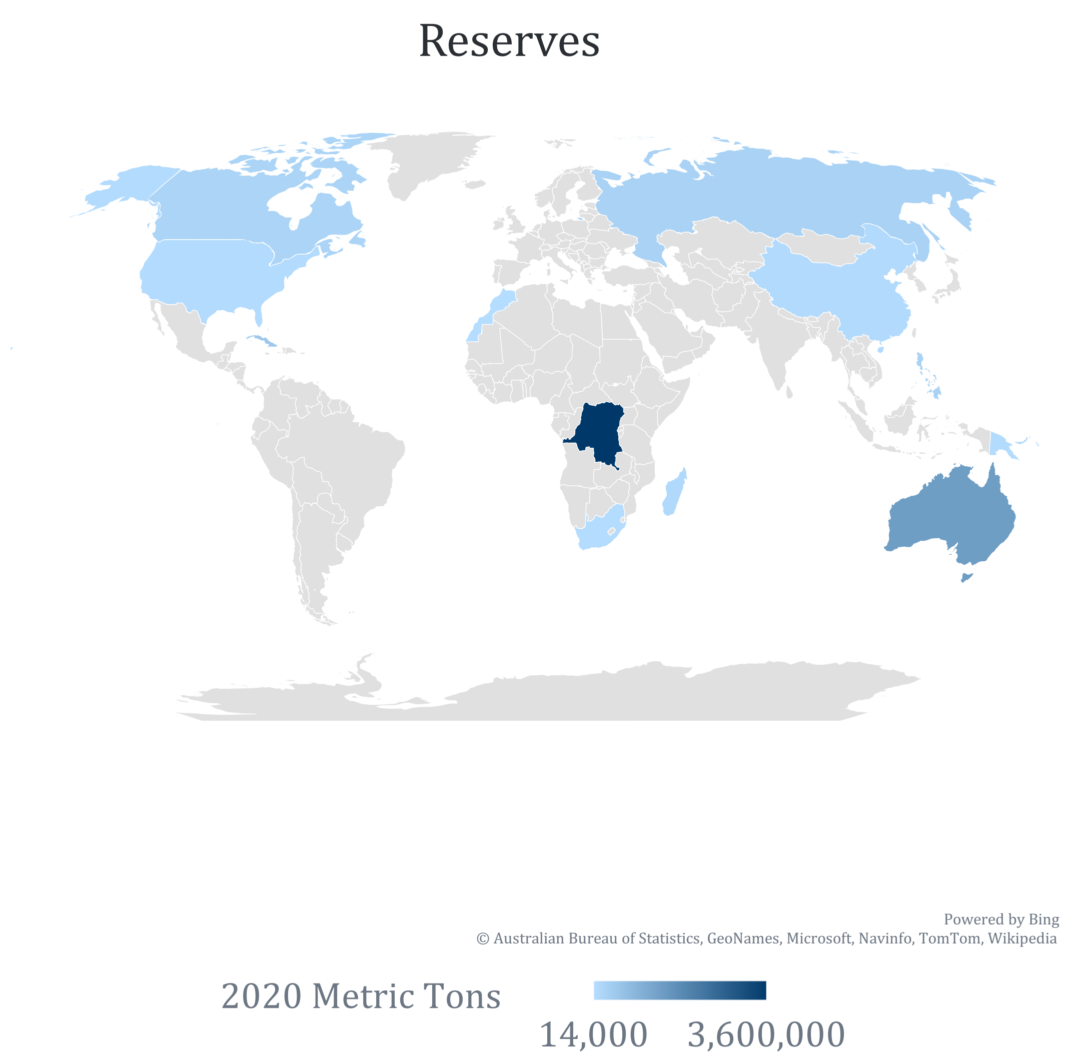
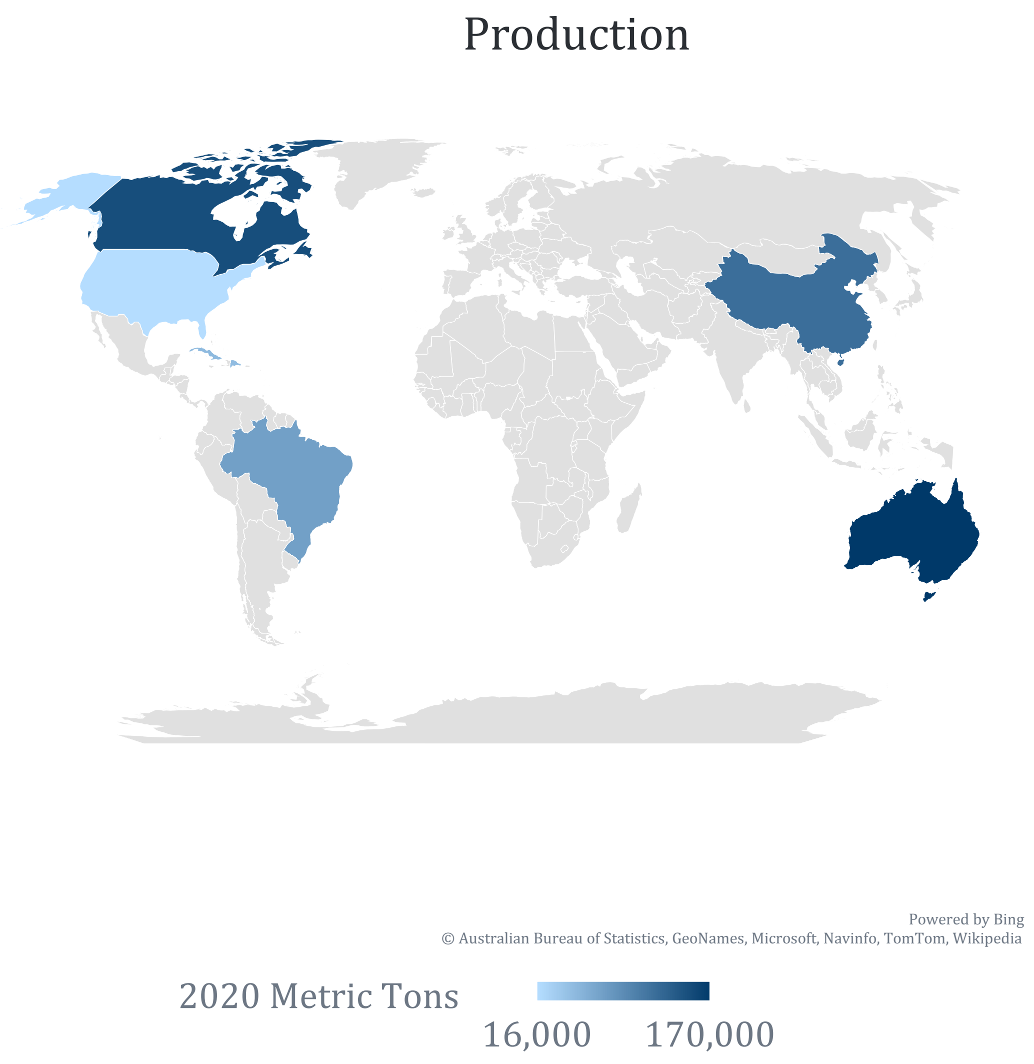
Source: 2000-2020 Nickel USGS Report

2020 Nickel Reserves vs. Production





Source: USGS

Martec

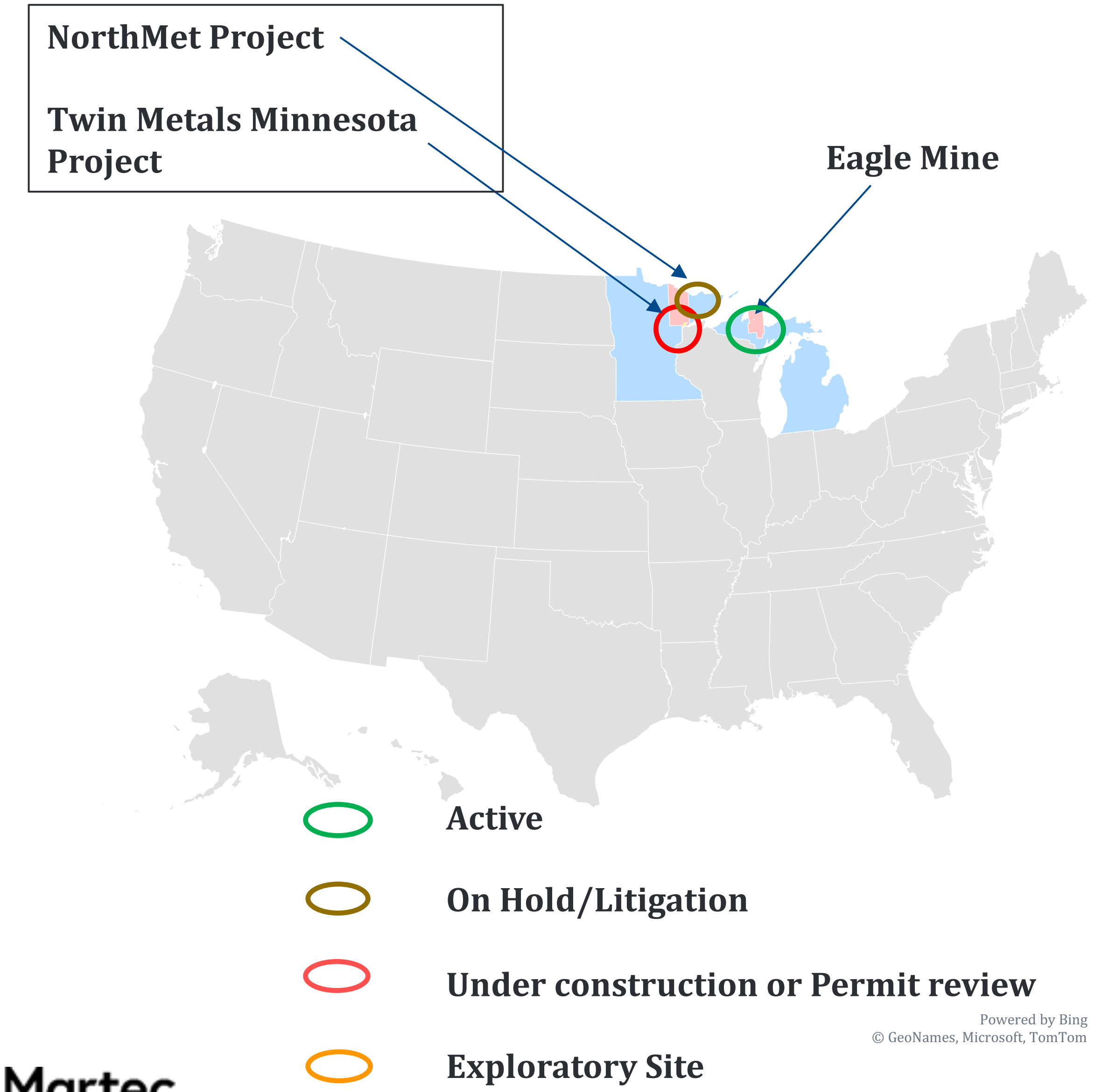
Mining Timeline General Overview for Nickel

Timeline can vary significantly from exploratory to actual commercial production for a mine

Timeline can range from 3 – 20 years before production

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Time Range	Laterite: Low Sulphide: High 1 -10 years	Laterite: Low Sulphide: High 1 – 5 years	Laterite: Low Sulphide: Medium 1 – 5+ years	Laterite: Low Sulphide: Medium	Laterite: Low Sulphide: High
Avg. Time by Stage	Laterite: 1 - 2 Sulphide: 2 - 3	Laterite: 1 - 2 Sulphide: 3	Laterite: 2 Sulphide: 4	Laterite: 25 years Sulphide: 25 years	N/A
Low to High Invmt. Cost	\$40M - \$150M	\$75M - \$250M	\$500M - \$2,800M	\$100M - \$200M+/yr.	\$25M – \$75M
Avg. Investment Cost by Stage	~\$100M+	~\$200M+	Avg. ~\$1,500M *(Ref: \$10k/1MT)*	\$150M+/yr.	~\$50M+
Key Steps by Stage (Check)	• Prospecting • Reconnaissance • Survey mapping • Sampling • Geochemical analysis	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase	• Ore extraction • Milling / Ore separation • Processing • Grade control • Waste rock/tailings & wastewater mgmt.	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

Nickel Mines & Deposits in the US



- US is not a large producer of Nickel
  - *US produced only 16,000 mt in 2020, <1% of Nickel mined globally*
- Only current active Nickel mine is in Marquette County in the Upper Peninsula of Michigan (Eagle Mine)
  - *Eagle Mine is owned by Lundin Mining (Canadian firm)*
    - Eagle is expected to exhaust the remaining Nickel by the end of 2025
  - *Mined Nickel is sent to Canada for refining*
- Additional Nickel deposits and mines under construction exist in Minnesota
  - *NorthMet Project, open pit mine (federally permitted in 2019)*
    - Site still is in litigation but will have a 20+ year life
  - *TMM Project, underground mine and is under permit review by state of Minnesota*

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Eagle Mine

US Nickel Mine

- Eagle Mine is located in Marquette County and is owned by Lundin Mining based out of Toronto, Canada
    - ➢ *Lundin Mining is a publicly traded company on the Toronto Stock Exchange (XTSE)*

- Eagle Mine has been in operation since 2014
    - ➢ *Underground mine with a mile long decline tunnel*
    - ➢ *Mine is expected to be exhausted by 2025*

- Mine encompasses an area of 150 acres (approximately equivalent to an 18-hole golf course)

- Primary materials are Nickel and Copper and smaller amounts of Cobalt
    - ➢ *Total available resources were estimated as the following back in 2014 when the mine started productions:*
        - – Cobalt = 165,000 mt
        - – Copper = 134,000 mt

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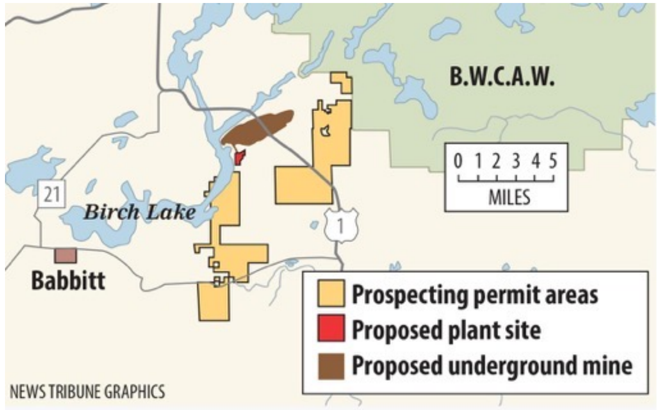
NorthMet Project

US Nickel Mine

- NorthMet Project is owned by Polymet Mining based out of Toronto, Canada
  - *Polymet is a publicly traded company on the NYSE*
- NorthMet deposit has been tied up in a variety of delays and court challenges during its permitting and construction process
  - *Open pit mine (~700 feet below surface)*
  - *Expected life of the mine is 20 – 25 years once it starts full operations*
  - *Mine is currently on hold due to recent Supreme court ruling in April-2021 and July-2021 due to open-end on mine and environmental challenges*
- Mine encompasses an area of ~19,000 contiguous acres (mine, processing site, transportation corridor and buffer area)
- Multiple materials will be mined at the NorthMet project over its life including:
  - *Copper (~526k mt)*
  - *Nickel (~77k mt)*
  - *Cobalt (2.8k mt)*
  - *Others (smaller amounts of Palladium, Gold & Silver)*

Twin Metals Minnesota (TMM) Project

US Nickel Mine



- TMM is owned by Chile-based mining company Antofagasta
  - *Antofagasta (Chile) acquired Duluth Metals (60%) ownership back in 2014*

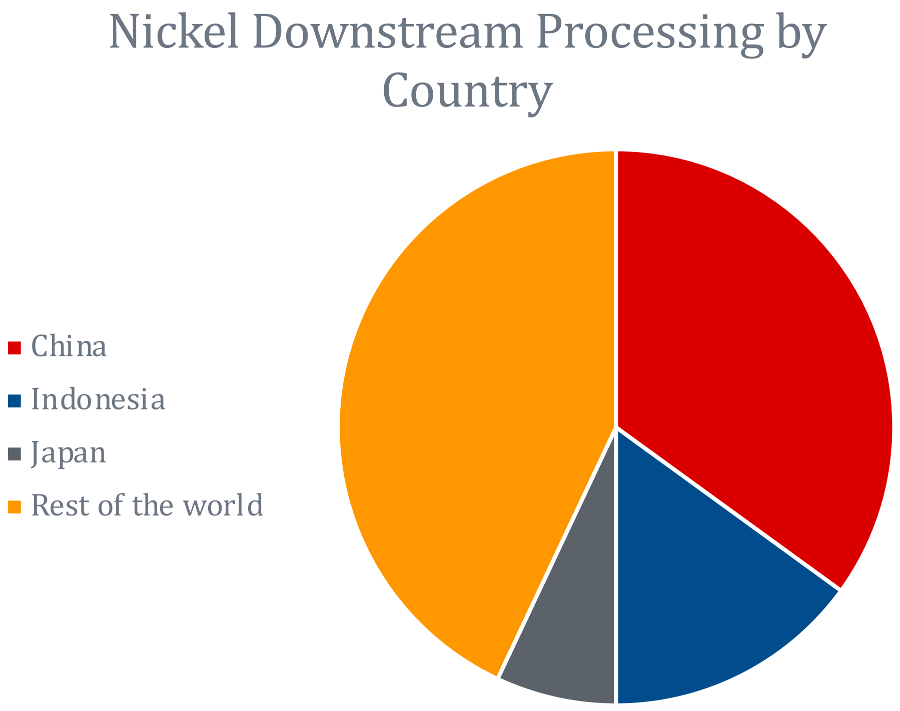
- TMM project is located near Ely, MN (in northern MN) and its permit is under review by the state of Minnesota
  - *Underground mine*
  - *Expected life of the mine is 30 years once it starts full operations*
  - *Multiple years for review and potential legal challenges are expected*

- Mine area encompasses an area of >30,000 acres
  - *Indications are the Duluth Complex where the TMM resides in contains ~95% of the Nickel available resources in the US*

- Multiple materials are planned to be mined at the TMM project over its life including:
  - *Copper (~2.6M mt)*
  - *Nickel (~544k mt)*
  - *Others (smaller amounts of Platinum, Palladium, Gold & Silver)*

Nickel Downstream Processing

China has a dominant global position in downstream Ni processing



Source: IEA – Role of Critical Minerals in Clean Energy Transitions

- China produces ~35% of the downstream processing of Nickel
    - *Indonesia and Japan are the next two leading countries with ~12% - 15% of Ni downstream processing combined*

- Nickel tends to be more broadly processed due to its heavy usage in stainless steel on a global basis compared to other key minerals

- Several companies are investing in new HPAL plants (High Pressure Acid Leaching) in Indonesia to process mined Nickel to produce battery-grade Ni-Sulphate
    - *Ningbo Lygend (China) – Obi Island: ~52k mt (~$1B investment)*
    - *GEM (China) – Morowali/Jingmen unit: ~50k mt (~$700M by 2022)*
    - *PT Aneka Tambang (Indonesia) - Antam ~50k – 100k mt by 2024*
        - Working with two Chinese firms (Shandong Xinhai & Huayu)
    - *PT Vale (Brazil) - Pomalaa plant: ~40k mt by 2026*

- Australia is expected to be a major contributor in the near future as it further ramps up its new Nickel Sulphate downstream processing plant at its Nickel West Kwinana refinery near Perth
    - *BHP in process of ramping up its new ~100k mt capacity (late-2021)*
    - *BHP looking to 2X capacity due to growth in auto BEV sector globally*

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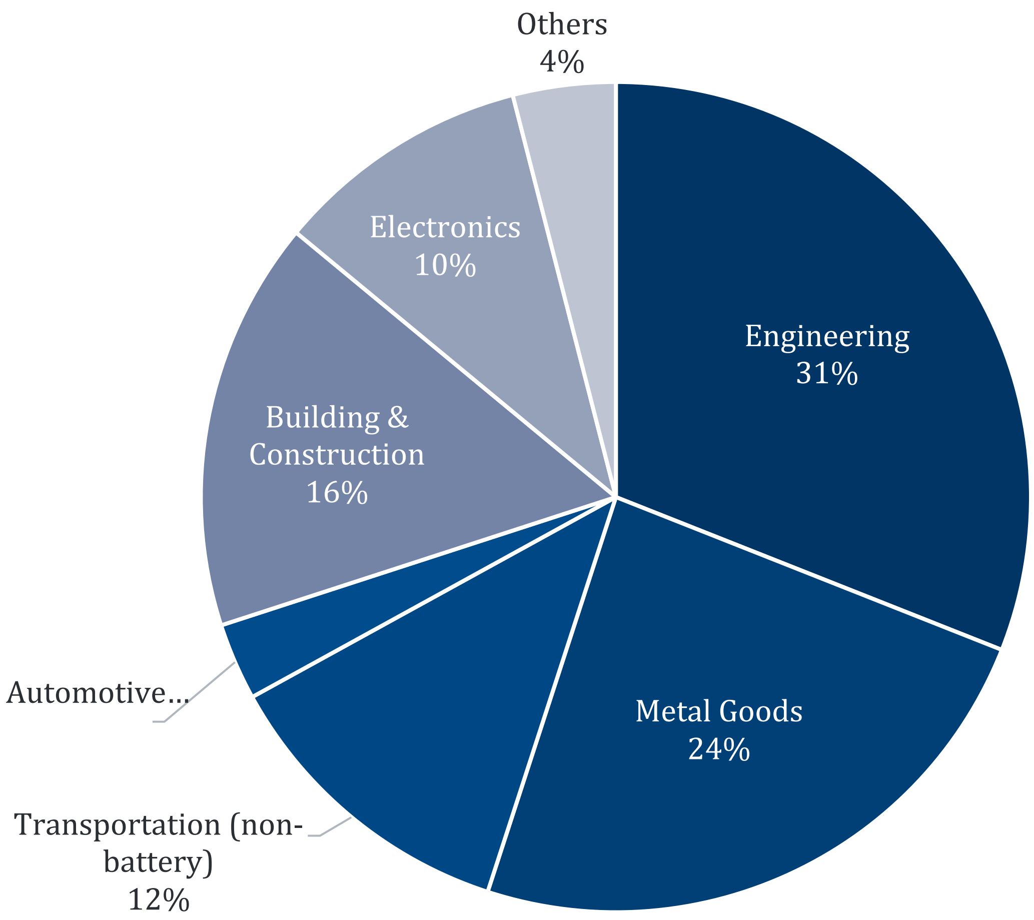
Nickel End Applications, Trends, & Events

Currently 8% of lithium-ion batteries are high nickel NMC batteries, but EV batteries only represent 3% of overall nickel usage. This is expected to rise to nearly 50% by 2030.

Nickel End-Application Usage



Note: *Li-Ion Energy Storage batteries represent <1%.*

Trends and Events

- Nickel is heavily utilized as a component in alloys to make stainless-steel in a variety of end use applications
  - *Stainless-steel alloys are a leading driver of nickel demand in the coming future as well as automotive batteries*
  - *~65% of Ni goes into production of alloys for stainless steel*
- Total domestic consumption of stainless-steel decreased by ~10% in 2020 primarily due to the impact of COVID
  - *Decreases have been primarily offset by a rapid recovery in China*
- Asia-Pacific is expected to play a prominent role in the nickel market in the future due to battery & stainless-steel production
  - *~80% of all Nickel is processed in China*
- Biggest challenge is not as much on the mining of Nickel for battery grade but the downstream processing that is very costly
  - *High up-front investment and high CO2 emission, dirty process with most capacity in China and Indonesia*

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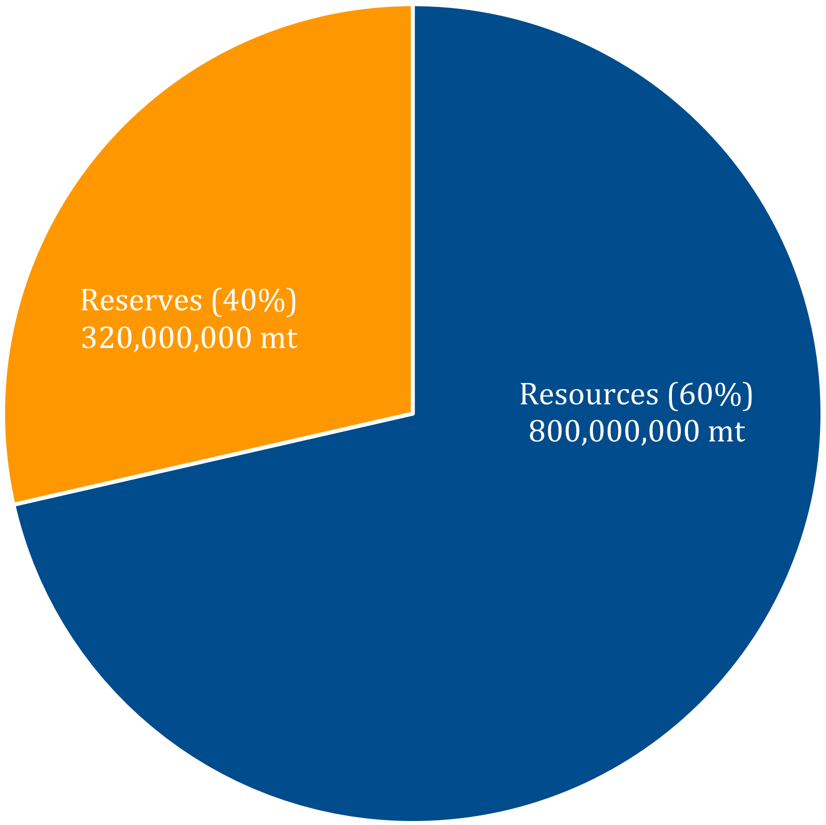
Source: 2020 Nickel USGS Report

graphite

Graphite Production, Reserves, & Resources

Nearly 500 million mt of graphite has not been explored while only <1% of the world's graphite is mined and produced. China produces the largest share of the world's graphite material at 59%.

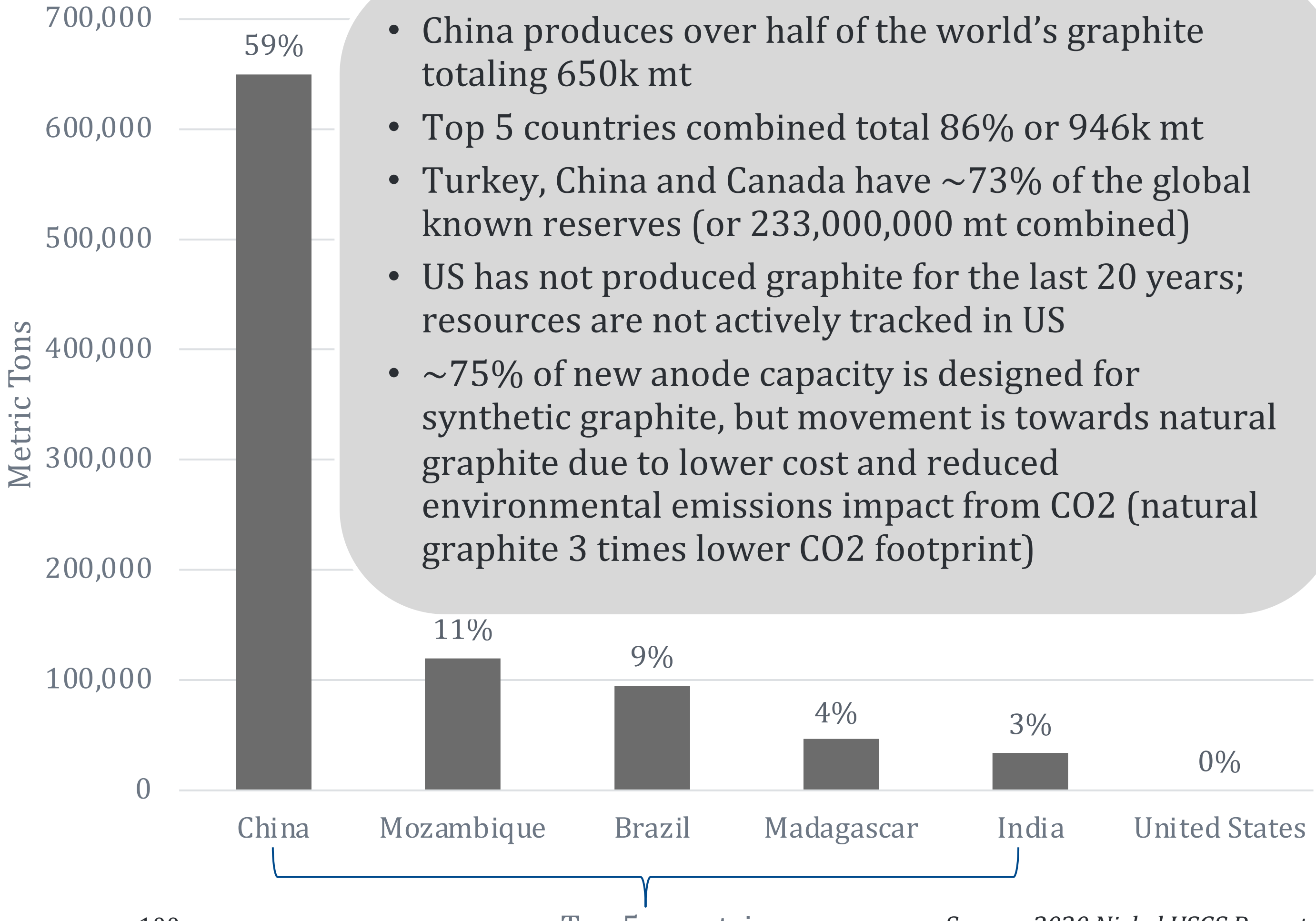
2020 Graphite Resource vs. Reserves



Resource statistics includes identified and inferred resource totals.

2020 Global Graphite Production by Top 5 Countries

(Global Production = 1,100,000 mt)

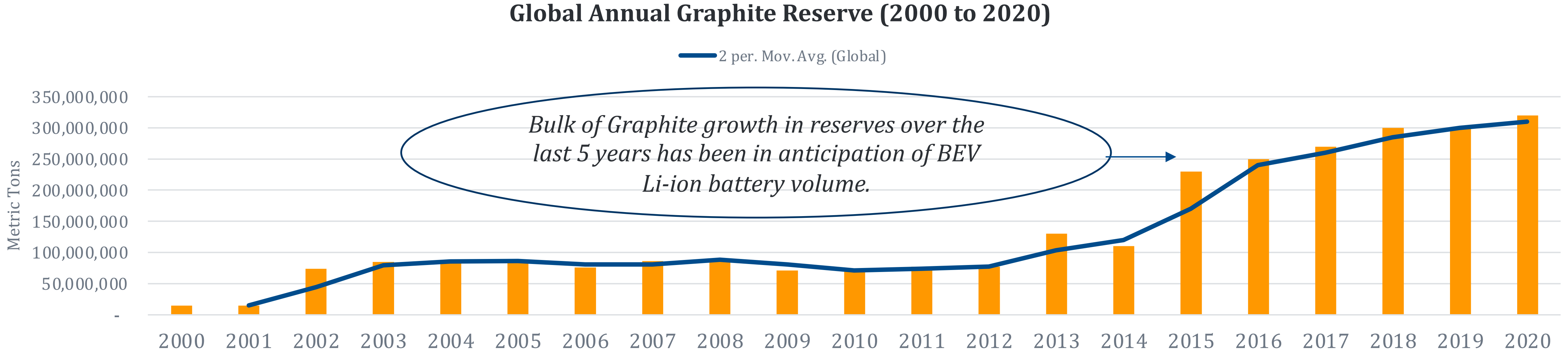


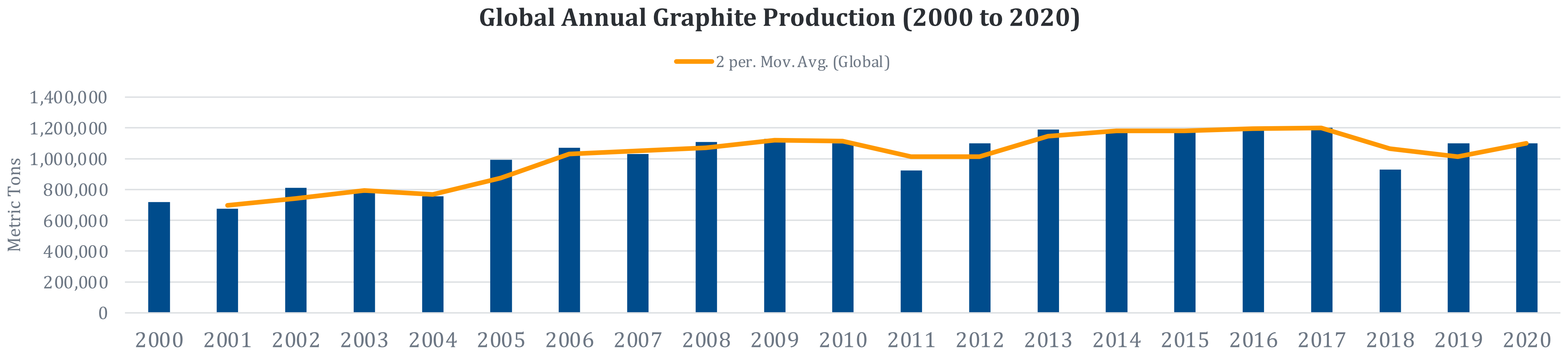
- China produces over half of the world's graphite totaling 650k mt
- Top 5 countries combined total 86% or 946k mt
- Turkey, China and Canada have ~73% of the global known reserves (or 233,000,000 mt combined)
- US has not produced graphite for the last 20 years; resources are not actively tracked in US
- ~75% of new anode capacity is designed for synthetic graphite, but movement is towards natural graphite due to lower cost and reduced environmental emissions impact from CO2 (natural graphite 3 times lower CO2 footprint)

Source: 2020 Nickel USGS Report

Graphite Historical Production vs. Reserve

Since 2015, graphite reserves exponentially grew, while production remained static through the last decade





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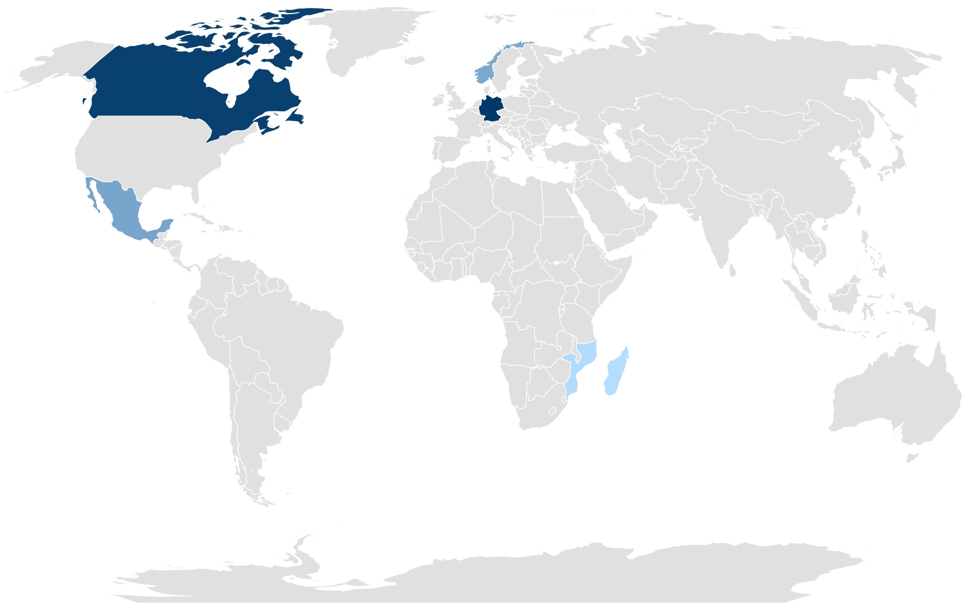
Source: 2000-2020 Nickel USGS Report

2020 Graphite Reserves vs. Production

Reserves



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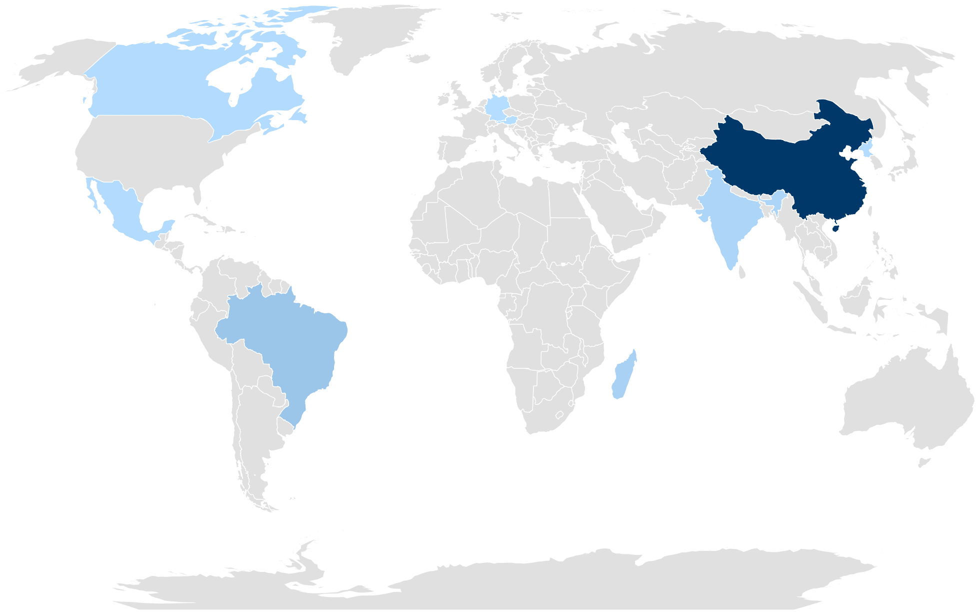
2020 Metric Tons

2,000,000 73,000,000

Production



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2020 Metric Tons

800 650000

Source: USGS

Mining Timeline General Overview for Graphite

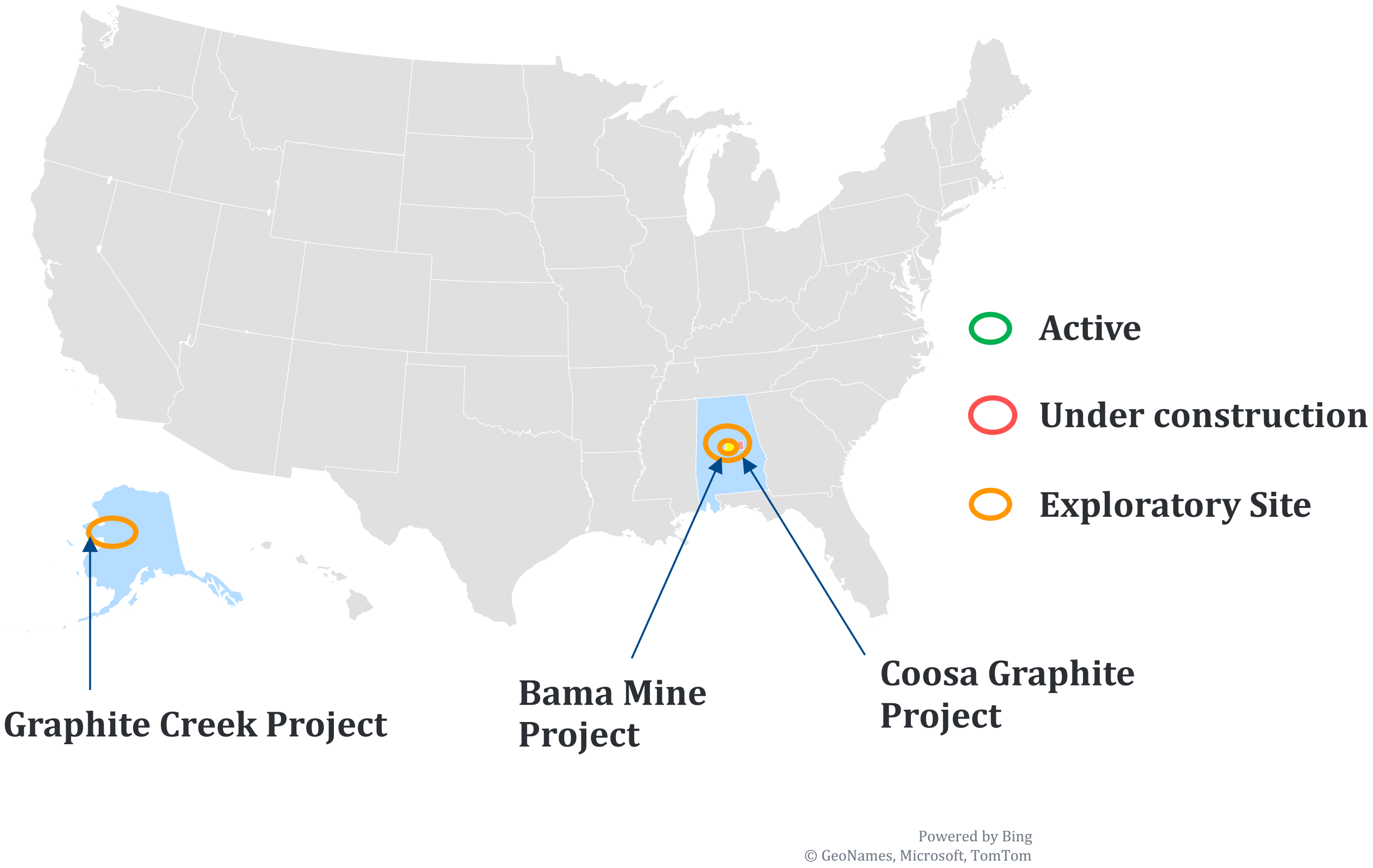
Timeline can vary significantly from exploratory to actual commercial production for a mine

Timeline can range from 6 – 10 years before production

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Time Range	China: Low ROW: 1 – 3 years *(excluding US*)*	China: Low ROW: 2 – 4 years *(excluding US*)*	3 - 5 years	25-60 years	5 years
Avg. Time by Stage	1 - 2 years	1 – 3+ years	4 years	30+ years	3+ years
Low to High Invmt. Cost	$10M - $30M+	$15M - $50M+	$200M - $300M *(excluding China)*	$25M - $100M/year	$10M - $30M+
Avg. Investment Cost by Stage	~$20M+ *(excluding US*)*	~$30M+ *(excluding US*)*	~$250M	~$65M *(operating cost typically $400 - $500/MT)*	~$25M
Key Steps by Stage	• Prospecting • Reconnaissance • Survey mapping • Sampling • Geochemical analysis • Resource estimation	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase • Construction	• Ore extraction • Milling / Ore separation • Processing • Grade control • Waste rock/tailings & wastewater mgmt. • Near mine exploration • Expansion life of mine	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

**Note: Excludes US as there are no active graphite mines.*

Graphite Mining in the United States



- Currently there are no sites where Graphite is actively mined in the US
- Graphite One started an exploratory project in 2021 in Alaska
  - *US Federal Government has deemed this project a High-Priority Infrastructure Project (HPIP)*
  - *Size is 18,000 acres*
- Westwater Resources has two exploratory projects in the pipeline in Alabama
  - *“The Bama Mine Project”*
    - Size is 1,500 acres
  - *“Coosa Graphite Project”*
    - Size is 42,000 acres

Graphite Creek Project

US Graphite Mine

Graphite One

- Graphite Creek project began construction during Q2 - 2019 and is spread over 18,000 acres north of Nome, Alaska
  - *New exploratory drilling project began July-2021*
- Mine will produce high-grade spherical graphite and will process 1.018M mt of graphite ore with 60,000 mt of which will be recovered annually
  - *Expected processing capability will be able to produce ~41,850 mt annually*
- Approximate mine lifespan is 40 years
  - *An estimated 80% of graphite from the raw ore will be recovered*
- Graphite Creek has ~81.6M mt of estimated resources
- Location is considered superior for graphite due to the grade, size, and percentage of large-flakes and overall infrastructure capabilities
  - *Primary end application is for Li-Ion batteries*
- Graphite One is the owner of Graphite Creek project and is a publicly traded company headquartered out of Canada
  - *Primary owner of GOR is "Keystone Wealth Partners" which owns all issued shares outside of institutional ownership*

Source: USGS

Coosa Graphite Mining Project

US Graphite Mine

WESTWATER RESOURCES

- Project began in 2015, all proper permits are expected to be finalized by end of 2021 with construction starting immediately
  - *Anticipate commercial production by end of 2023*
  - *Expected life span of the mine is ~27 years*
- Project was started by Alabama Graphite Corporation (AGC), then Colorado based company Westwater Resources Inc. agreed to purchase all shares of AGC, ownership transfer completed in 2018
  - *Westwater Resources Inc. is a publicly traded company on AMEX (WWR)*
- Mining operations are spread over 42,000 acres
- Mining is broken out into stages, as the mine continues to operate it will become more efficient
  - *When commercial mining begins expect ~8,050 mt annually to start*
  - *After 7 years the mine is expected to be running at full capacity and processing ~16,500 mt annually*
  - *Reserves at the site are estimated to be 78.4mt indicated and another 79.4M inferred with a recovery rate of 92%*

Bama Mining Project

US Graphite Mine

WESTWATER RESOURCES

- Bama Mining Project sits on roughly 1,500 acres and is also owned by Colorado based firm Westwater Resources Inc.
  - *Bama Mine (Graphite Belt Region) historically ceased production of Graphite back in the 1930s*

- Bama site is much smaller than the Coosa mining site and are in the same county
  - *Actual reserves are currently unknown at this point*

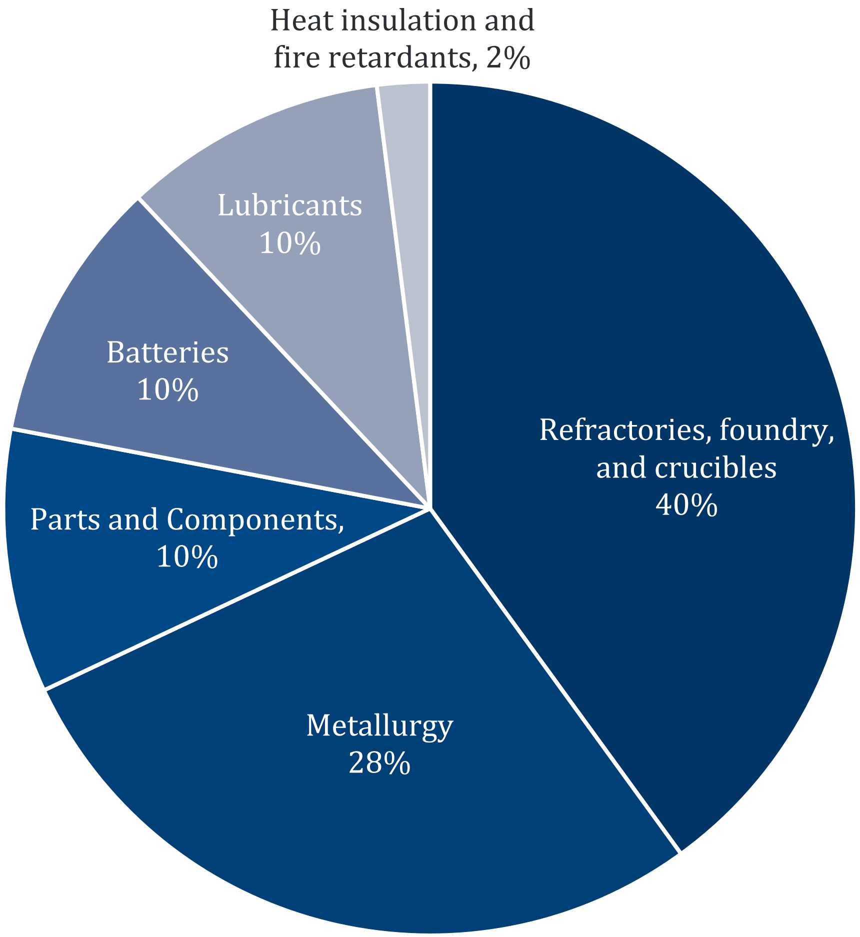
- Westwater Resources Inc. announced in July-2021 that it will be investing significant funds to develop a state-of-the-art processing plant with the intention of supplying material for BEVs
  - *Initial investment of $80M to build a graphite processing plant*
  - *Second phase of the investment will be ~$44M to help hire 200+ workers for the site along with other capital & site improvements*
  - *This new processing operation will process material from both mining operations in Alabama (Bama and Coosa)*

- Top 3 owners of WWR are Vanguard Group, Susquehanna International, and Blackrock Inc.

Graphite End Applications, Trends, & Events

10% of the world's graphite is utilized for batteries which would equate to ~110,000 mt of graphite production

Graphite End-Application Usage



***Note:** Li-Ion Energy Storage batteries represent <0.5%.*

Trends and Events

- Major end uses of natural graphite are brake linings, lubricants, powdered metals, refractory applications, and steelmaking
- Imports and consumption both peaked, and declined each year during 2019 and 2020
- Through 2026 Graphite is forecasted to have a CAGR of approximately 5%
- Rising production of steel using the electric arc furnace process and EV batteries are expected to increase the demand for graphite
- Demand for lithium-ion batteries in China is expected to grow rapidly, owing to a rise in the adoption of new energy vehicles (NEVs) and ESS for on-grid and off-grid applications

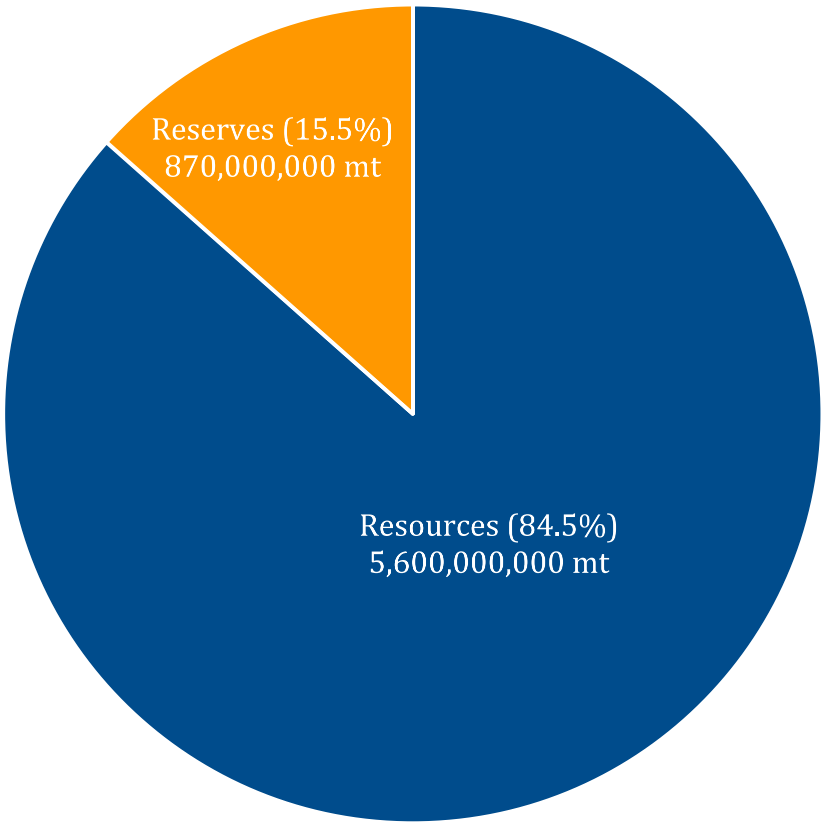
Source: 2020 Graphite USGS Report

copper

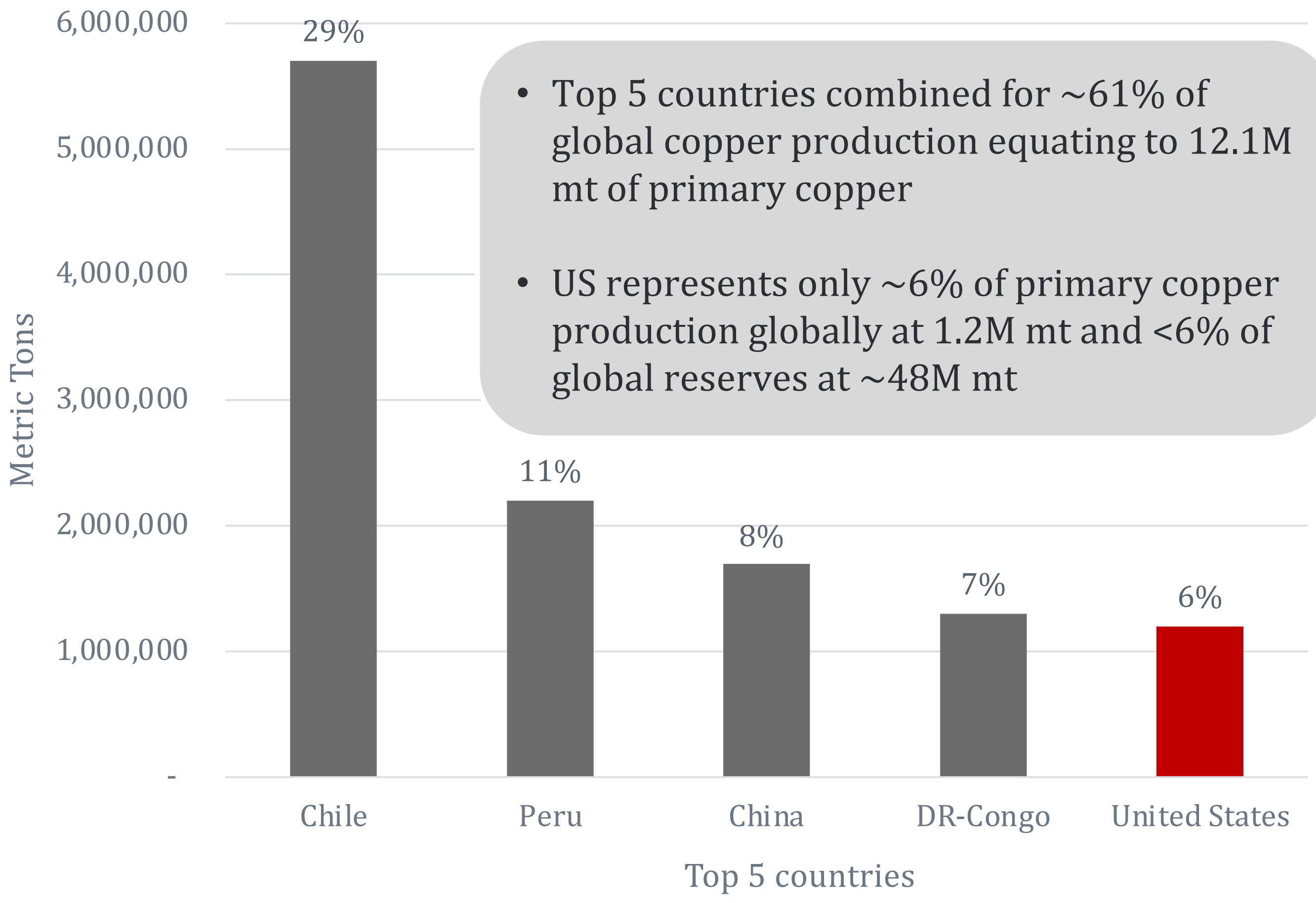
Copper Production, Reserves, & Resources

Nearly 5 billion of the world's copper has not been explored with only 15% of copper in reserves.

Chile is the leading producer of copper with 29% of global production or 5.7M metric tons.



Resource statistics includes identified and inferred resource totals.

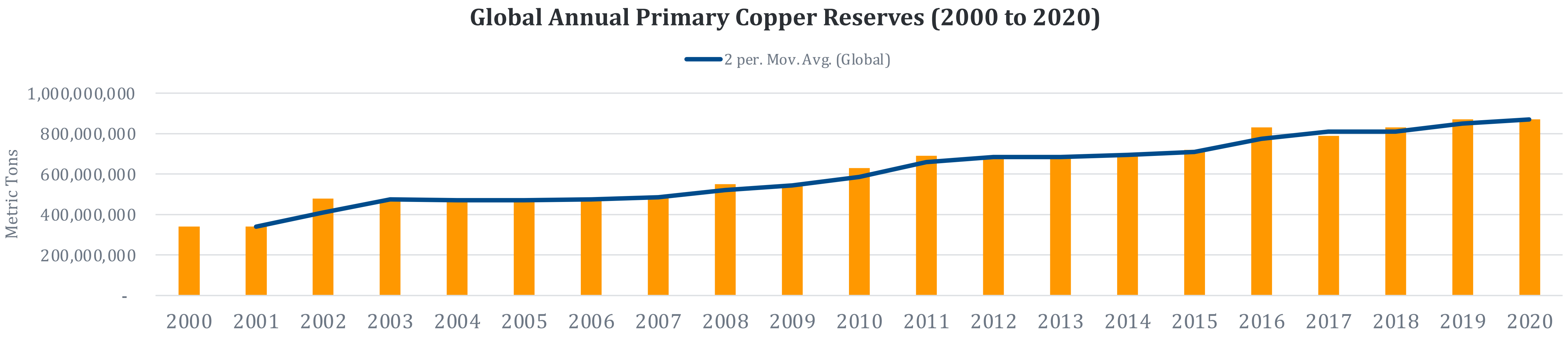


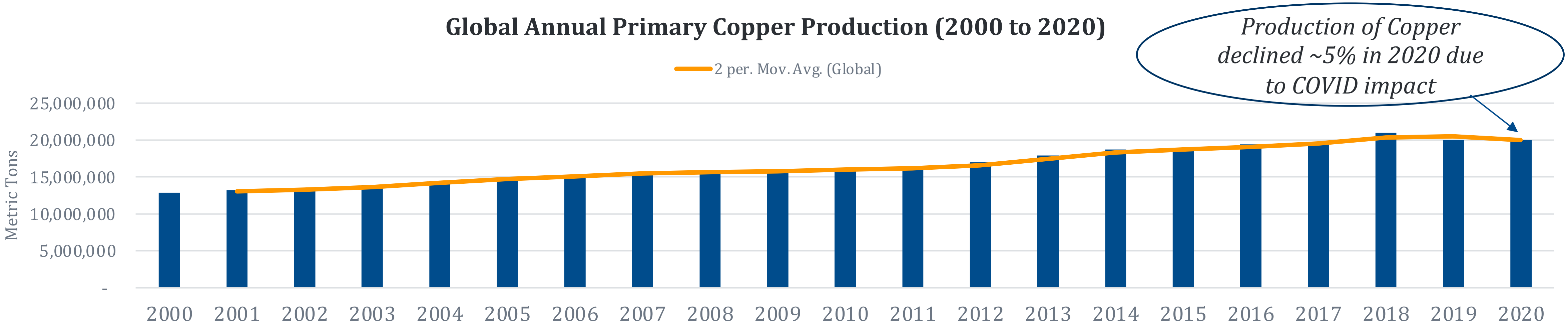
- Top 5 countries combined for ~61% of global copper production equating to 12.1M mt of primary copper
- US represents only ~6% of primary copper production globally at 1.2M mt and <6% of global reserves at ~48M mt

Source: 2020 Copper USGS Report

Copper Historical Production vs. Reserves

Global primary copper production has increased 7M mt/yr. since 2000 while reserves have grown 2.5 times.





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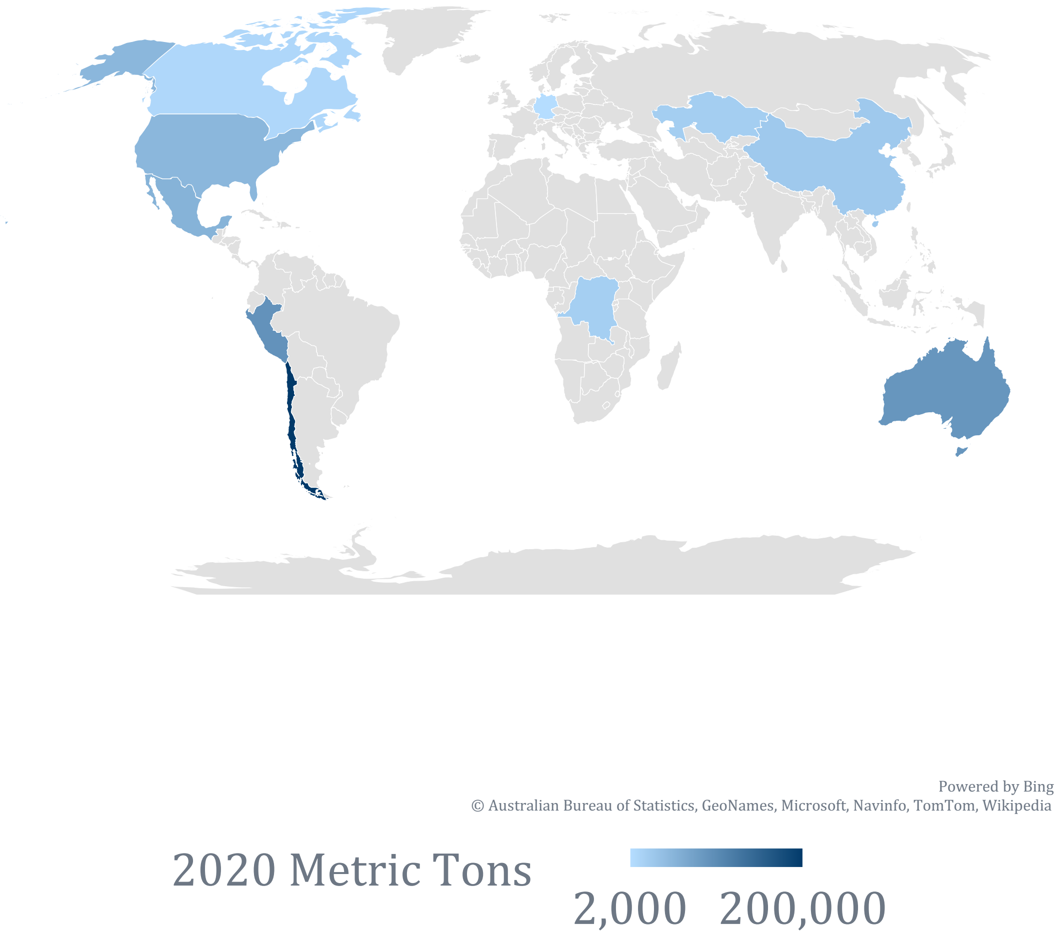
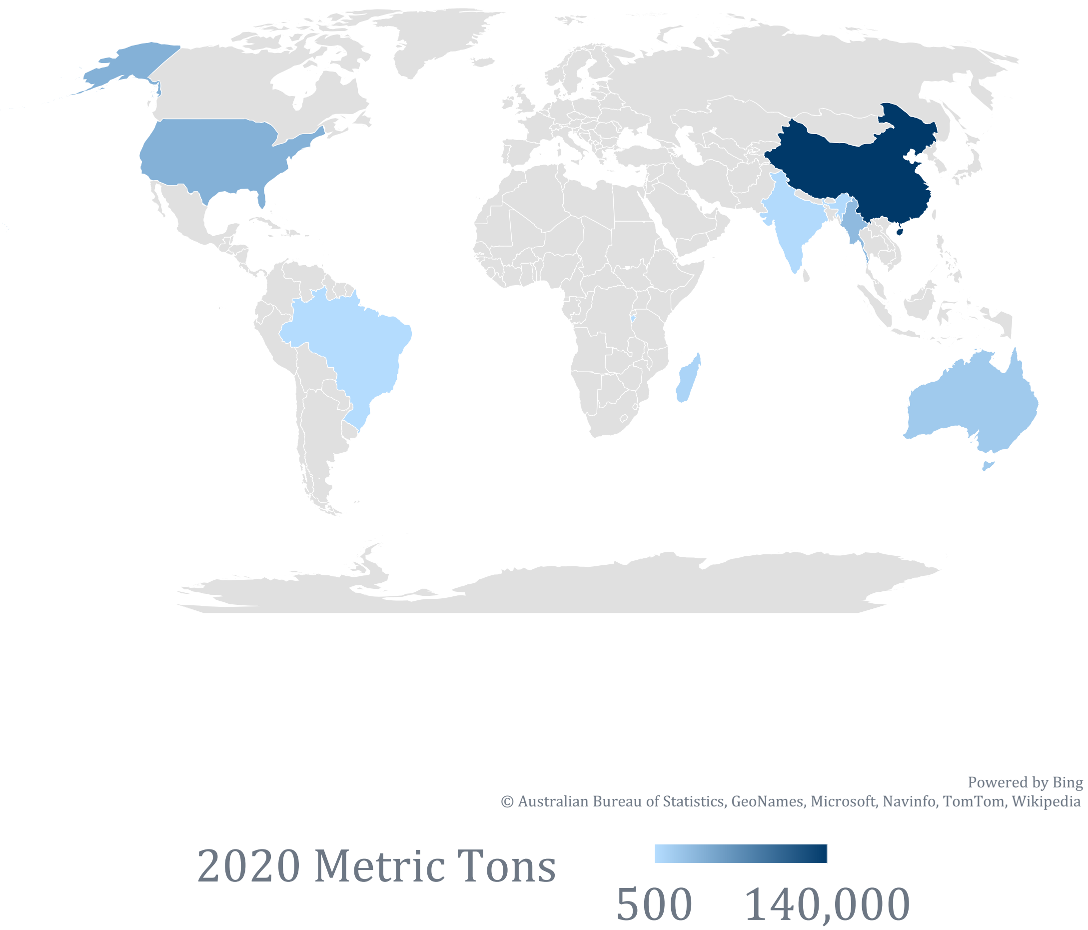
Source: 2000-2020 Copper USGS Report

2020 Copper Reserves vs. Production

Reserves



Production*



**Note: Excludes use of secondary copper*

Source: USGS

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Mining Timeline General Overview for Copper

Timeline can vary significantly from exploratory to actual commercial production for a mine

Timeline can range from 6 – 20 years before production

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Time Range	2 - 10 years	2 - 5 years	2 - 5 years	10 - 40 years	2 - 10+ years
Avg. Time by Stage	~8 years	~3 years	~3 years	~20 years	N/A
Low to High Invmt. Cost	\$10M - \$200M	\$50M - \$500M	\$100M - \$3,500M	\$20M - \$300M/year	\$20M - \$200M
Avg. Investment Cost by Stage	\$50M	\$200M	\$2,000M	\$200M	\$100M+
Key Steps by Stage	• Prospecting • Reconnaissance • Survey mapping • Sampling • Geochemical analysis • Resource estimation	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation • Planning & investment	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase • Construction	• Ore extraction • Milling / Ore separation • Processing • Grade control • Waste rock/tailings & wastewater mgmt. • Near mine exploration • Expansion life of mine	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

Mining Timeline Overview by Key Country/Region for Copper

Timeline can vary significantly from exploratory to actual commercial production for a Cu mine

Question ↓		Region			
		United States	Chile/Peru/Rest of LATAM	Australia	SE Asia
Compared to average numbers, how much longer/more investment does it take to start a new mining project in this region and what are the core reasons explaining these differences?	Value [month/%]	Above	Considered the market benchmark (by volume)	Below	Below
	Reasons	• Environmental permitting is more complex with longer timelines and higher risk of delays compared to other countries • Managed at a state level vs. country level like other countries	• Environmental challenging and complex permitting process	• Simpler and more efficient administrative procedures from exploration, discovery and development/ construction phases compared to other countries/regions • Perceived as easiest country to work with by mining community	• Simpler administrative procedure
	Value [$M/%]	15% less	Considered the market benchmark (average)	10% less	10% more to operate
	Reasons	• Simpler projects, usually of smaller size than in LATAM and SE Asia • Higher productivity workforce • Cu mines are more common in US with knowledgeable/ experienced workforce	• Challenging from environmental and infrastructure point of view • Complementary infrastructure	• Simpler projects, usually of smaller size than in LATAM and SE Asia • Higher productivity workforce	• Challenging from environmental and infrastructure point of view • Complementary infrastructure

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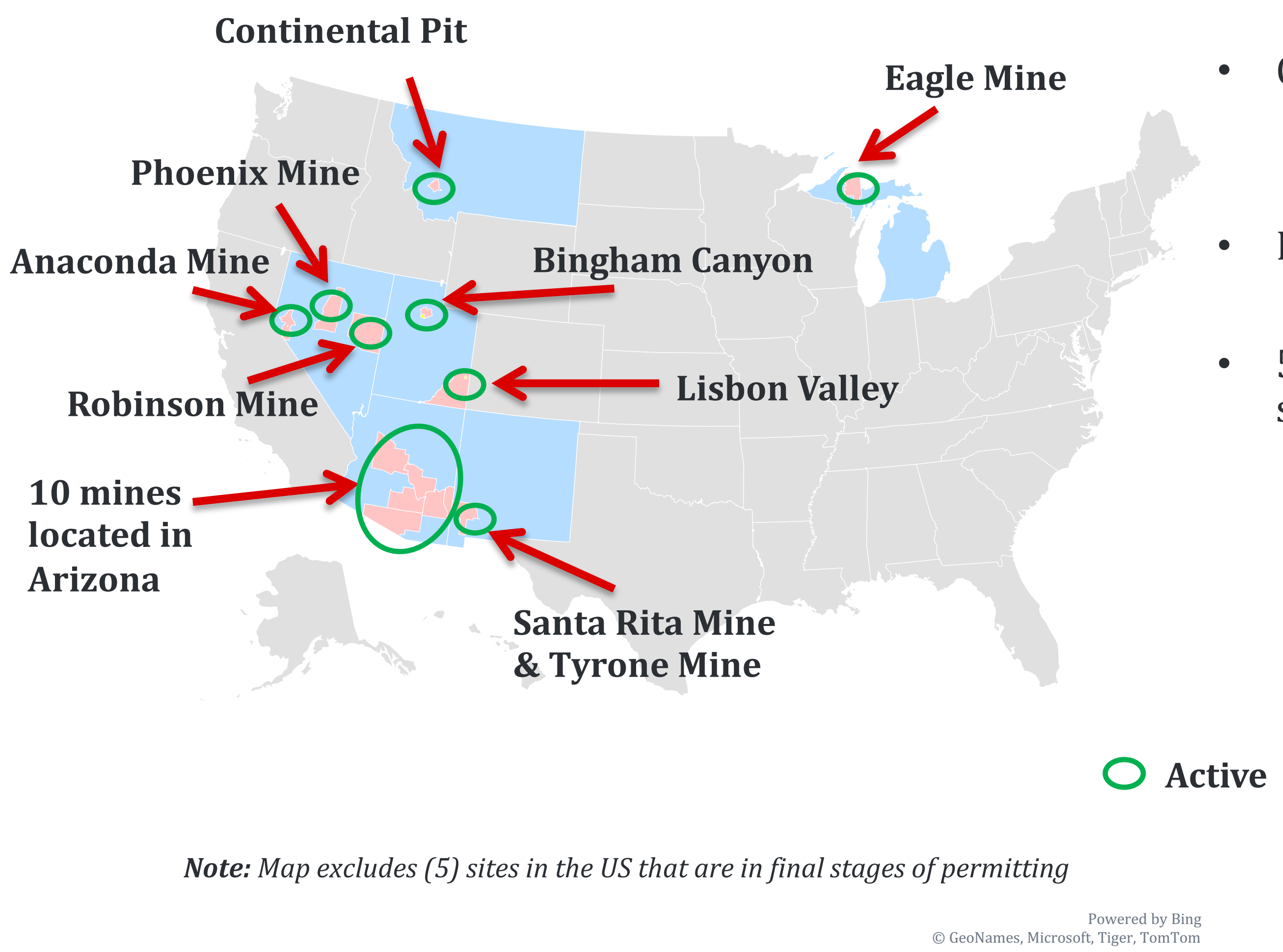
Copper Mines in the United States



Note: *Map excludes (5) sites in the US that are in final stages of permitting*

- 19 total copper mines are active in the US with the bulk of these mines located in the west
- Copper mining is heavily concentrated in AZ with 11 active sites
  - *3 of the 5 top producing mines are in Arizona*
- Freeport-McMoRan owns 7 of the 19 active Cu mines in US
- 5 additional copper mines are in the final permitting process stages for approval
  - *These (5) new copper mines are in Alaska, Montana, Minnesota and (2) Arizona*
    - Rosemont Mine (Vail, AZ) fighting environmental groups and legal delays since 2007
    - Resolution Copper Mine (Superior, AZ) has been a project since 2008, but constant legal delays
    - Twin Metals Copper-Nickel Mine (Ely, MN), federal applications rejected in Q4-2021
    - Pebble Mine (Bristol Bay, AK) continued delays from local community and federal permitting even though deemed by some as the second largest valued ore mine globally

Details on Copper Mines in the United States

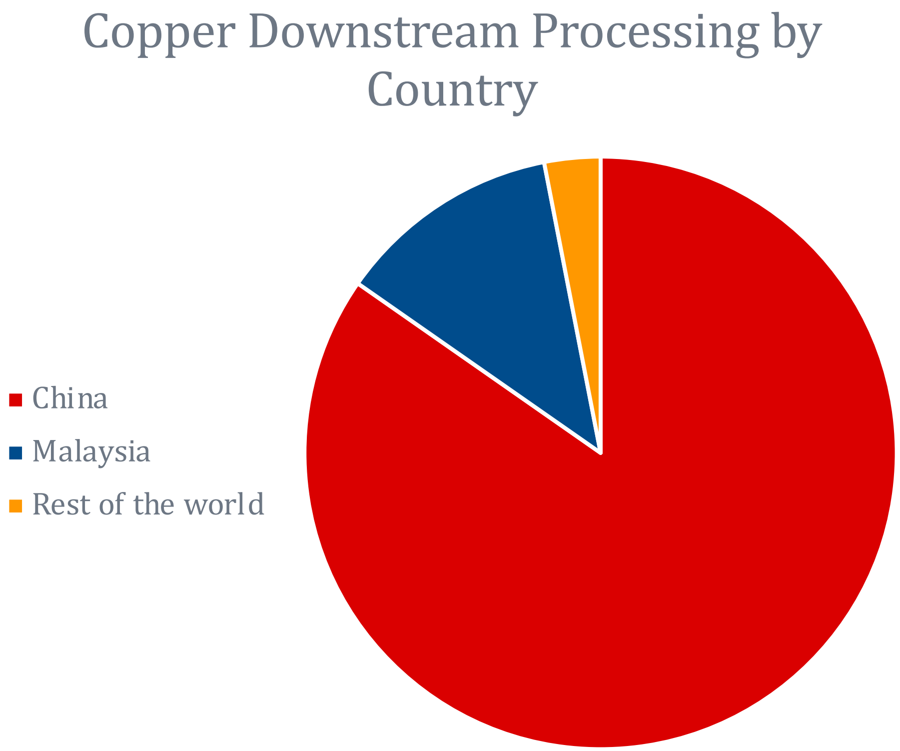
Item	Morenci	Bingham Canyon	Bagdad	Santa Rita	Sierrita	Safford	Pinto Valley	Ray	Robinson
Location	Arizona	Utah	Arizona	New Mexico	Arizona	Arizona	Arizona	Arizona	New Mexico
Size	8,648.68 acres	1,900 acres	~889 acres	~800 acres	1235.53 acres	16,297 acres	1,317 acres	53,000 acres	8,887 acres
Raw Ore Resource Capacity	~3.2B mt	365M mt	~873M mt	87M mt	2,875M mt	136M mt	446M mt	835.7M mt	565M mt
Stage	Active	Active	Active	Active	Active	Active	Active	Active	Active
Owner	Freeport-McMoRan 72% Sumitomo Group 28%	Rio Tinto Group	Freeport-McMoRan	Freeport-McMoRan	Freeport-McMoRan	Freeport-McMoRan	Capstone Mining Corp.	Grupo Mexico	KGHM Polska Miedź

Details on Copper Mines in the United States *(continued)*

Item	Mission Complex	Continental Pit	Tyrone	Silver Bell	Eagle Mine	Phoenix	Lisbon Valley	Miami	Carlota	Anaconda (Pumpkin Hollow)
Location	Arizona	Montana	New Mexico	Arizona	Michigan	Nevada	Utah	Arizona	Arizona	Arizona
Size	~19,000 acres	3,706.58 acres	8,559.1 acres	19,000 acres	150 acres	6,877 acres	2,573 acres	210.04 acres	1,428 acres	~3,400 acres
Raw Ore Resource Capacity	236M mt	364M mt	52M mt	76.5M mt	110M mt	156.3M mt	27.4M mt	498M mt	21.879M mt	2.95M mt
Stage	Active	Active	Active	Active	Active	Active	Active	Active	Active	Active
Owner	Grupo Mexico	Montana Resources LLP	Freeport-McMoRan	Group Mexico	Lundin Mining	Newmont Mining Corporation	Lisbon Valley Corporation	Freeport-McMoRan	KGHM Polska Miedź	Nevada Copper

Copper Downstream Processing

China has a dominant global position in downstream Copper processing



Source: IEA – Role of Critical Minerals in Clean Energy Transitions and Martec Analysis

- China conducts approximately 80% - 85% of the downstream processing of Copper
  - ➢ *China has a dominant position in downstream processing of Copper*

- Malaysia is the second largest downstream processor of Copper

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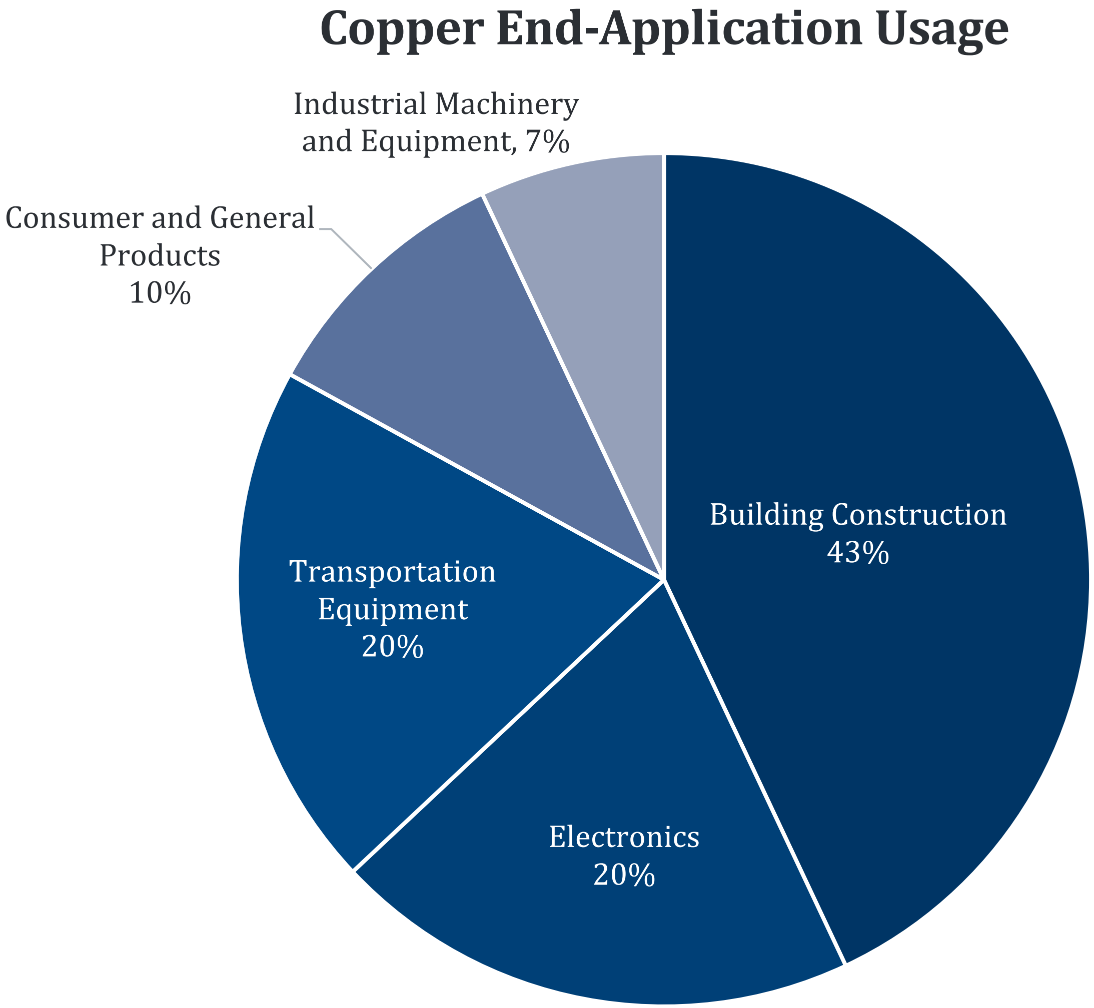
Copper End Applications, Trends, & Events

Approximately 20% of copper is used for transportation sector or ~4,000,000 mt of primary copper production.



Trends and Events

- Through 2025 Copper is predicted to have a CAGR of 2.9%
- Increasing demand for EV charging stations will directly impact the requirements of raw materials like copper
  - *It is used for critical manufacturing components of EV charging stations*
    - For example: enclosures, cables, connectors, cable insulation and jacketing, and flexible conduits
- Asia-Pacific is anticipated to be the fastest growing market for copper due to the massive consumption of copper in automotive, construction and manufacturing industries, particularly in China

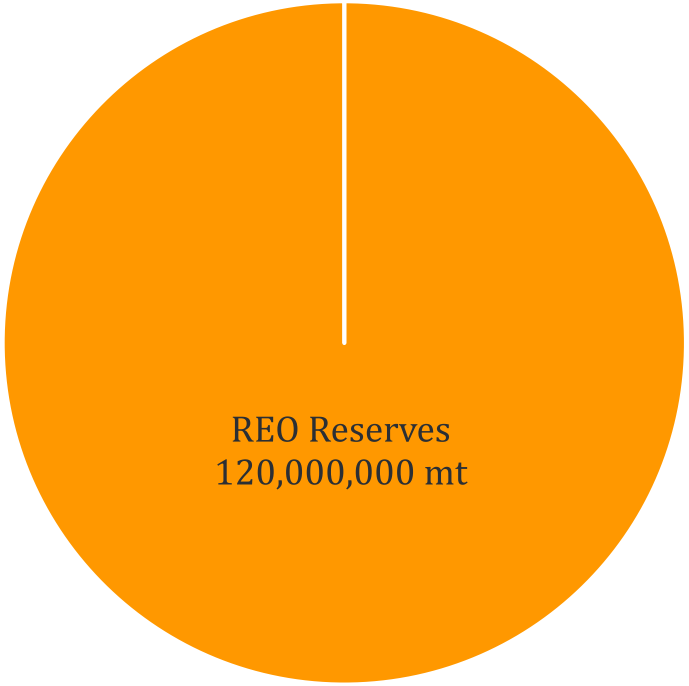
Sources: Copper Institute and 2020 USGS report

rare earth

Rare Earth Oxides Production & Reserves

China produces over half of the world's rare earth metals with 140,000 mt of production follow by 68,000 mt from both the U.S and Burma. The US production of rare earth decreased dramatically in 2015.

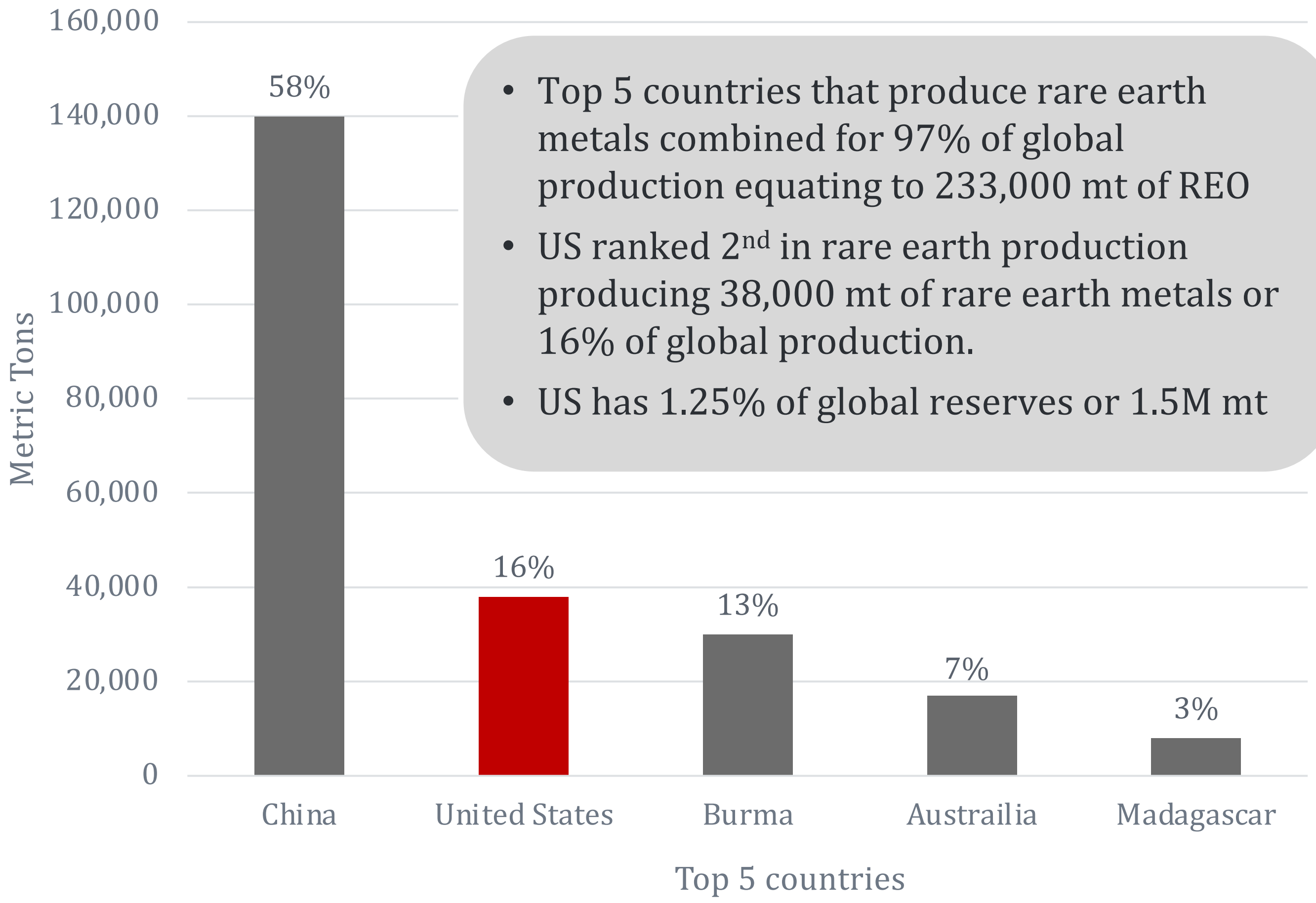
2020 Overall REO Resource vs. Reserves



Note: *REO Resource data is not actively tracked like other minerals. Martec is only reporting Reserves.*

2020 Global Rare Earth Production

(Global Production = 240,000 mt)



- Top 5 countries that produce rare earth metals combined for 97% of global production equating to 233,000 mt of REO
- US ranked 2nd in rare earth production producing 38,000 mt of rare earth metals or 16% of global production.
- US has 1.25% of global reserves or 1.5M mt

Source: 2020 Rare Earth USGS Report

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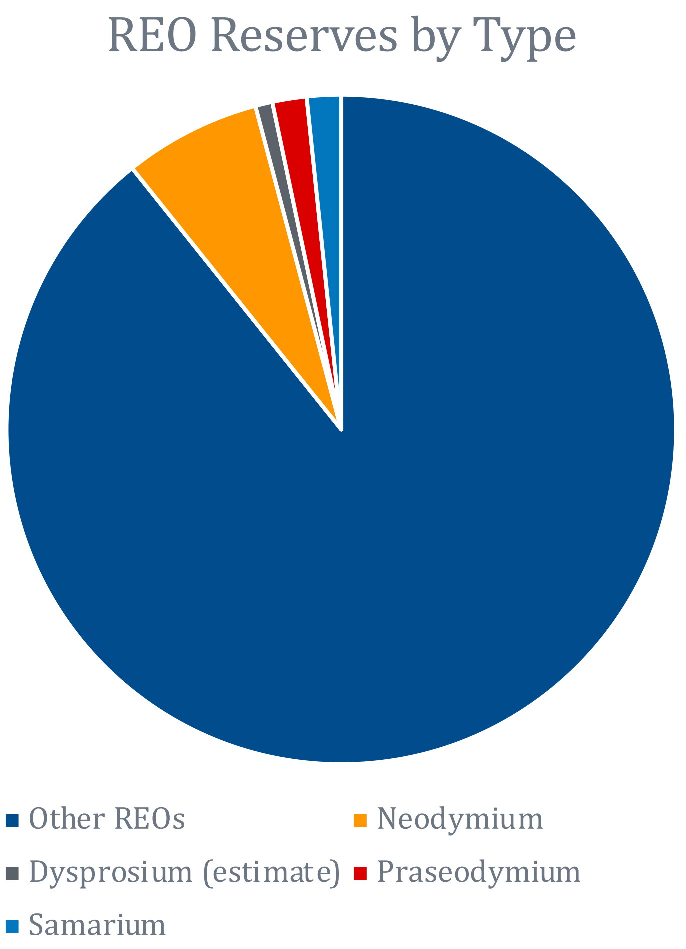
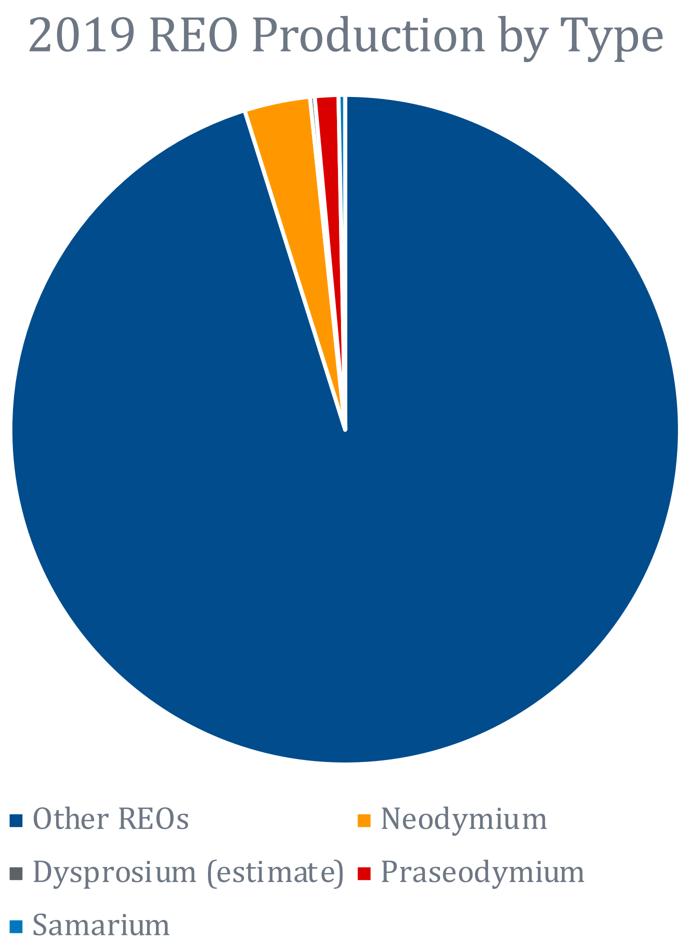
Rare Earth Reserves Globally

There are 17 REOs that exist in which the four key materials for permanent magnet motors only represent between 10-15% of total REO global reserves emphasizing the limited availability of these materials.





Note: *Limited information available on Dysprosium due to bulk of material availability coming form China.*

Source: Lenntech

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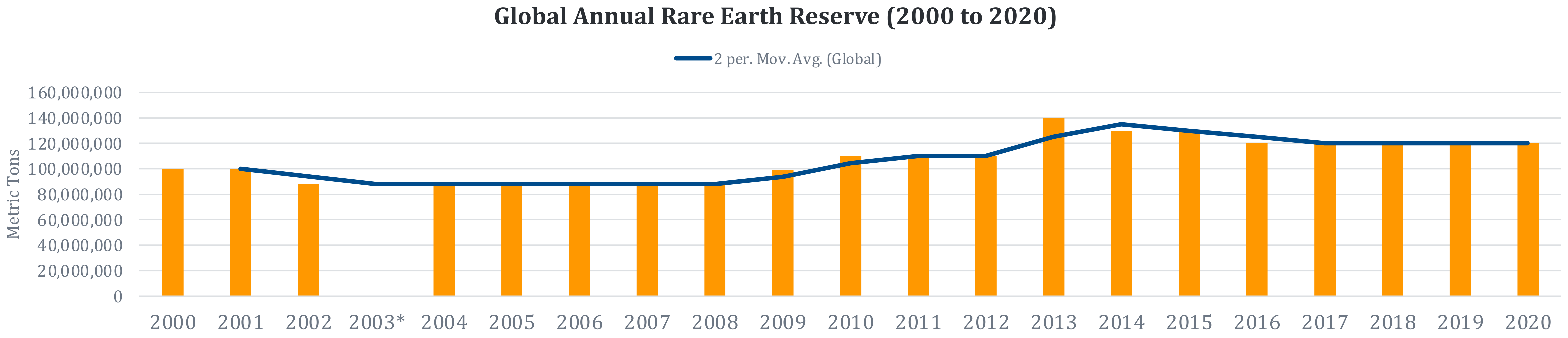
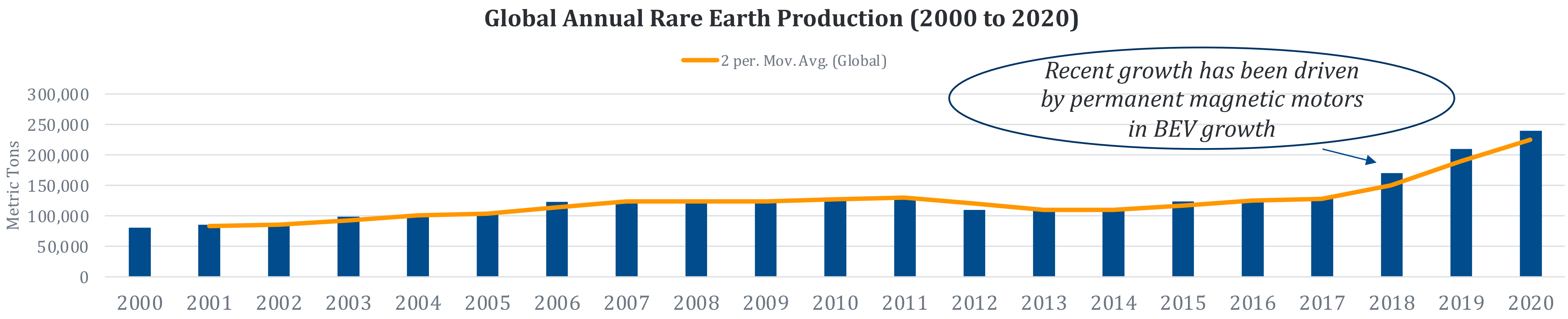
Rare Earth Historical Production vs. Reserve

Rare earth production doubled in the last 5 years to approximately 240,000 mt with minor increase in reserves.





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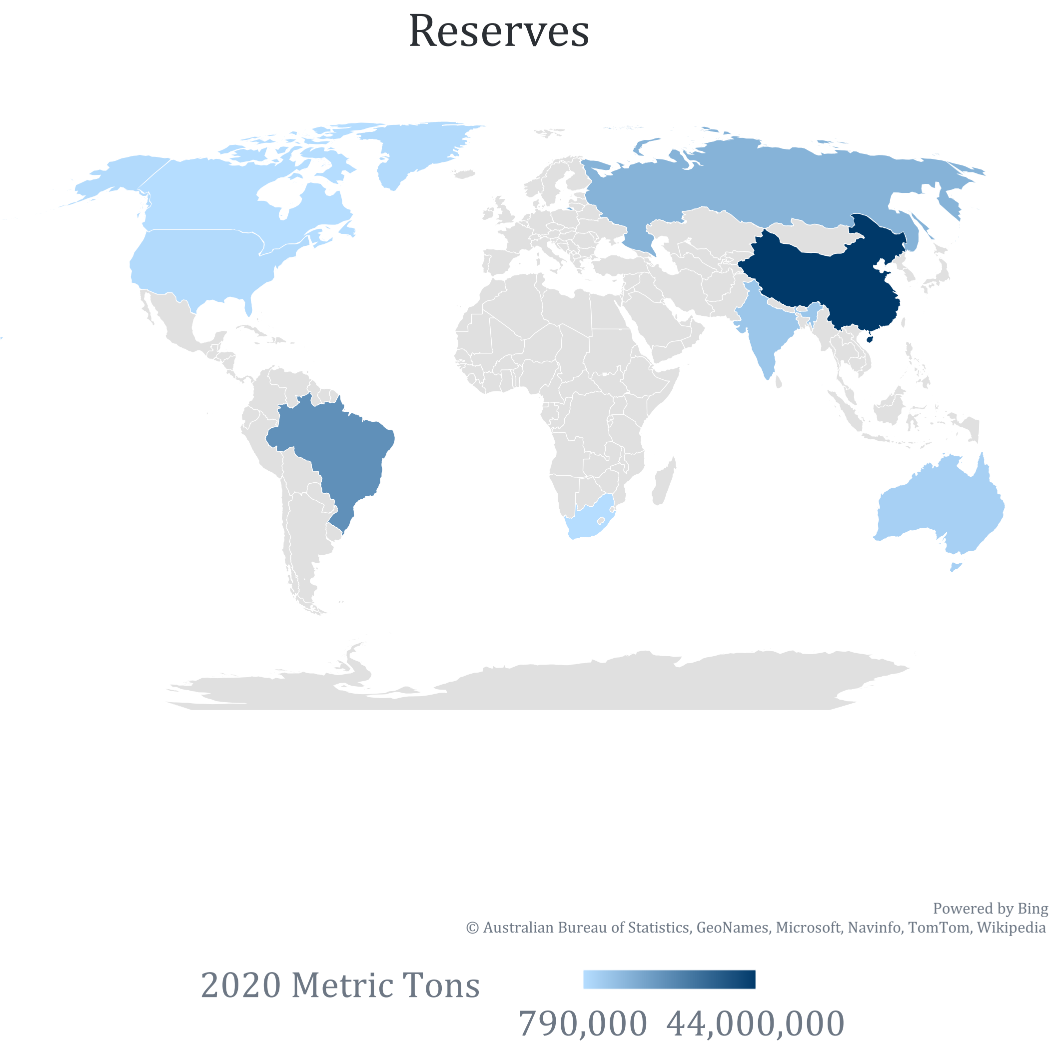
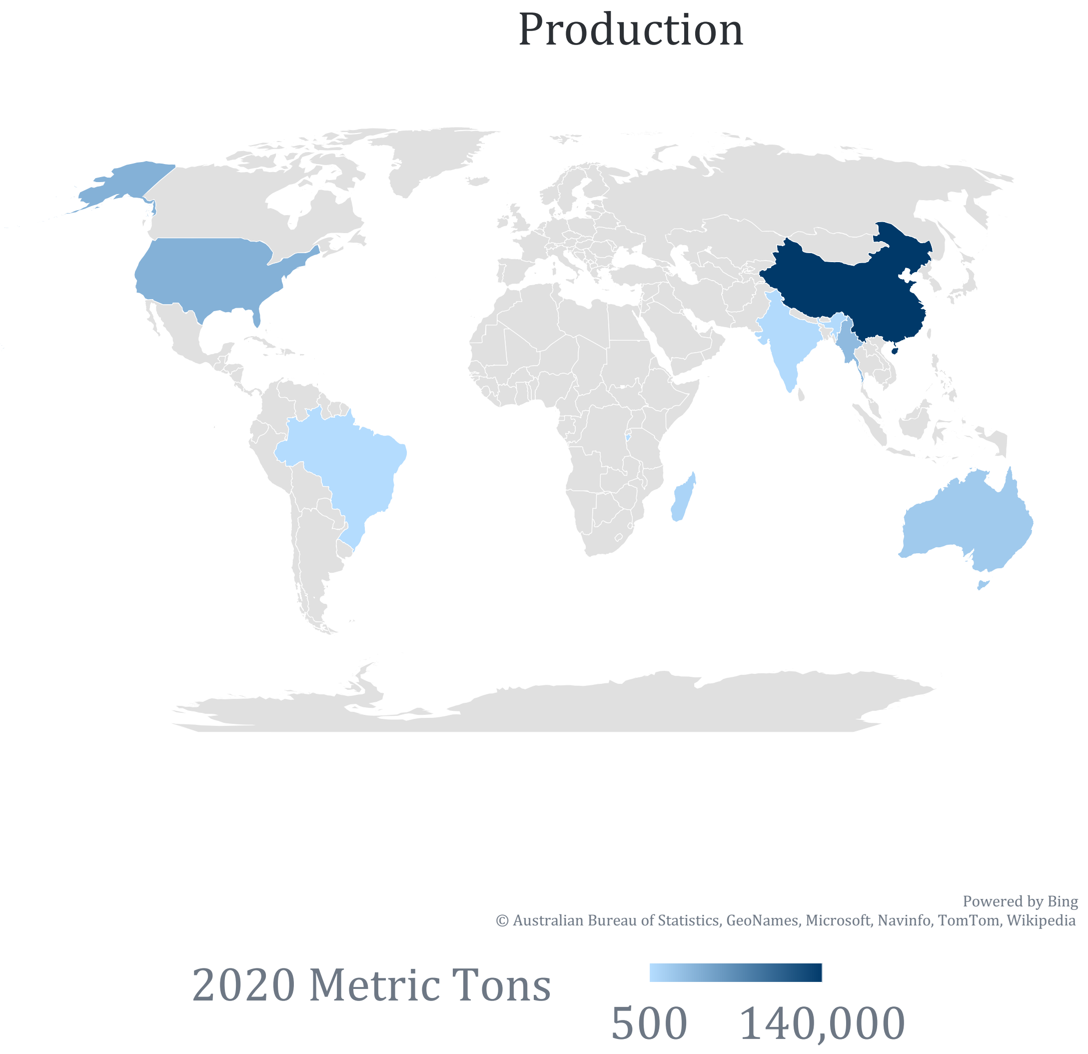
Note: *2003 USGS Rare Earth data unavailable for extraction.*

Source: 2000-2020 Rare Earth USGS Report

2020 Rare Earth* Reserves vs. Production





**Note: Rare Earth Oxides (REOs)* *Source: USGS*

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Mining Timeline General Overview for Rare Earth

Timeline can vary significantly from exploratory to actual commercial production for a mine

Timeline can range from 8 – 13+ years before production

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Time Range	China: Low ROW: 1 – 3 years *(ex. US)*	China: Low ROW: 2 – 5+ years	≥5 years *(due to market risk)*	20 - 70 years *(high variances exist due to deposits)*	≥10 years *(long process due to radioactive contents)*
Avg. Time by Stage	1 - 2 years	1 - 4 years	7+ years	50+ years	10+ years
Low to High Invmt. Cost	\$10M - \$50M+	\$30M - \$100M+	~\$300M - \$600M+ *(ex-China)*	\$30M - \$150M/yr.	~\$30M - \$100M+ *(will vary by country)*
Avg. Investment Cost by Stage	~\$30M+	~\$70M+	~\$500M+	~\$100M+/yr.	~\$60M+
Key Steps by Stage	• Prospecting • Reconnaissance • Survey mapping • Sampling • Geochemical analysis • Resource estimation	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase • Construction	• Ore extraction • Milling / Ore separation • Processing • Grade control • Waste rock/tailings & wastewater mgmt. • Near mine exploration • Expansion life of mine	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

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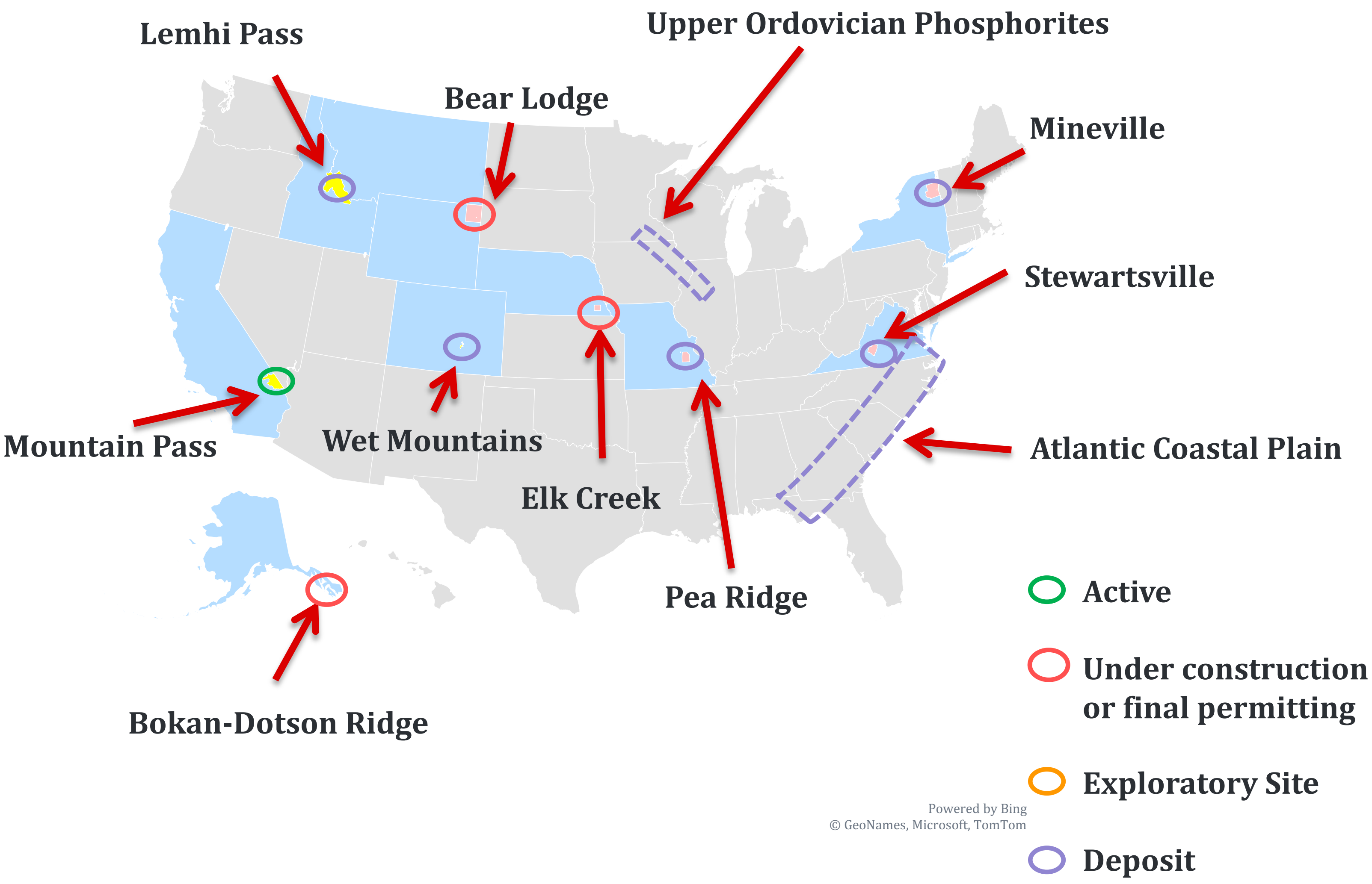
REO Mines in the United States



- Commercial-scale REO production is exclusively done in Mountain Pass, CA
  - *There are (8) non-active REO deposits across the US*
- Elk Creek, Bear Lodge, and Bokan Mountain sites are in the permitting process for commercial production
  - *Accumulative capacity of in-process mines is ~83M mt raw ore resources*
- Some raw resource deposits do not have any activity in two regions in the US (Atlantic Coast Plain and Upper Ordovician Phosphorites)
  - *Over 70M mt of REO sits without plans for mining*

Note: *Upper Ordovician Phosphorites and Atlantic Coastal Plain known to contain REO, are spread out and not heavily concentrated.*

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Mountain Pass

US REO Mine

- Owned by US-based MP Materials which is publicly traded on the NYSE
- Total size is approximately 15,000 acres
- MP Materials mined 11,998 mt of raw ore resources during the first 3 quarters of 2021
    - *Utilizes conventional open-pit mining method*
    - *Previous annual output was ~16,000 mt in 2018 and ~23,500 mt in 2019 of raw ore resources*
- Revenue increased 143% year-over-year from 2020 to Q3-2021

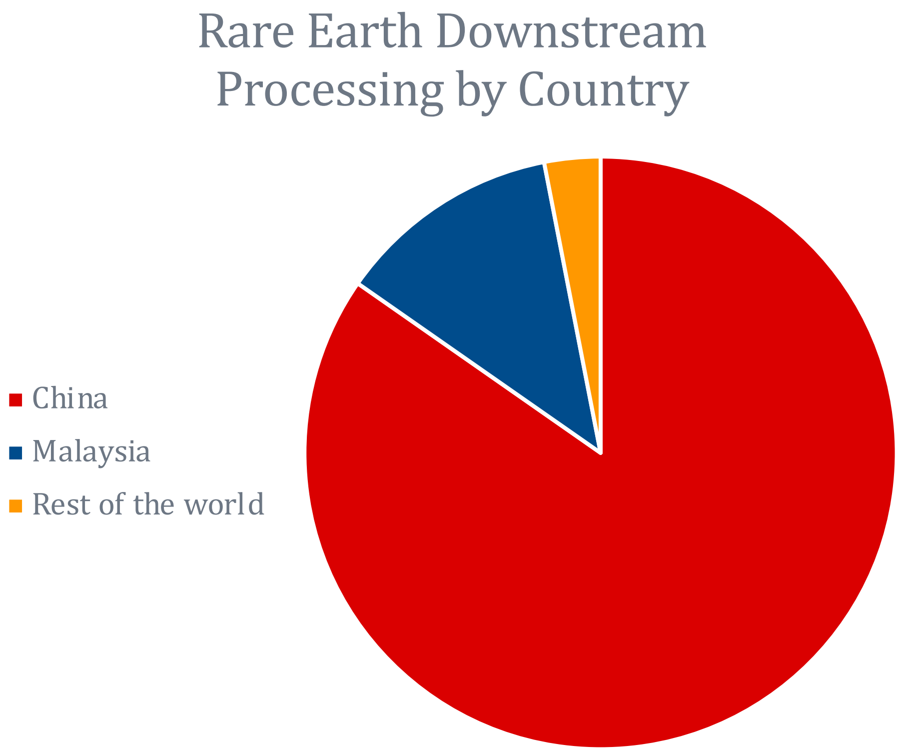
REO Mines in the United States

Item	Mountain Pass	Bear Lodge	Elk Creek	Bokan-Dotson Ridge
Location	California	Montana	Nebraska	Alaska
Size	~15,000 acres	9,000 acres	7,800 acres	~7,400 acres
Raw Ore Resource Capacity	~28M mt	~18M mt	~33M mt	~4.8M mt
Stage	Active	Final Permitting	Final Permitting	Final Permitting
Owner	MP Materials	Rare Element Resources Ltd.	NioCorp	Ucore Rare Metals

Note: *Non-active deposits include Lemhi Pass, Mineville, Wet Mountain, Stewartsville, Pea Ridge, Upper Ordovician Phosphorites, and the Atlantic Coastal Plain*

Rare Earth Elements Downstream Processing

China has a dominant global position in downstream rare earth elements processing



Source: IEA – Role of Critical Minerals in Clean Energy Transitions and Martec Analysis

- China conducts approximately 80% - 85% of the downstream processing of Rare Earth Elements
  - *China has a dominant position in both upstream mining (~58% global share) and downstream processing of REOs*
- Malaysia is the second largest downstream processor of REE
  - *Malaysian facility primarily processes REO coming from Australia*
- Biden is targeting a $30M initiative through the DOE to help develop REE downstream processing capability here in the US
  - *Investment into a new REE processing plant will require a significant investment (a couple $100M investment)*

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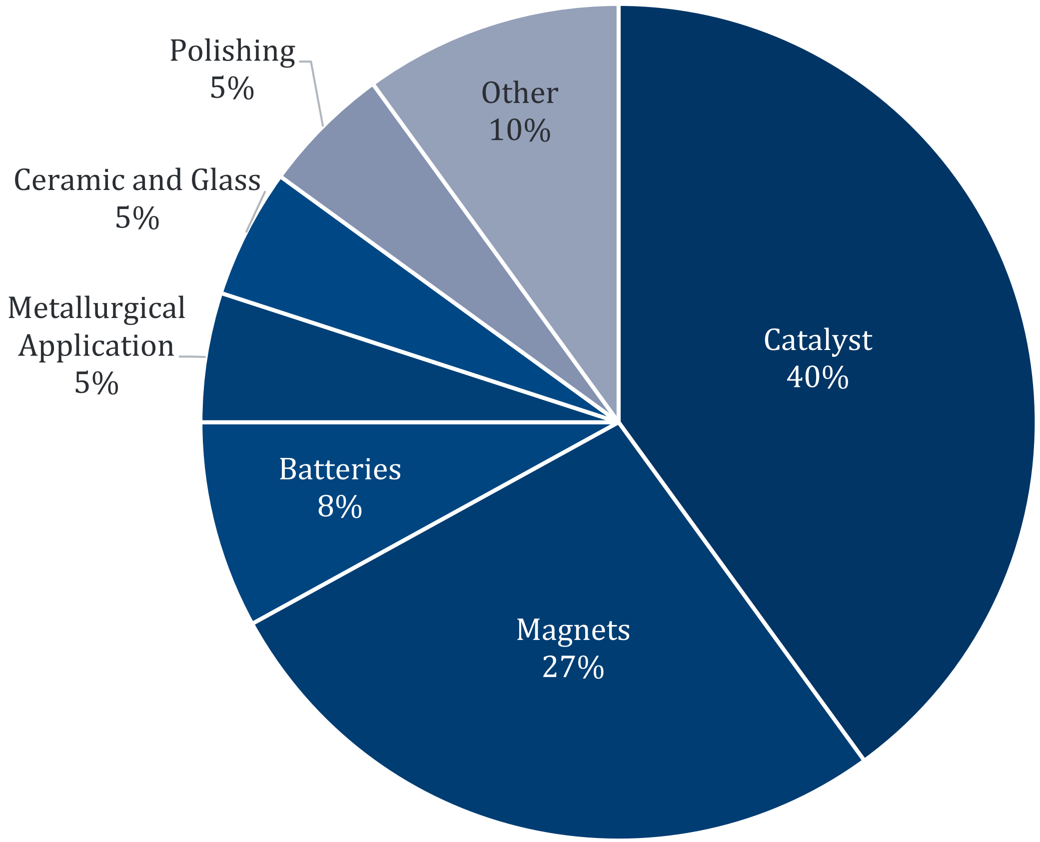
Rare Earth End Applications, Trends, & Events

¾ of the world's rare earth metals are used as catalysts primarily both in industrial and automotive applications

Rare Earth Metal End-Application Usage



Note: *Sources include a combination of 2020 Rare Earth USGS, Core and Edison Group reports. Martec continues to investigate as differing opinions exist on end use application mix.*

Trends and Events

- Rare Earth Oxides (REO) are expected to grow at a 10.4% CAGR through 2025, end applications are seen with catalysts being used to refine petroleum and automotive catalytic converters, permanent magnet electric motors and hybrid batteries
- Permanent magnet motors utilize REO and are actively growing in usage in BEVs
- China is the major producer, processor and consumer of rare earth elements
  - *To maintain self-sufficiency and to meet future demand, China has been raising the export tariffs on rare earth elements shipped to countries including the US, Japan, India, Brazil, and the EU*
- In 2019 China supplied over 80% of REO imports to the US
- USA's Mountain Pass, CA mine currently ships all its output to China for processing & separation (MP Materials)
  - *Recent government funded program from DoD in 2017 to set up a processing plant in the US for a portion of its volume that is targeted to be operational by 2022*
  - *DoD recent grants also in recycling REO materials from magnets*

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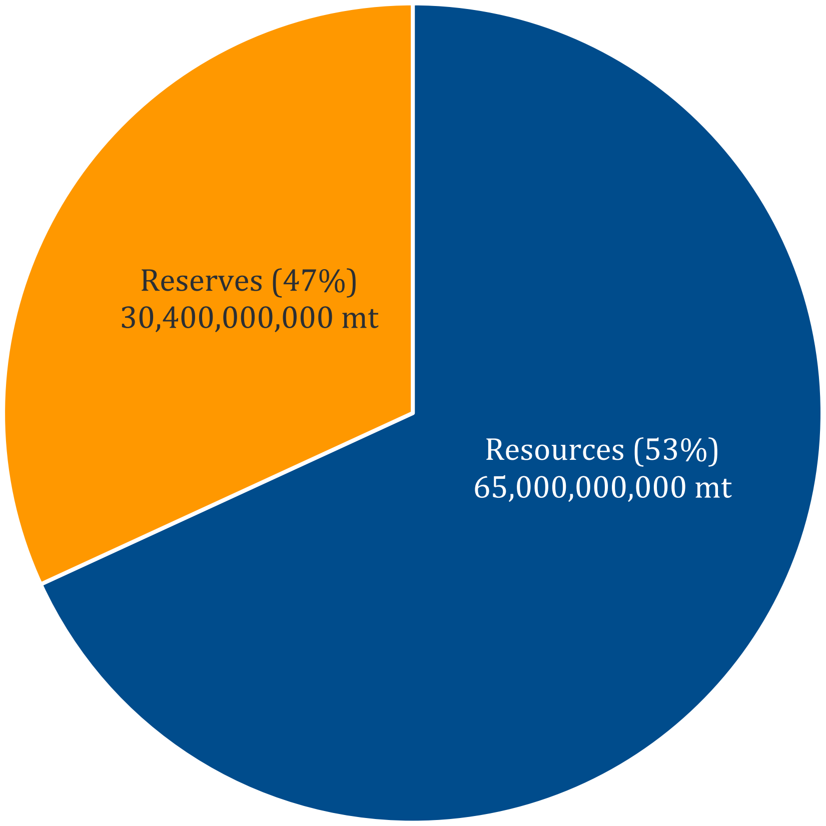
aluminum

Aluminum Production, Reserves, & Resources

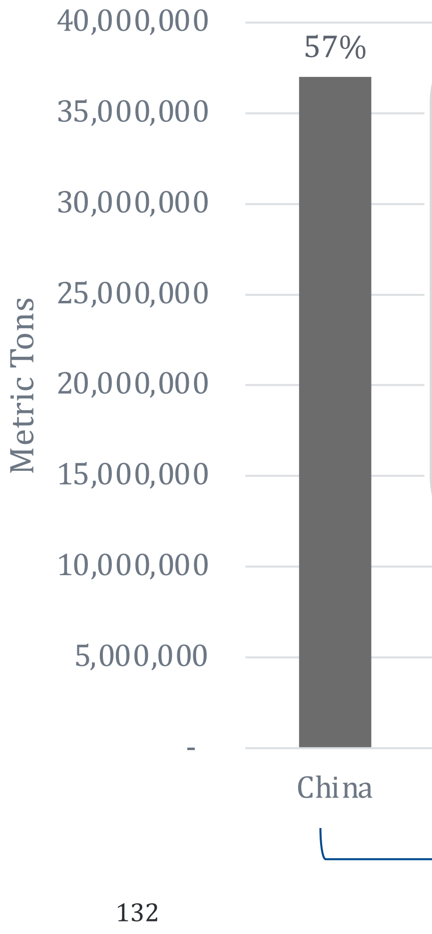
Just over half of the world's bauxite ore resources has not been explored but is sufficient to meet global demand for metal well into the future. China leading with ~37,000,000M mt of aluminum produced annually.

2020 Bauxite Ore Reserve vs. Resource



Resource statistics includes identified and inferred resource totals.

2020 Global Aluminum Production
(Global Production = 65,200,000 mt)



- Top 5 countries combined for 78% of global aluminum production equating to 50.6M mt
- US ranked 9th in smelted aluminum production producing 1,000,000 mt in 2020 or 2% of global production, down 8.5% from 2019
- US operates at only 56% of its total smelting capacity

Source: 2020 Aluminum USGS Report

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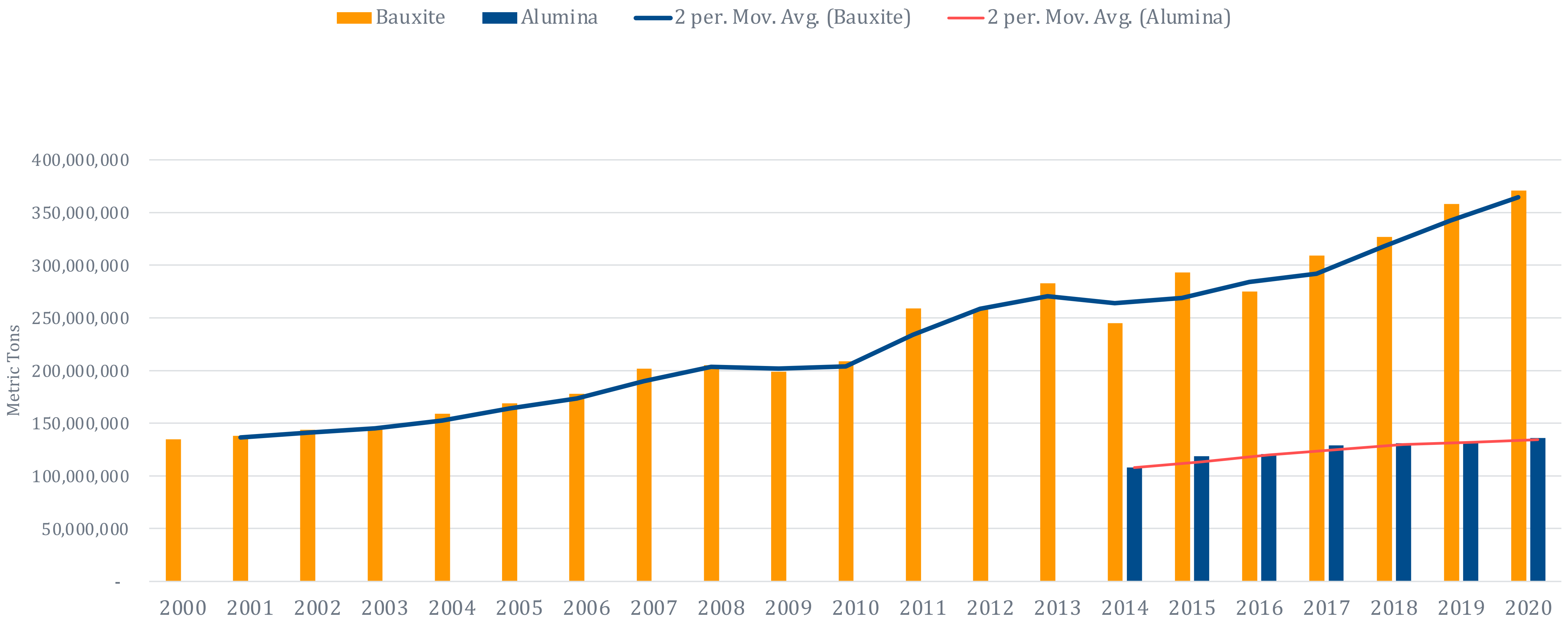
Bauxite and Alumina Historical Production

Alumina is produced from bauxite, an ore that is mined from topsoil in various tropical and subtropical regions. In order to produce pure aluminum, alumina is smelted for primary production.

Historical Global Annual Bauxite and Alumina Production (2000 to 2020)



Notes: *Historical data for Alumina is unavailable from 2000 to 2013 via USGS reports.*
Reserves were not actively tracked historically until 2014.

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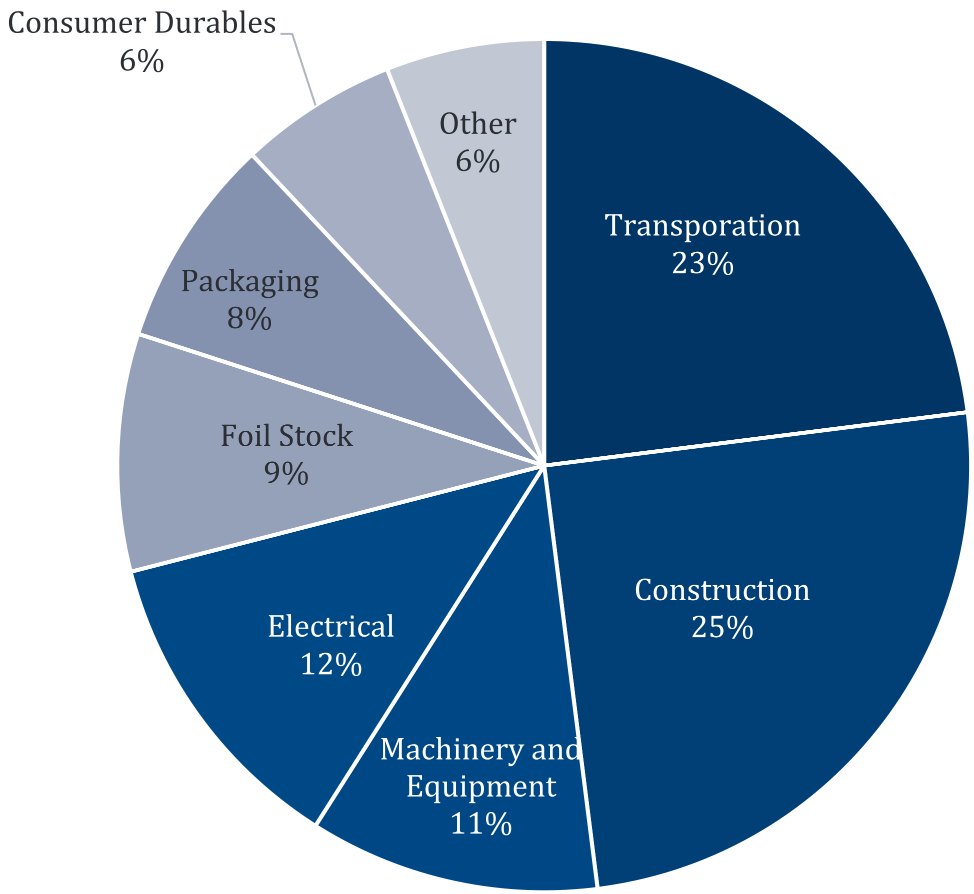
Aluminum End Applications, Trends, & Events

~23% of aluminum's end application is utilized for transportation or approximately 15M mt of aluminum

Aluminum End-Application Usage



Trends and Events

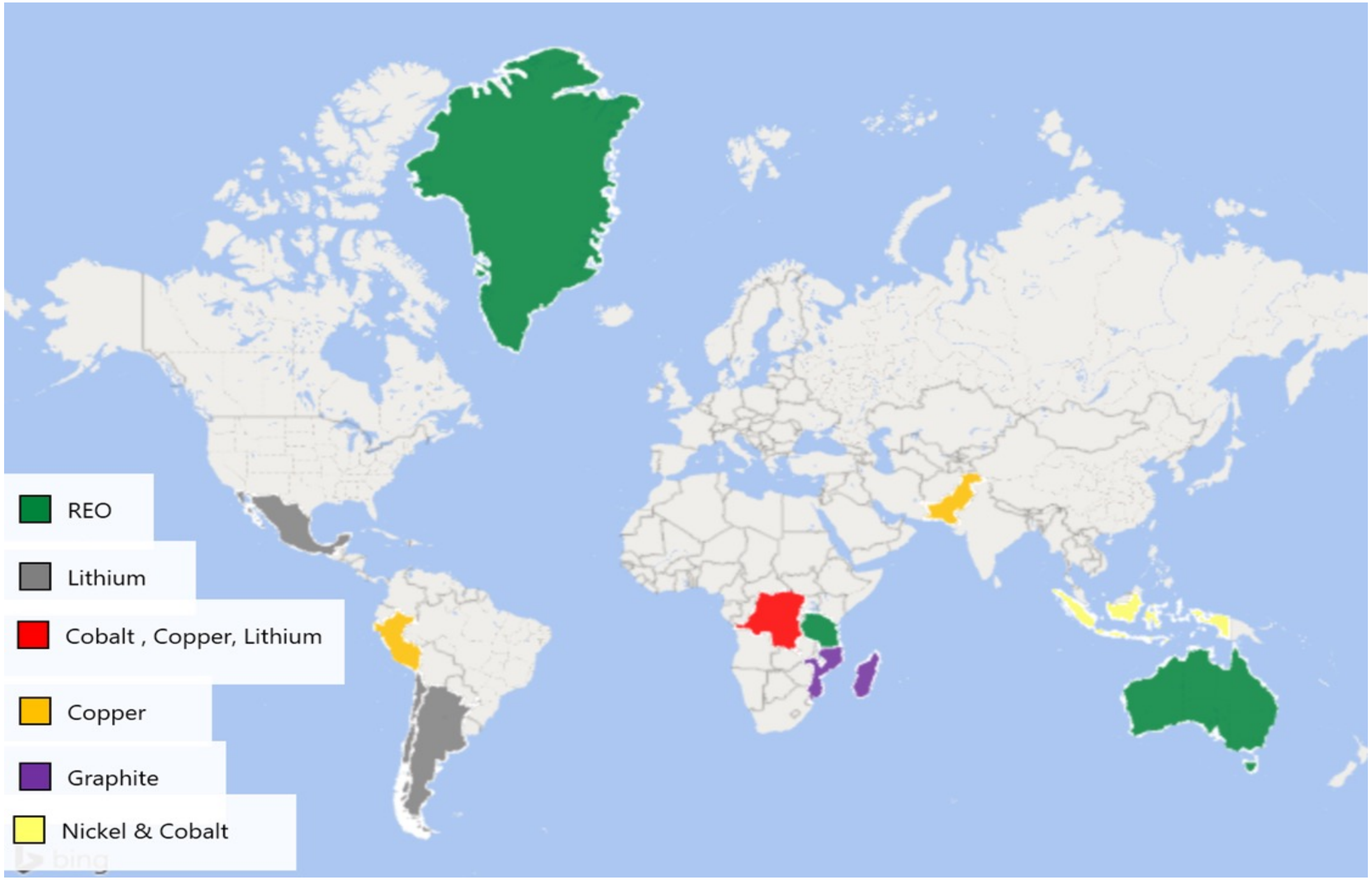
- Through 2025 the aluminum market is anticipated to grow at a CAGR of >5%/yr.
- Asia-Pacific is anticipated to be a dominant player in this market in the medium term due to increased construction activity that is making up for lost time during COVID-19
- Largest Asia-Pacific countries to see growth are China, India, and Japan
- After building & construction, automotive is the next largest sector for aluminum, with a push in electric vehicles in China and across the globe
- Aluminum is a key material to enable light weighting in the vehicle body/chassis and in Li-ion battery anodes

Source: 2020 Aluminum USGS Report

New Major Global Mining Investments & China Involvement

China's role in new mining projects globally is increasing

Chinese companies have been taking a very active role investing or committing to resources in other countries to secure future volumes.



Chinese companies are investing in several key mining projects globally in each of the critical minerals.

- <u>Lithium (5):</u>
  - *Argentina, (2) Chile, DRC-Congo & Mexico*
- <u>Nickel (4):</u>
  - *(4) Indonesia (mining & processing)*
- <u>Cobalt (5):</u>
  - *(4) DRC-Congo and (1) Indonesia*
- <u>Graphite (4):</u>
  - *(2) Mozambique & (2) Madagascar*
- <u>Copper (4):</u>
  - *(2) DRC-Congo, Pakistan, Peru*
- <u>Rare Earth/REO (4):</u>
  - *(2) Australia, Tanzania & Greenland*

Martec

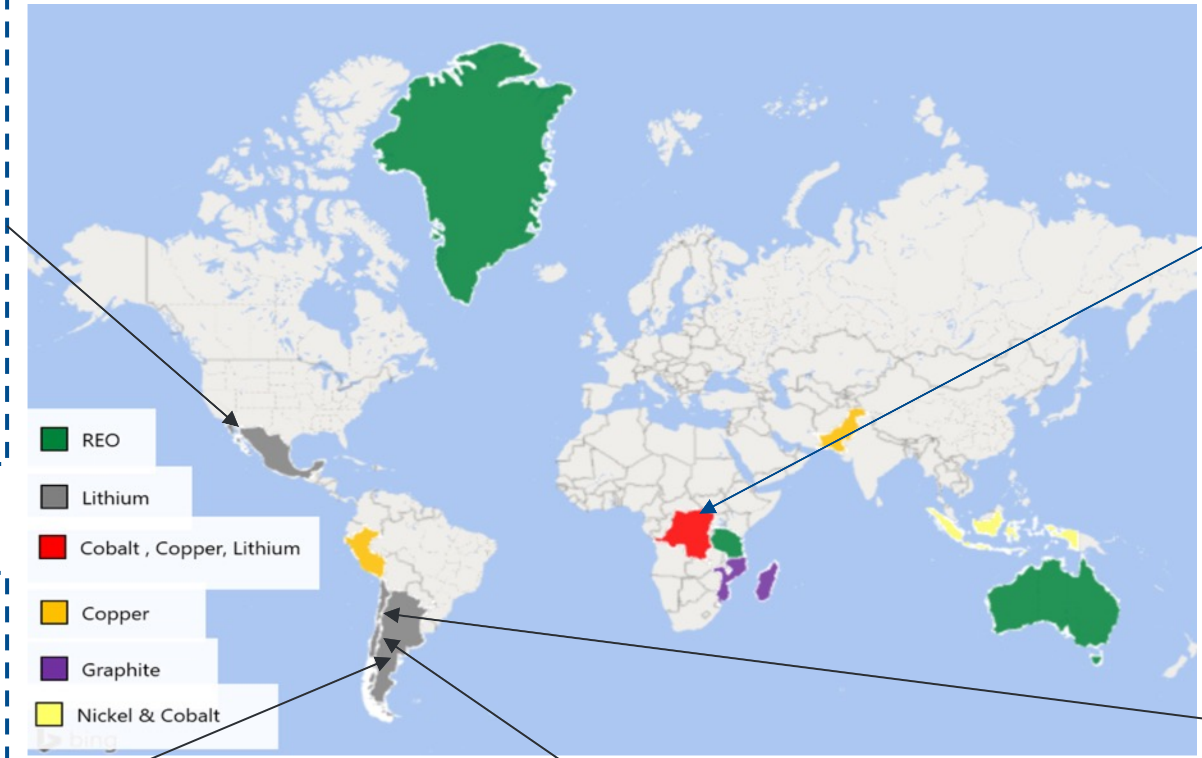
**Source: PlusMining, Inc. and Martec analysis.*

China's role in new global mining projects: Lithium

Chinese companies are involved and have an ownership position in the following (5) Lithium projects**:

Lithium Projects of Interest:

- **Sonora:**
  - *Location: Mexico*
  - *Production: Stage I 17.5k mt LCE/yr.; Stage II up to 35k mt LCE/yr.*
  - *Status: Stage I $0.42B 2023 startup; Stage II $0.38B*
  - *Ownership: Ganfeng Lithium-China (29%); Ganfeng in process of acquiring Bacanora' s remaining ownership for $391M as of 8/2021*
  - *Lifetime: ~20 years*



- **Manono:**
  - *Location: DR-Congo*
  - *Production: ~130k – 150k mt LCE/yr.*
  - *Status: Feasibility assessment with $0.55B CAPEX with a 2022 startup target*
  - *Ownership: Gécamines-Congo state-owned (25%); Chinese Consortium of companies (16%); Australian Executives (6%); Publicly traded (53%)*
  - *Lifetime: >20 years*

- **Cebtenario-Ratones Salt Lakes:**
  - *Location: Argentina*
  - *Production: 24k mt/yr. LCE*
  - *Status: Feasibility assessment phase; ~$0.4B CAPEX; construction start 2022 and startup 2024*
  - *Ownership: Eramet-France (50.1%); Tsingshan Holding-China (49.9%)*
  - *Lifetime: >20 years*

- **Salar de Atacama:**
  - *Location: Chile*
  - *Production: 72k mt/yr. LCE (2020)*
  - *Status: In production with planned 110k mt LCE/yr. expansion, ~$1B investment from 2021 – 2024*
  - *Ownership: Pampa Group-Chile (54%); Tianqi-China (44%)*
  - *Lifetime: ~10 years*

- **BYD Awarded Lithium Tender with Chile Government:**
  - *Location: Chile*
  - *Secured Resources: 80k mt (metallic Lithium)*
  - *Status: BYD (China) awarded 80k mt with $61M investment, mining firm(s0 are still TBD as well as timing of extraction*
  - *Lifetime: N/A*

Martec

**Source: PlusMining, Inc., JustAuto and Martec analysis.*

***NOTE: These are only an example locations as other sites may exist globally. Sites with significant contribution over the next 3 years were identified.*

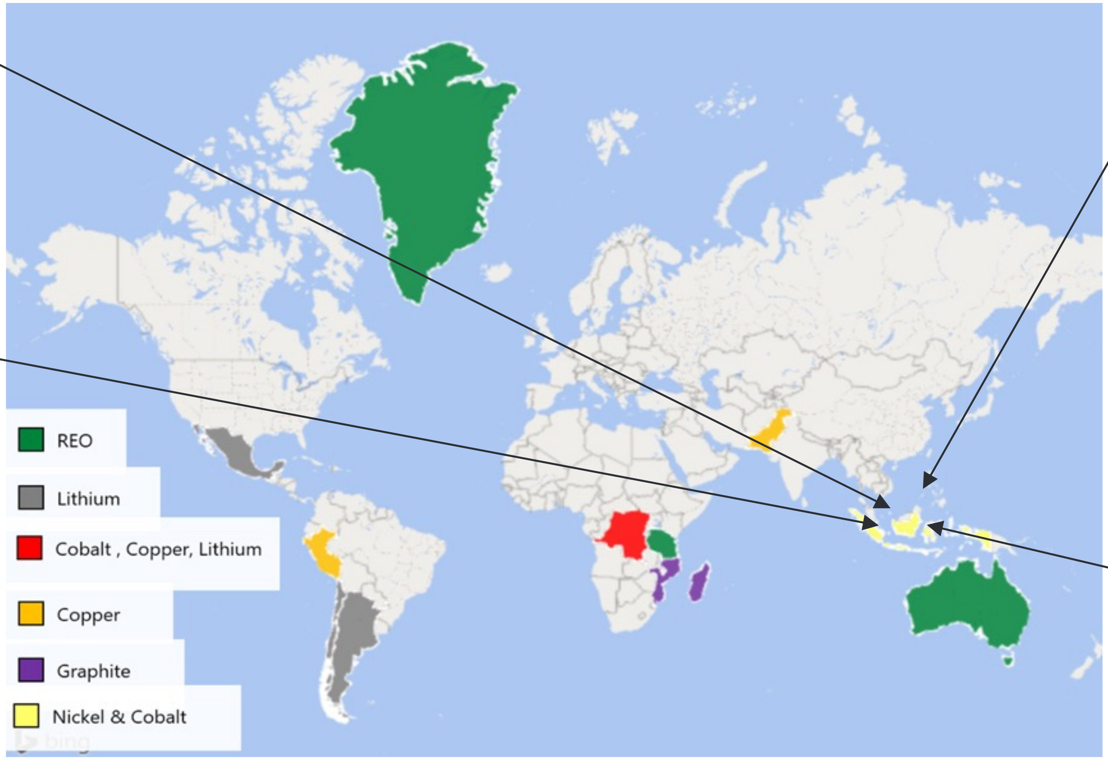
China's role in new global mining projects: Nickel

Chinese companies are involved and have an ownership position in the following (2) Nickel projects**:

- **Weda Bay Nickel:**
  - *Location: Indonesia*
  - *Production: ~23.5k mt/yr. (2020 and ~30k mt/yr. (2021) was planned production*
  - *Status: Started production in 2019 and has continued to ramp up; Contains ~9.3 million mt of reserves*
  - *Ownership: Tsingshan-China (51%); Eramet-France (39%); PT Aneka Tambang/Antam-Indonesia (10%)*
  - *Lifetime: >50 years*

- **Jingmen Processing Unit (Morowali):**
  - *Location: Indonesia*
  - *Production (backend processing only): ~50k mt Ni/yr. (start in 2022)*
  - *Status: Production was delayed in 2020 and will start in 2022 $700M CAPEX planned*
  - *Ownership: GEM-China (36%), CATL-China (25%); Tsingshan Group-China (21%); PT Indonesia Morowali and Hanwa-Japan (18% combined)*
    - GEM-China has offered to increase share to 72%
  - *Lifetime: N/A*

Nickel Projects of Interest:



- **PT Huayu Nickel Cobalt (JV):**
  - *Location: Indonesia*
  - *Production (backend processing only): ~120k mt Ni/yr. and 15k mt Co/yr.*
  - *Status: JV started in Q4-2021; investment 12/2021; $2.08B CAPEX planned in order to support backend processing of minerals mined domestically in Indonesia*
    - JV was done to help offset Indonesian mined material from being all exported to China for final processing
  - *Ownership: Zhejiang Huayou Cobalt-China (20%), EVE Energy-China (17%); Glaucous International-Singapore (30%); Yongrui-Indonesia (31%); Lindo Inv.-Singapore (2%)*
  - *Lifetime: N/A*

- **Obi Island (processing plant):**
  - *Location: Indonesia*
  - *Production (processing only): ~37k mt Ni/yr. and 4.5k mt Co/yr. (initial capacity)*
  - *Status: Production started late-2021; $1.05B CAPEX planned; GEM-China 8-yr. customer contract commitment in 2020*
  - *Ownership: Lygend Mining-China (primary owner); Harita Group-Indonesia (minority)*
  - *Lifetime: N/A*

Martec

**Source: PlusMining, Inc., JustAuto and Martec analysis.*

***NOTE: These are only an example locations as other sites may exist globally. Sites with significant contribution over the next 3 years were identified.*

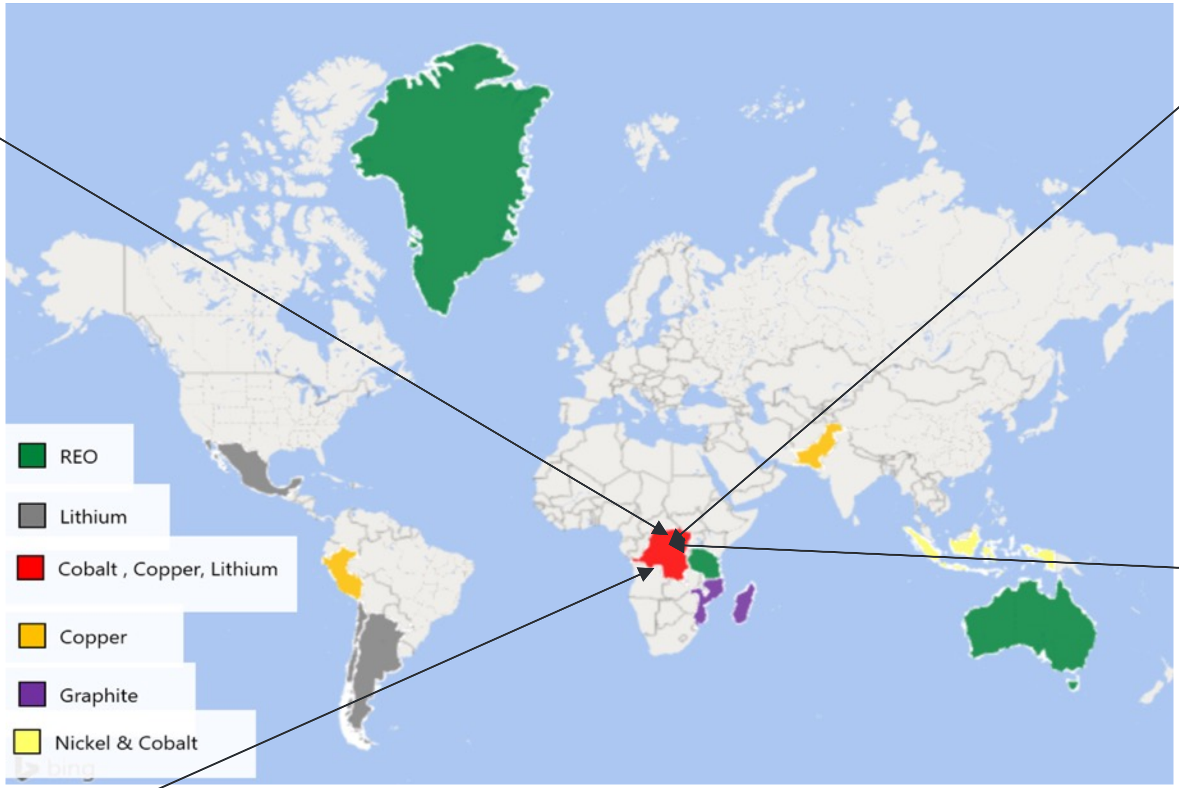
China's role in new global mining projects: Cobalt

Chinese companies are involved and have an ownership position in the following (4) Cobalt projects**:

- **Deziwa:**
  - *Location: DR-Congo*
  - *Production: 8,000 mt Co/yr. and 80,000 mt Cu/yr.*
  - *Status: Ramping up production, started in 2020; $880M in CAPEX planned investment*
  - *Ownership: China Nonferrous Metal Mining Company/CNMC (51%) and State-owned Gécamines-DRC (49%)*
  - *Lifetime: >30 years*

- **Musonoi:**
  - *Location: DR-Congo*
  - *Production: 7,400 mt Co/yr. and 38,000 mt Cu/yr.*
  - *Status: Under construction; production start-up planned for 2023; CAPEX ranges form $350M - $550M planned investment*
  - *Ownership: Jinchuan Group-China (75%), State-owned Gécamines-DRC (25%)*
  - *Lifetime: >30 years*

Cobalt Projects of Interest:



- **Kisanfu:**
  - *Location: DR-Congo*
  - *Production: Unknown, estimates are Kisanfu represents ~15% of undeveloped reserves in DR-Congo*
  - *Status: Feasibility assessments; Undeveloped. In 2020, China Molybdenum acquired Freeport-McMoRan's (US) 95% share for $550M. In 2021, CATL-China acquired 20% share from China Molybdenum*
  - *Ownership: China Molybdenum (71%), CATL-China (24%), State-owned Gécamines-DRC (5%)*
  - *Lifetime: Unknown*

- **Tenke Fungurume:**
  - *Location: DR-Congo*
  - *Production: 15,400 mt Co/yr.*
  - *Status: In production with planned expansion for additional 7,300 mt Co/yr.; $2.5B CAPEX planned investment*
  - *Ownership: China Molybdenum (80%), State-owned Gécamines-DRC (20%)*
  - *Lifetime: ~30 years*

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**Source: PlusMining, Inc., JustAuto and Martec analysis.*

***NOTE: These are only an example locations as other sites may exist globally. Sites with significant contribution over the next 3 years were identified.*

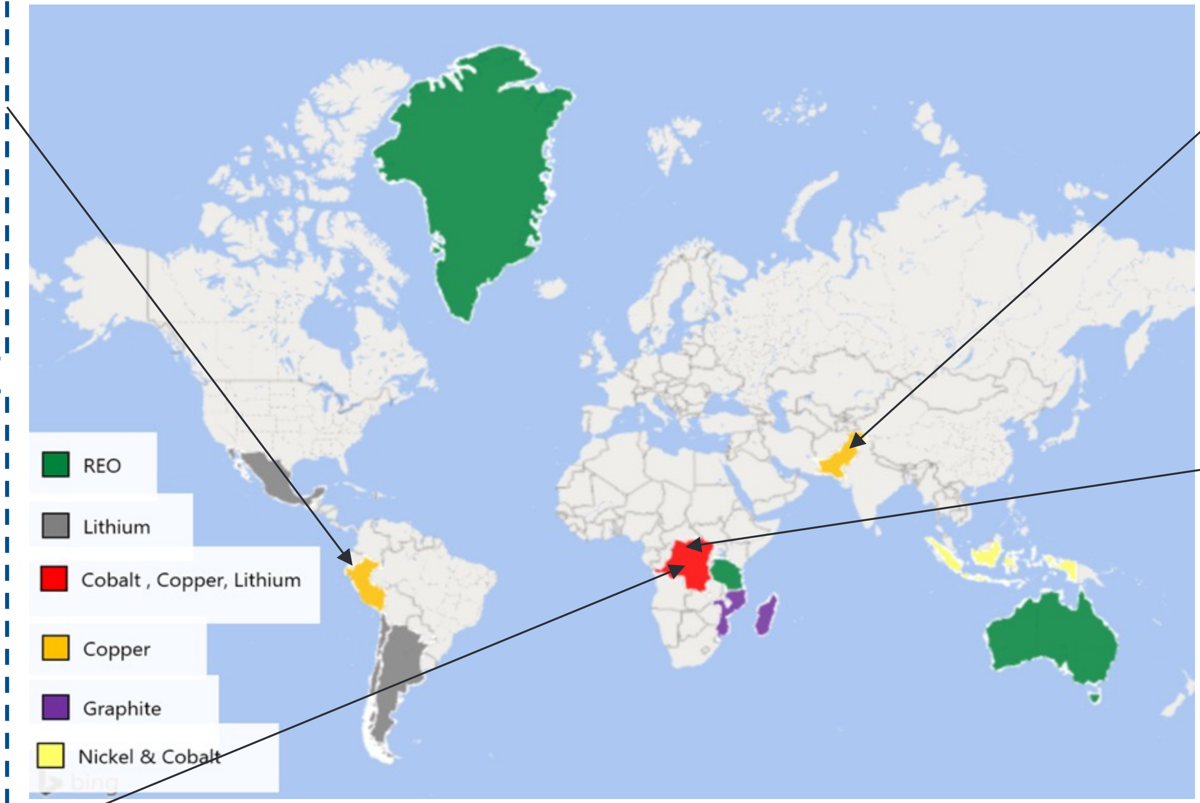
China's role in new global mining projects: Copper

Chinese companies are involved and have an ownership position in the following (4) Copper projects**:

- **Las Bambas:**
  - *Location: Peru*
  - *Production: 300k – 350k mt/yr.; Molybdenum to a lesser degree*
  - *Status: Was in production but production was recently stopped due to local community unrest; recently sold by Glencore*
  - *Ownership: MMG-China (62.5%); Gouxin-China (22.5%); CITIC Metals-China (15%)*
  - *Lifetime: ~20+ years*

- **Kamoa-Kakula:**
  - *Location: DR-Congo*
  - *Production: ~200k mt/yr. (2021); growing to 800k mt/yr. in future*
  - *Status: Currently producing and in process of ramping up to full production; CAPEX $1.3B planned*
  - *Ownership: Ivanhoe Mines-Canada (39.6%); Zijin Mining-China (39.6%); Crystal River Global-BVI (0.8%); DR-Congo government (20%)*
  - *Lifetime: ~37 years*

Copper Projects of Interest:



- **Reko Diq:**
  - *Location: Pakistan*
  - *Production: ~200k mt/yr.; Also, a portion of Gold as a by-product*
  - *Status: Currently blocked by court decision; CAPEX $3.3B planned; Ship to China for processing*
  - *Ownership: Tethyan Copper/Antofagasta-Chile (75%); Government of Balochistan-Pakistan (25%)*
  - *Lifetime: ~56 years*

- **Tenke Fungurume:**
  - *Location: DR-Congo*
  - *Production: ~183k mt/yr.; Cobalt as by-product ~15.4k mt/yr.*
  - *Status: Production, in process of expansion to 200k mt more of Cu and 17k mt of Co.*
  - *Ownership: China Molybdenum acquired Freeport's 70% ownership for $2.65B as of 8/2021*
  - *Lifetime: ~30 years*

**Source: PlusMining, Inc., JustAuto and Martec analysis.*

***NOTE: These are only an example locations as other sites may exist globally. Sites with significant contribution over the next 3 years were identified.*

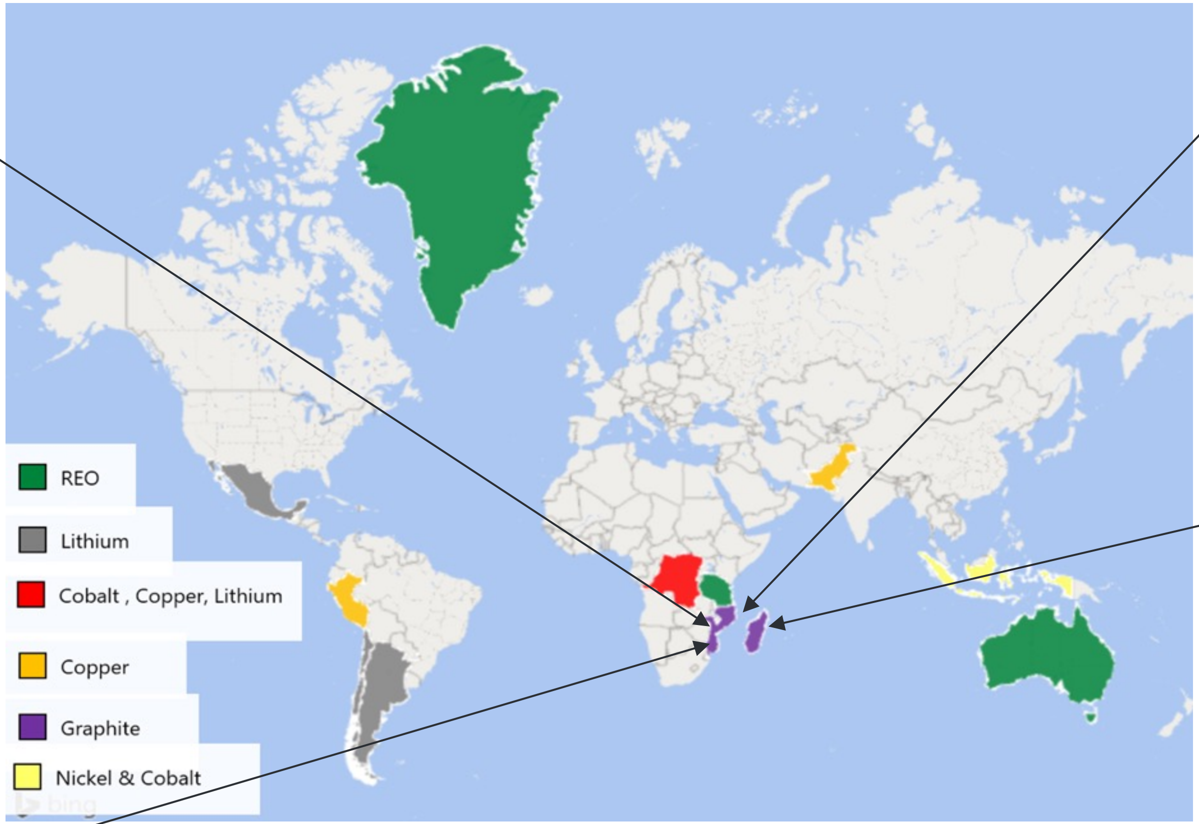
China's role in new global mining projects: Graphite

Chinese companies are involved in a position or have future commitments of supply in the following (4) Graphite projects**:

- **Ancuabe:**
  - *Location: Mozambique*
  - *Production: ~60k mt/yr.*
  - *Status: In discovery, financing and early construction stage; ~$100M CAPEX; Indications are all future production is committed to be exported to China customers for processing*
  - *Ownership: Triton Minerals-Australia (~66%); Jinan Hi-Tech-China (~34%)*
  - *Lifetime: ~27 years*

- **Balama:**
  - *Location: Mozambique*
  - *Production: ~350k mt/yr.*
  - *Status: Production started in 2019 and early-stage expansion: ~$200M CAPEX; Future production and expansion committed to China customers for final processing*
  - *Ownership: Syrah Resources (publicly traded)*
  - *Lifetime: ~40 - 45 years*

Graphite Projects of Interest:



- **Vatomina & Sahamamy Projects:**
  - *Location: Madagascar & Mozambique*
  - *Production: ~9k mt/yr. (2020); ~12k mt/yr. (2021); ~84k mt/yr. by 2024*
  - *Status: Production and medium stage expansion and discovery (Vatomina greenfield portion); plan is will be sent to India for downstream processing, but portion of volume will be sent to China*
  - *Ownership: Tirupati Graphite plc-UK*
  - *Lifetime: 30+ years*

- **Molo:**
  - *Location: Madagascar*
  - *Production: ~45k mt/yr.*
  - *Status: Discovery, financing and early construction stage; Looking to sell future commitments, attempting to target to non-China customers*
  - *Ownership: NextSource Materials-Canada (~83%); Vision Blue Resources-UK (~17%)*
  - *Lifetime: 40+ years*

**Source: PlusMining, Inc., JustAuto and Martec analysis.*

***NOTE: These are only an example locations as other sites may exist globally. Sites with significant contribution over the next 3 years were identified.*

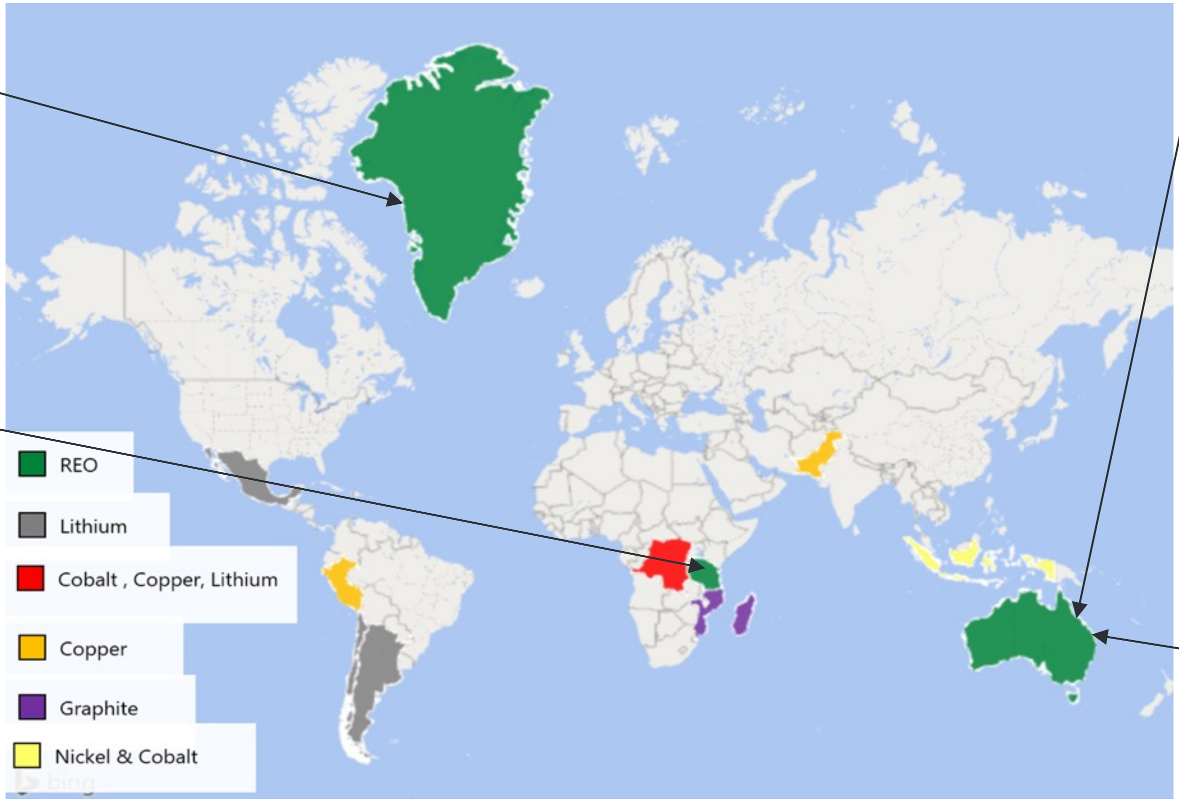
China's role in new global mining projects: Rare Earth

Chinese companies are involved and have an ownership position in the following (4) Rare Earth projects**:

- **Kuannersuit/Kvanefjeld:**
  - *Location: Greenland*
  - *Production: Nd/Pr ~5.1k mt/yr.; ~24.4k mt/yr.*
  - *Status: Discovery and financing stage; ~$840M planned CAPEX*
  - *Ownership: Greenland Minerals-Australia (87.5%); Shenghe Resources-China (12.5%)*
  - *Lifetime: ~37 years*

- **Ngualla:**
  - *Location: Tanzania*
  - *Production: 32.7k mt/yr. (concentrates @ 45% REO with 2.8k mt/yr. of Nd & Pr)*
  - *Status: Discovery & financing stage; ~$360M CAPEX including refinery post processing onsite*
  - *Ownership: Peak Resources-Australia (84%); Tanzania Government (16%)*
  - *Lifetime: ~26 years*

Rare Earth Projects of Interest:



- **Alkane/Dubbo Project:**
  - *Location: Australia*
  - *Production: ~1,158 mt NdPr/yr. + other metals*
  - *Status: Discovery & financing stage; CAPEX $980M*
  - *Ownership: Alkane Resources-Australia public company*
  - *Lifetime: ~22 years*

- **Nolans Project:**
  - *Location: Australia*
  - *Production: Nd & Pr 4.4k mt/yr. + Phosphoric acid*
  - *Status: Discovery & financing stage; CAPEX $768M; Promote targeting non-China business but still ~30%+ of committed future volume is to China*
  - *Ownership: Arafura Resources-Australia (100%)*
  - *Lifetime: ~38 years*

**Source: PlusMining, Inc., JustAuto and Martec analysis.*

***NOTE: These are only an example locations as other sites may exist globally. Sites with significant contribution over the next 3 years were identified.*

BEV materials supply chain assessment

DRIVERS & BARRIERS ANALYSIS

Drivers & Barriers Impacting the Future BEV Market Overview

The following drivers & barriers were analyzed by Martec during this engagement:

Drivers	Barriers
• Government zero emission targets (ZEV) & mandates ➢ *Countries vs. US States* • US Government investments & incentives • Government contracts (purchasing targets) • OEM Corporate / Fleet statements & mandates	• Location of key materials (mining & processing) • Speed of capture of mined minerals ➢ *Exploration, development, mining, refining/purification, etc.* • Cap-Ex / Investment by mining & processing community • Environmental sustainability & resources • Material price volatility

Drivers:
Key Takeaways

BEV Market Drivers Overview

Martec has analyzed a variety of drivers both domestically and globally that are driving vehicle electrification

- Global and US Government mandates/goals are significantly driving BEV growth and investment
  - ➢ *US targeting 50% of all new vehicles sold by 2030 to be zero-emission vehicles*
  - ➢ *Other major and developed countries have been initiating new mandates and targets for electrification and zero emissions*
    - – Most targets range anywhere from 30% up to 100% of new vehicle sales by 2030

- Countries have either started or are introducing incentive plans to help accelerate BEV adoption
  - ➢ *<u>US Incentive:</u>*
    - – Ranges from current $7.5k up to $12.5k proposed
  - ➢ *<u>Global Incentive Range:</u>*
    - – India: up to ~$2k
    - – France: up to ~$2.4
    - – China: up to ~$3.5k
    - – Sweden and Japan: up to ~$7k
    - – Germany: up to ~$10.5k

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BEV Market Drivers Overview *(continued)*

- Electrifying Governmental fleets:
  - *US:*
    - Electrify entire global fleet (>650k LD vehicles)
    - Experts have estimated this to cost ~$20B USD
      - *Martec believes this figure is extremely low based on average vehicle cost of $30.6k per vehicle*
  - *Global Examples:*
    - UK: 100% of Governmental car fleet being "ultra low emission" by 2030

- Government Investments:
  - *US:*
    - ~$15B going towards BEVs and their infrastructure; Targeting 550,000 charging stations by 2030
    - DOE investing in projects for securing domestic materials supply-chain, mining and processing
  - *Global Examples:*
    - Germany: Investing in 1M charging stations by 2030
    - Great Britain: Investing 2.4% of countries GDP into business R&D
    - Sweden: Investing to increase charging stations from 500 to 10k by 2030
    - France: Investing $34.9B USD into "France 2030" to increase domestic BEV and hybrid production

BEV Market Drivers Overview *(continued)*

- US OEM/Corporate ambitions:
    - *Electrifying entire fleets*
        - Amazon pledging 100,000 delivery vans by 2030
        - Walmart electrifying entire fleet by 2040
        - UPS introducing 10k BEV trucks by EOY 2024

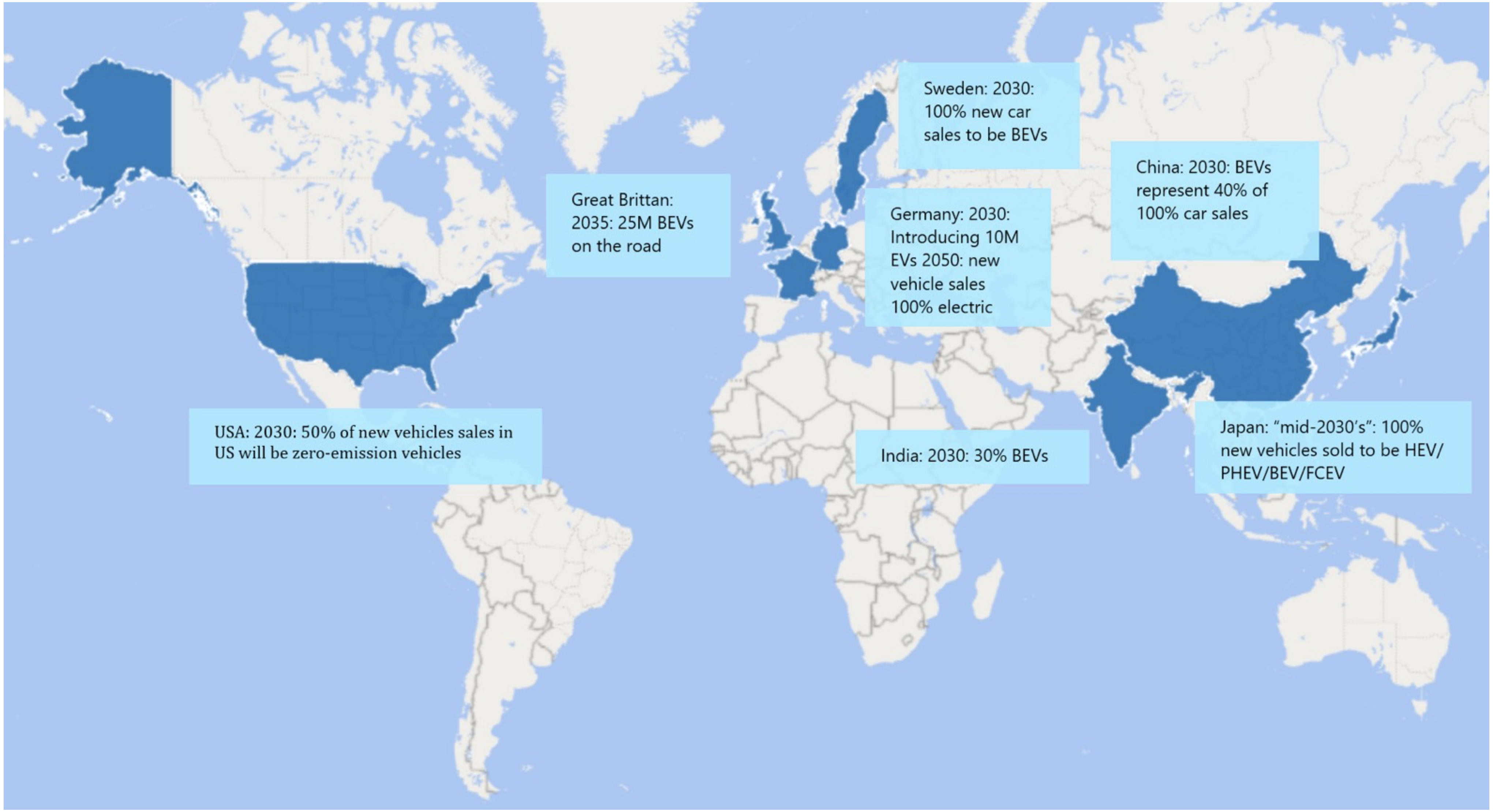
    - *US Carbon neutrality goals for plants and HQs*
        - Amazon has dedicated $2B USD to being carbon neutral by 2040
        - FedEx pledges to have a carbon neutral supply-chain with no timeline given
        - General Motors aims to have all plants be carbon neutral by 2040
        - Ford plans to have all plants run on renewable energy by 2035

- OEM/Corporate investments & innovation:
    - *Investments in new fuel types (FCEV, BEV)*
        - FedEx to invest ~$2B USD in alternative fuels for aircraft and vehicles
        - UPS has ordered 10 BEV aircraft for 2024 to deliver between facilities
    - *JVs to accelerate projects to meet goals set for electrification*
        - Walmart partnered with Argo AI to for a BEV delivery solution

Driver:
Government ZEV Targets & Mandates

Prominent Countries with BEV Mandates/Goals

Martec has analyzed and summarized the BEV mandates for the following key countries & regions



Source: Martec research & analysis

Global EV Goals and Policy Overview

Countries/State	BEV Goals/Ambitions with Timing
Unites States	**2030:** 50% of all new vehicles sold in US will be zero-emission vehicles
China	**2030:** BEVs represent 40% of all new car sales
Japan	**"Mid-2030's":** 100% new vehicles sold to be only hybrids and electrics
Sweden	**2030:** 2.5 million EVs and PHEVs on the road
Germany	**2030:** Introducing 10M EVs and installing 1M charging stations
France	**2030:** Produce at least 2M BEVs and PHEVs in France
Great Britain	Government's Decarbonization Goals (accumulative): • **2025**: 3M BEVs • **2030**: 10M BEVs • **2035**: 25M BEVs
European Union	**2030:** Goal of 30M EVs on the road by member states
India	**2025:** Targeting to have an initial 4k BEVs domestically produced and on the road

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US EV Policy and Goals

- Biden Administration set a non-binding goal of 50% of all new vehicles sold by 2030 to be zero-emission vehicles
    - *Applies to BEV, PHEV, and FCEV*
- Current total amount of credit allowed for a vehicle is $7.5k
    - *The Biden administration has promised to increase the federal tax credit for electric vehicles to $12,500 for union assembly only*
    - *No timeline has been announced by the administration*
        - *Part of pending BBB legislation*
- US has set a target of 550,000 charging stations by 2030
    - *Total cost of publicly supplying charging stations is estimated at $50B*
    - *Biden Administration proposed $15B in 3/2021 to Congress*
    - *Currently there are 43,514 charging stations in US (2021)*
- Biden Administration has made a pledge to electrify the entire US Government fleet
    - *No timeline has been stated yet*
    - *~654k remaining vehicles*

Some experts estimated $20B of funds would be needed, but this would only allow ~$30.6k per vehicle assuming all US government vehicles were converted to EVs. Martec believes it would be significantly higher than $20B.

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Chinese EV Policy and Goals

- BEV sales targets:
  - *20% of all LD auto sales by 2025*
  - *40% of sales by 2030*
  - *50% of sales by 2035*
    - *2021 LD Auto VIO of 292M (via China Ministry of Public Security)*

- Chinese vehicle manufacturers and importers are required to make or import at least 12% electric vehicles
  - *Applies to companies that manufacturer or import >30k vehicles annually*

- Under the "New Energy Vehicle (NEV) Policy" (2020) BEV subsidies were cut 20% from 2020 for a range of 300-400km being lowered to ¥13k (~US$2k) per vehicle, from ¥16.2k (~US$2.5k) in 2020

- BEV subsidies for range of >400km will drop to ¥18k (~US$2.8k) per vehicle in 2021, from ¥22.5k (~US$3.5k) in 2020

- China aims to electrify its LD Government fleet by 2035

**Note: Conversion 1 Chinese Yuan ~ $0.16 USD*

Great Britain EV Policy and Goals

- 25% of Governmental car fleet is “ultra low emission” by 2022
- 100% of Governmental car fleet being “ultra low emission” by 2030
- Ending the sale of new ICE cars and vans by 2040
- The Government plans to decarbonize the economy will require the number of BEVs on Britain’s roads to rise from around 100,000 currently to 3M by 2025, 10M by 2030 and 25M by 2035.
- Largest increase in public investment in R&D (2.4% GDP) – £64.8B ($89.3B) by 2027
    - *Increasing business R&D tax credit to 12%*

**Note: Conversion 1 Pound ~ $1.37 USD*

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European Union EV Policy and Goals

- Goal of 30M EVs on the road by 2030 in member states*
  - *2020 LD VIO of 264.2M*

- Introducing proposals for binding emission targets for member states*
  - *55% cut in CO_2 emissions by 2030 to be 100% by 2035*

- Proposed 100% ban would effectively end sales of gas, diesel, and hybrid-engines by 2035

***NOTE: Member Countries Include:** Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.*

Germany EV Policy and Goals

- Included in the *€130B ($151.3B) Coronavirus relief package, was €2.5B* for up to 10M EVs and 1M charging stations by 2030
  - *2020 LD VIO of 48M*

- Germany's 'Umweltbonus' (environmental bonus) program offers grants for the purchase or lease of EVs:
  - *Program ran 2016 - 2020 and extended until 2026*

BEVs	*BEVs up to €40k ($46.5k)*	*BEVs over €40k ($46.5k)*	*BEVs (used) – No price given*
€ Grant	*€9k*	*€7.5k*	*€5k*
$ Grant	$10.5k	$8.7k	$5.8K
PHEVs	***PHEVs up to €40k ($46.5k)***	***PHEVs over €40k ($46.5k)***	***PHEVs (used) – No price given***
€ Grant	*€6.7k*	*€5.6k*	*€3.8k*
$ Grant	$7.8k	$6.5k	$4.3k

- Motor Vehicle Tax:
  - *Registered BEVs from 2011 - 2030 have a 10-year exemption from the motor vehicle tax: ~€200 ($233)/yr.*
  - *PHEVs pay tax but is ~ €28 ($33)/yr.*

- Tax Benefits:
  - *Anyone that charges their vehicle at their employers' premises are exempt from declaring this as a cash benefit in their income taxes*
  - *Employers offering free charging of EVs will not be taxed for this service until 2030*

**Note: Conversion 1 Euro ~ $1.16 USD*

France EV Policy and Goals

- France is investing €30B ($34.9B) into its 'France 2030" plan
  - *Goal to produce at least 2M electric and hybrid vehicles in France by 2030*

- Extending current incentives through July 2022 for the purchase of a new BEV or PHEV
  - *Continuing trade-in bonuses for cleaner new and used cars*

- Purchase incentive of €6k euros ($6.9k) to private buyers and €4k ($4.6k) euros to business customers who purchase a new BEV costing €45k ($52.6k) euros or less

- Buyers get €2k ($2.4k) off the price of a BEV costing €45k ($52.6k) to €60k ($70k)

- PHEVs are eligible for €1k ($1.2k) in incentives

- All incentives are capped at 27 percent of the total cost of the vehicle

**Note: Conversion 1 Euro ~ $1.16 USD*

Sweden EV Policy and Goals

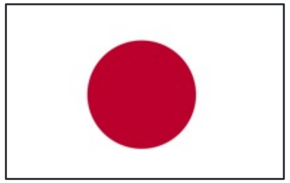
- Target of carbon-neutrality by 2045
  - *Requires 2.5 million EVs and PHEVs by the end of the (2030)*
    - Sweden's 2019 LD VIO: 5M

- Grant of 60k SEK ($7k) is available for up to 25% of the car's purchase price (new) BEV and PHEVs (under certain standards):
  - *Vehicles serviced before 2020 with CO2 emissions of up to 60g/km*
  - *vehicles serviced during 2020 or later with CO2 emissions of up to 70g/km*
  - *The grant is available for both individuals and businesses*

- Between 2012 and 2020, the number of charging units in Sweden has increased from 500 to 10k

**Note: Conversion 1 SWD ~ $0.12 USD*

Japanese EV Policy and Goals



- End of 2020 Japan launched their "Green Growth Strategy"

- Goal of reducing GHG emissions to zero by 2050

- Goal of all new vehicles sold by "mid-2030's" to be only hybrids and electrics
  - ➤ *Strategy sets 100% electrification including EV, FCEV, PHEV, and HEV with the phase out of pure ICE engines*
  - ➤ *Currently hybrids and electrics make up 29% of Japan's VIO of 5.2M*

- In late 2020 subsides in Japan were doubled from ¥400k (3.5k) to ¥800k ($7k) for BEVs
  - ➤ *PHEVs credit will remain at ¥200k ($1.7k)*
  - ➤ *FCEV credit will remain at ¥2.25M ($20k)*

**Note: Conversion 1 Japanese Yen~ $0.0088 USD*

India EV Policy and Goals

- <u>Subsidy encouragement:</u>
  - *Two-wheeler: Up to 20k Rupee ($267)*
  - *Three-wheeler : Up to 50k Rupee ($667)*
  - *Four-wheeler : Up to 1.5M Rupee ($2k)*

- <u>MSRP Cap:</u>
  - *2-wheelers: Purchase price up to Rs. 1.5 ($2k)*
  - *3 wheelers: Purchase price up to Rs. 5 ($6.7k)*
  - *Four-wheeler: Purchase price up to Rs. 1.5M ($20k)*

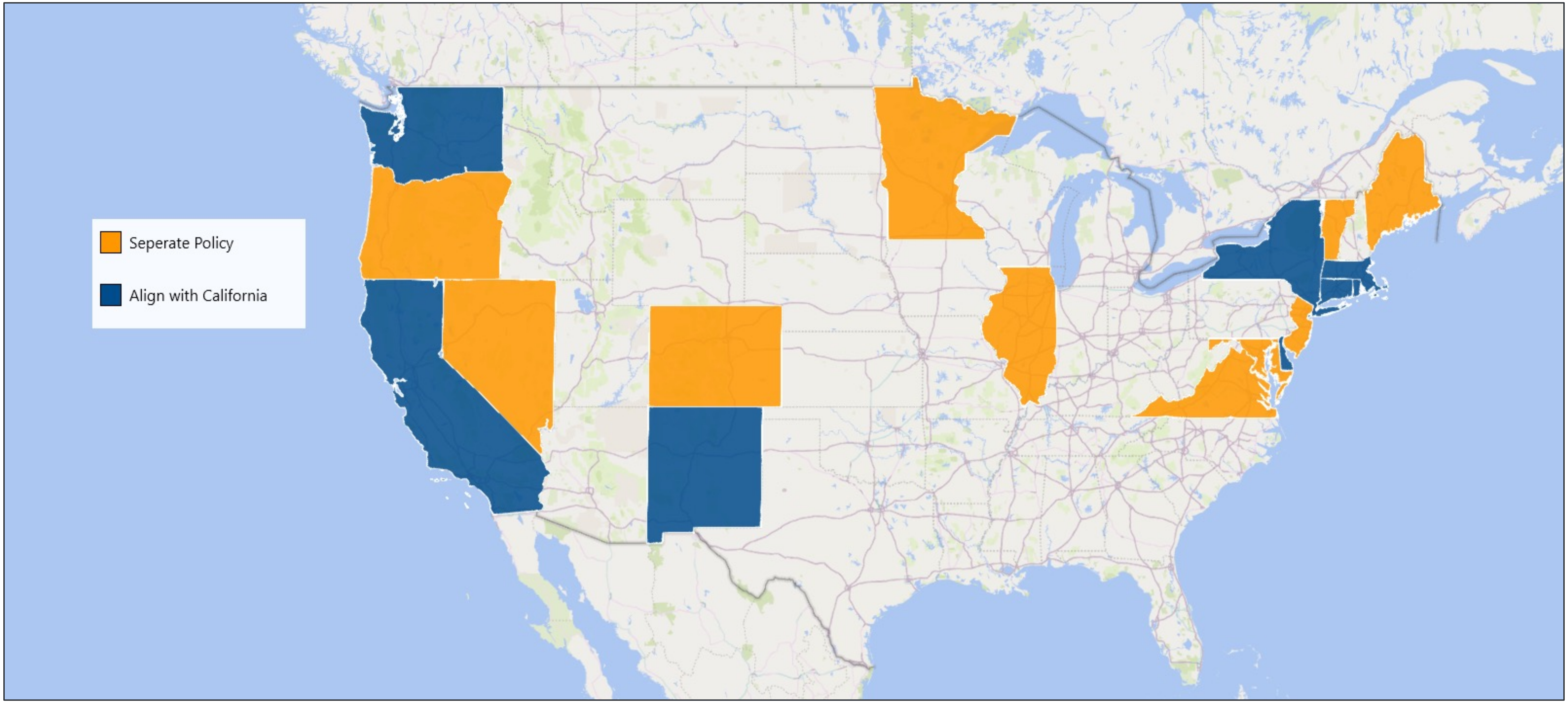
- Ambition to have 4k BEVs on the road in the next four years (by 2025)

**Note: Conversion 1 USD ~ 75 Rupee*

Driver:
US Local & State Level Government ZEV Targets & Mandates

US States with ZEV Goals Overview

Eighteen US States and the District of Columbia have set individual mandates or goals to help drive ZEV growth



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US ZEV Mandates / Goals by State

Below is a high-level description of each state's own internal mandates/goals that have been announced

States	ZEV Mandates	States	ZEV Mandates
California	**2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles	**Nevada**	**2025**: 10% of all manufactured vehicles must be BEVs
Colorado	**2030:** Increase EV adoption to ~940k vehicles equals 3M ton reduction in GHGs. **2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles	**New Jersey**	**2025:** Goal to register 330,000 EVs in New Jersey by 2025
Connecticut	**2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles **2050:** Goal to make 100% new passenger vehicles ZEVs	**New Mexico**	**2035:** Goal to reach 100% ZEV market
Delaware	**2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles	**New York**	**2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles
Washington, D.C.	**2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles	**Oregon**	**2035:** 90% new cars and LD trucks sold will be required to be zero-emission vehicles
Illinois	**2030**: 1M BEVs on the road	**Rhode Island**	**2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles
Maine	**2025:** 50% of newly purchased or leased state fleet to be ZEV or PHEV **2030:** Goal to make entire state fleet 100% BEV **2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles	**Vermont**	**2025:** Goal to register at least 50k – 60k BEVs
Maryland	**2025:** 300,000 ZEVs on the roadway	**Virginia**	**2025:** 22% of all new vehicles sold must be BEV or PHEV
Massachusetts	**2035:** 100% new cars and LD trucks sold will be required to be zero-emission vehicles	**Washington**	**2030:** 100% new cars and LD trucks sold or registered will be required to be zero-emission vehicles
Minnesota	**2030**: Increase to 200,000 BEVs on the road		

California EV Policy and Goals

- By 2035 all new cars and passenger trucks sold to be zero-emission vehicles (BEV, FCEV, PHEVs only)
    - *PHEVs will need to go 50+ all-electric miles and be "all-electric capable" throughout their charge-depleting mode*
    - *Automakers in California will only be able to rely on 20% of annual PHEV sales to satisfy ZEV obligations*
    - *Executive order signed on September 23rd, 2020*
- Tax credit of up to $7k to purchase or lease a new BEV, PHEV, or FCEV
- Goal to achieve 250k electric charging stations by 2025 and 5M zero-emission vehicles by 2030
    - *2020 ~32M LD VIO*

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Colorado EV Policy and Goals

- Automakers are required to sell >5% zero-emission vehicles by 2023 and >6% by 2025
  - *Signed into law August 23rd, 2019*
- Increase EV adoption to ~940k vehicles in state by 2030
  - *Requires maintaining 50% plus annual growth rates*
  - *Interim targets are to increase the number of new LD EVs sold on an annual basis from 4.2k in 2017 to 23.5k by 2022*
  - *2020 VIO for LD vehicle is ~5.5M*
- Colorado to participate in the development of ZEV standards for model years 2026+
  - *Supports the changes needed to achieve full electrification of LD vehicles*

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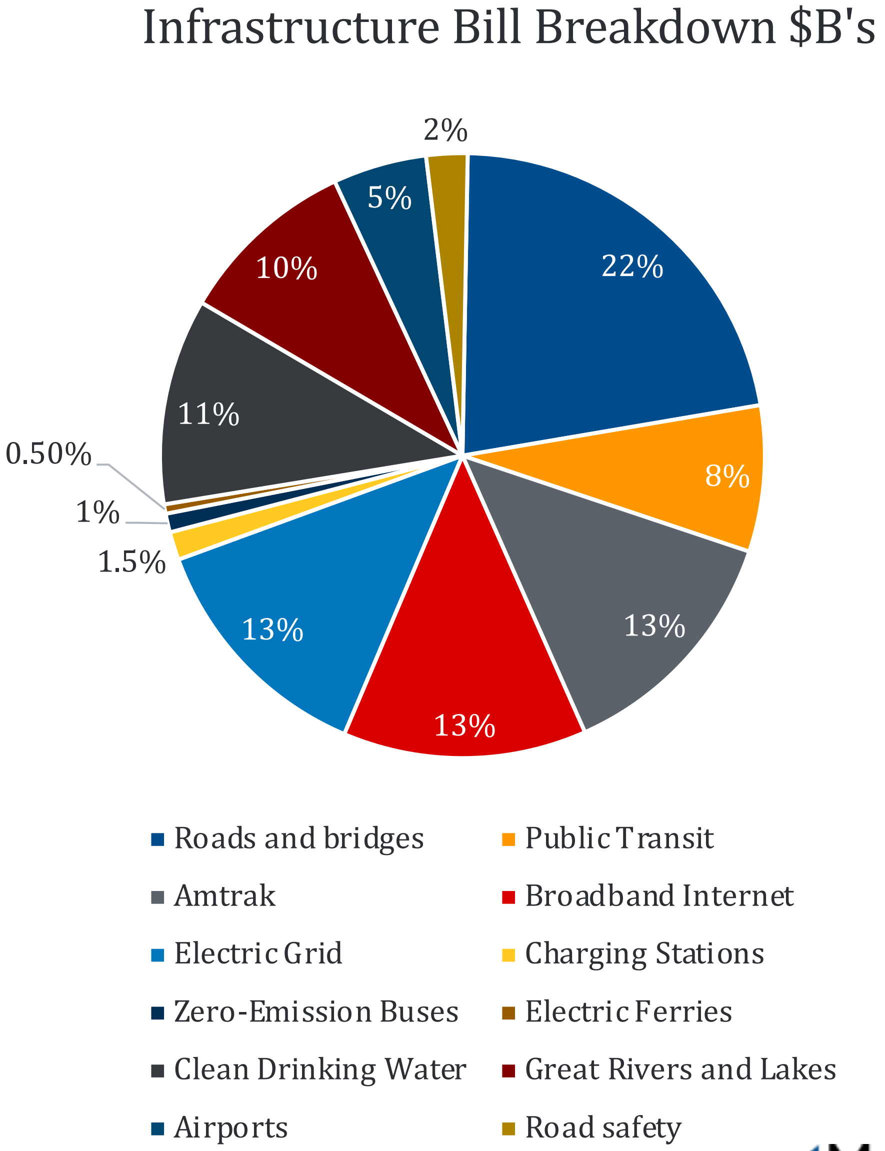
Driver:
US Government Investments & Incentives

Breakdown of $1.2T Infrastructure Package

- Electric Vehicles Infrastructure:
  - *$7.5 billion (1.5%) is dedicated to establishing a nationwide network of plug-in charging stations*
    - This funding will go towards the goal of installing 550,000 public charging stations by 2030
  - *An additional $7.5 billion for zero- and low-emission buses and ferries*
    - Aiming to deliver thousands of electric school buses

- Top-5 states receiving public finding for EV charging stations: Initial $1.3B
  - *This is based on a formula developed by the Federal Highway Administration (Top-5 states listed below)*
    - Texas - $407 million
    - California - $383 million
    - Florida - $198 million
    - New York - $175 million
    - Illinois - $148 million



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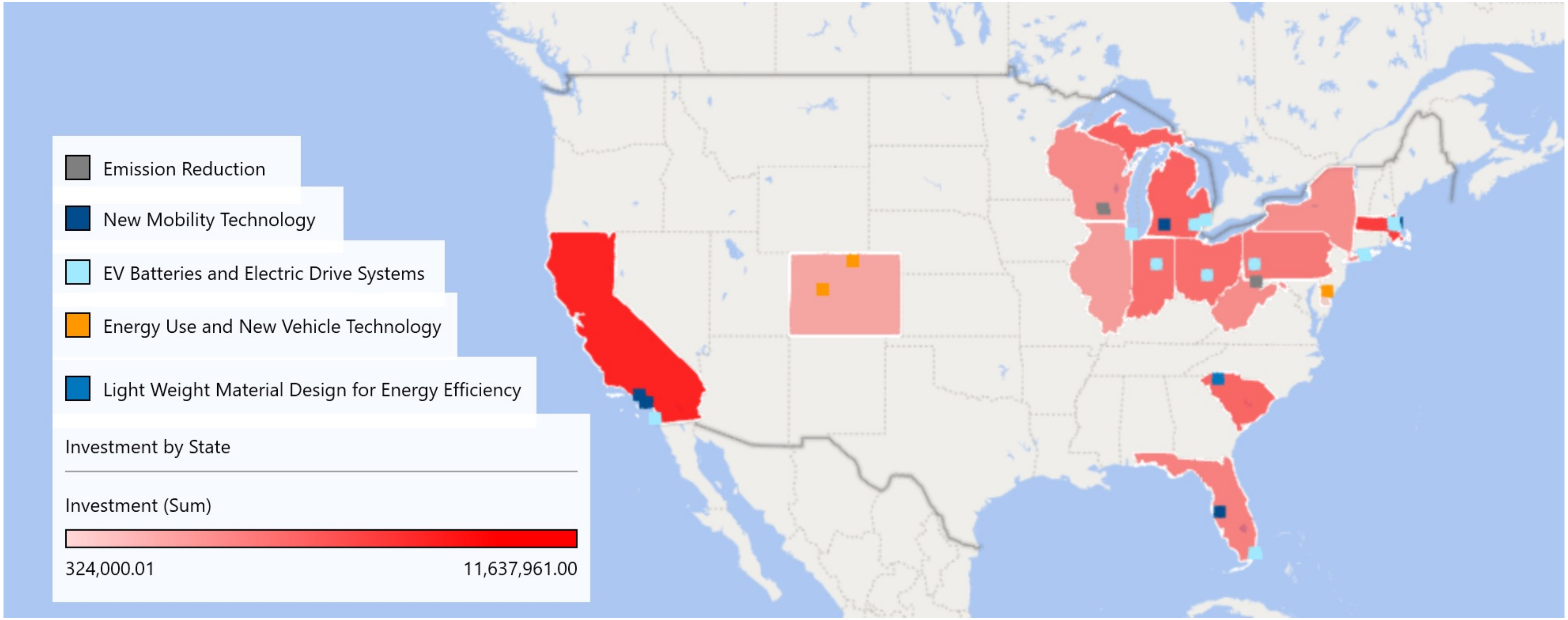
DOE New Project Locations and Investment Size

$60M broken out over 24 projects across the country with South Carolina having the largest investment of $5.7M



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DOE $60M Investment in Adv. Vehicle Technologies

DOE: $60 million Investment for 24 R&D projects aimed at reducing CO2 emissions from passenger cars and light- and heavy-duty truck

- $28.1 million will be awarded to accelerate innovation in EV batteries and electric drive systems
  - ➢ *12 projects on developing next-generation lithium batteries with improved lifespan, safety, and affordability*

- $20.2 million will be invested across six projects to help develop "a better understanding of new mobility technologies,
  - ➢ *Studying how automated, connected, electric, and shared vehicle technology, interact with the larger transportation system*
    - o *Ex. automated electric shuttles and connected vehicle/infrastructure technologies*

- $5.8 million plan to develop lightweight materials to increase passenger and commercial vehicle efficiency
  - ➢ *Clemson University will develop a lightweight, multi-material passenger vehicle body structure, addressing changes in joining dissimilar materials*

- $5.1 million will go to two projects aiming to reduce exhaust emissions while improving commercial vehicle engine efficiency.
  - ➢ *Developing simulation tools to accelerate and optimize the development of advanced emissions systems for heavy-duty vehicles*

- $1.0 million will go to "improve understanding of energy use and environmental impact of new vehicle technologies".
  - ➢ *Three projects will develop tools to understand charging infrastructure needs for medium- and heavy-duty electric vehicles and analyze environmental, cost, and energy impacts of infrastructure upgrades*

Source: US Department of Energy – July 2021 announcement

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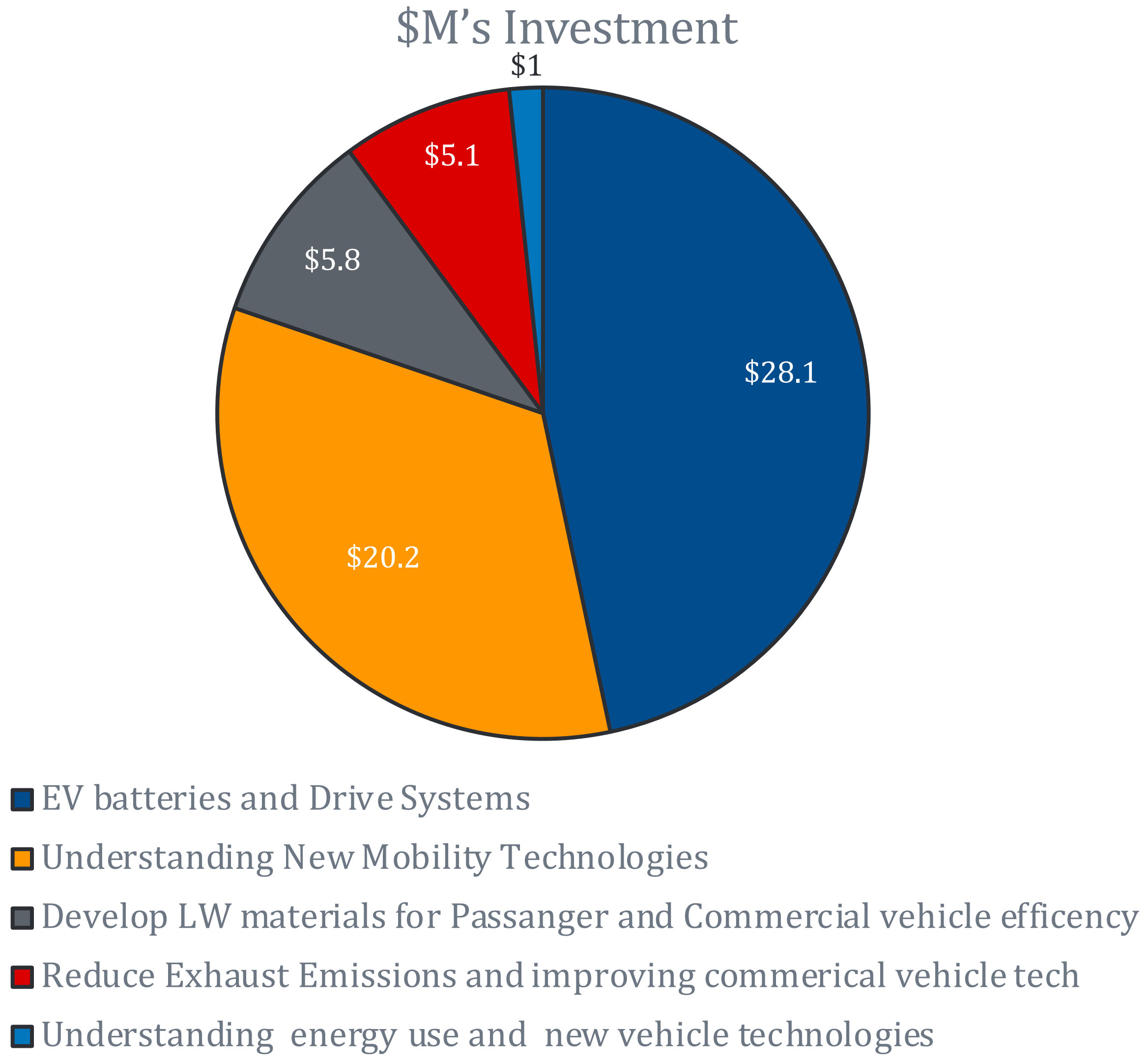

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US Investments in Material Supply-Chain

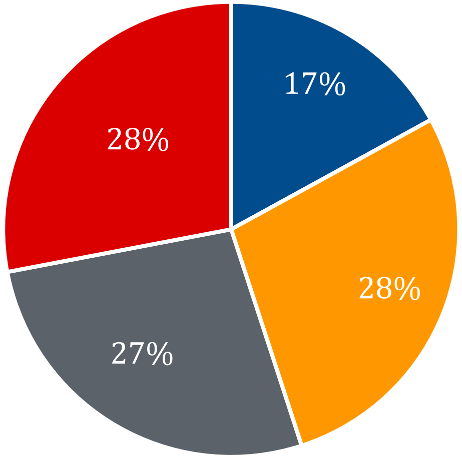
- DOE awarded $19M to 13 projects for fossil fuel producing communities to support production of Rare Earth Elements and Critical Minerals

- DOE awarded $30M into researching and securing the US domestic supply chain for REOs and other key minerals for battery making like lithium, cobalt, and Neodymium

- DOE Office of Fossil Energy to award $28.3M for research of advanced processing for rare earth elements and critical minerals
  - *Funding focus on R&D projects to develop midstream processing technology from coal-based and/or alternate resources that will be environmentally benign*

- Pentagon awarded Lynas Corp. (Australian based REO processor) $30.4M grant to build a light REO processing facility in Hondo, Texas
  - *No timeline stated currently on construction*
  - *If successful, this site will process/refine ~25% of worlds supply of REOs (source: DOD)*
  - *Estimated to produce ~4,536 MT annually*

$Ms Invested



Note: Different colored text coordinates with pie chart colors.

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Proposed Alternative EV Tax Credits & Incentives

Item	Senate Finance Committee	House Ways & Means
Tax Credit for new EVs	$7,500, if EV has 15 kWh battery (retroactive for EVs purchased after May 24, 2021)	$7,500 if EV has 40 kWh battery (not specified whether retroactive)
US assembly credit	$2.5k	Not specified
Union credit	$2.5k	$4.5k
US made battery credit	Not Specified	$500
Maximum credit (e.g., Ford, GM)	$12.5k	$12.5k
Maximum credit for Tesla (Cybertruck, Models 3 and Y. Excludes models S and X)	$10k	$8k
Adjusted Gross Income	Not Specified	$400k – Individuals $600k – HOH $800k – joint filers
MSRP Cap	$80k	$55k – Sedans $64k – Vans $69k – SUVs $74k – Pickups
Tax Credit Ends	When EVs exceed 50% of annual new car styles in the US, then a 3-year phase out (currently at 1.8%)	December 21, 2031
Credit for used EV (with at least 10kWh battery)	$2.5k with cap of $75k for AGI for individuals, $112.5k HOH, $150K joint filers	$2.5k with cap of $75k for AGI for individuals, $112.5k HOH, $150K joint filers
Tax credit refundable	Yes (starting 2022)	Yes (starting 2022)
Committee Pass Status	Yes (August 10, 2021)	Bill currently is in markup and no vote has been set

Driver:
ZEV Government Contracts
- Purchasing Targets -

US Government Contracts

- The Biden administration's "Buy American" executive order states:
    - *Currently, in order to be eligible for a US Government purchase/contract, 50% of the vehicle must be made in the US with union labor*
        - No electric vehicle in the US currently meets this threshold for procurement
        - Tesla does not use union labor
        - GM uses union labor but ~75% of parts come from outside of the US

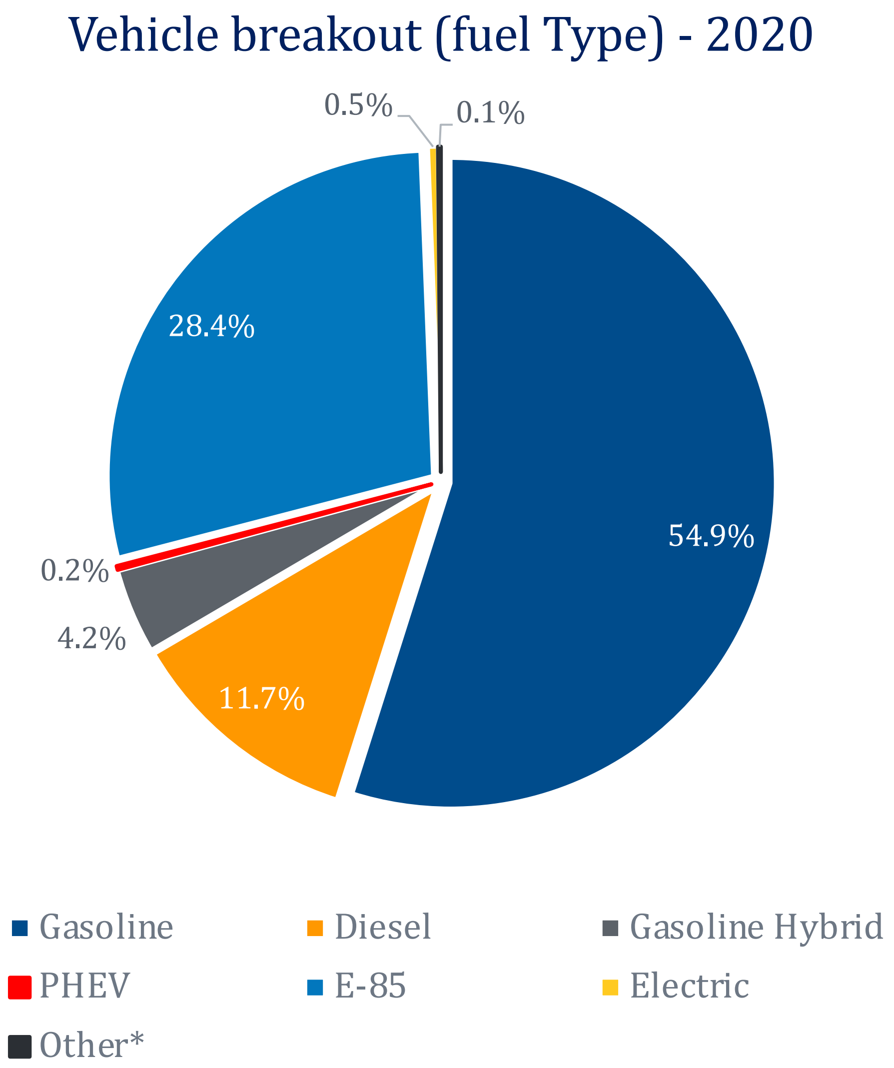
Source: General Services Administration 2021

US Federal Government Vehicle Breakdown

- As of 2020 the US Government owns ~657.5k total vehicles (LD,MD,HD)*
  - *~228,858 – Passenger vehicles*
  - *~277,277 – LD Trucks*
  - *~103,215 – MD Trucks*
  - *~39,246 – HD Trucks*
  - *~8,910 – other (ambulance, buses)*

- US Government owns ~3,170 (0.48%) BEVs*

- Outside PHEV minivans, BEVs have the largest additional Governmental cost (referenced in 2019 report)
  - *FY 2017(referenced in 2019 report) stated HEVs have an additional Government purchase cost of ~$5,200 more than a conventional ICE vehicle*
  - *PHEV sedans and minivans have an additional Government purchase cost ranging from ~$8,700 to ~$15,300 more than a conventional ICE vehicle*
  - *BEV sedans have an additional Government purchase cost of ~$8,900 more than a conventional ICE vehicle*



Total: 657,506

***Note - Others Include:*
Liquified Natural Gas, Diesel LGHG, Diesel Hybrid, Compressed Natural Gas

Source: FY 2020 Federal Open Data Set

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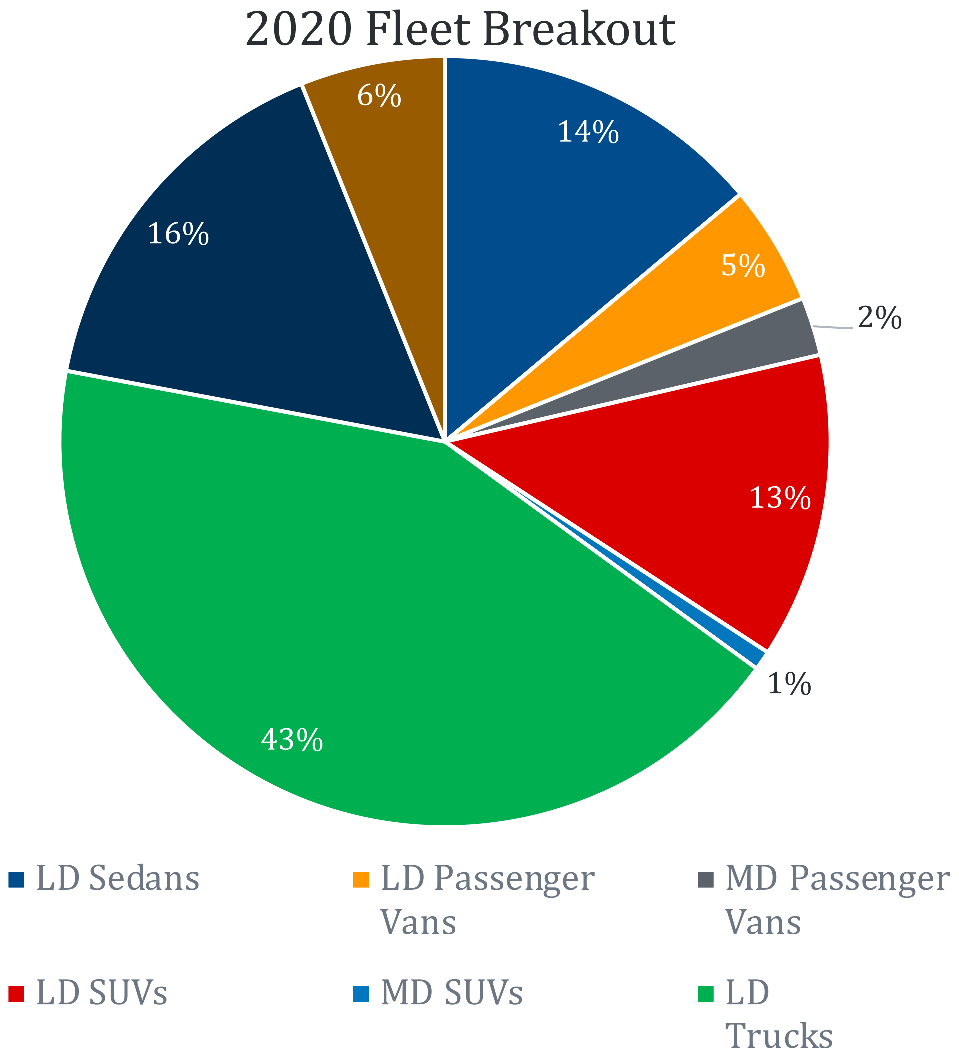
US Government Fleet Breakdown By Category

- LD & MD trucks make up 58% of the US Government Fleet
  - *LD representing 42% out of that 58%*
- Passenger vehicles make up ~1/3 of the US Government fleet
  - *4-door passenger sedans making up 14% of that ~1/3*
- 0.48% of this make up are BEV vehicles
- Law enforcement vehicles make up ~1.3% of all vehicles in the US fleet
  - *Law enforcement vehicles tend to cost more according to the GSA due to upgrades that are needed (see next slide for details)*



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US Government Contracts/Pricing - BEVs

Model	MY2022 MSRP	2021 GSA Pricing*	GSA Detail
Model Y	$56,990	$99,016	Custom up-fitted Surveillance/Law Enforcement vehicle with options to meet customer requirements Options include: ➢ *Window tint* ➢ *Laptop stands* ➢ *Power door locks* ➢ *Keyless entry* ➢ *Bluetooth compatibility* ➢ *Carpet floor mats* ➢ *Deactivated daytime running lights* ➢ *Radio* ➢ *Trunk vault* ➢ *With additional to meet further customer requirements*
Model 3	$43,990	$93,286	
Model X	$104,990	$143,924	
Model S	$94,990	$134,609	
Mustang MACH-E	$42,895	$93,264	
Chevy Bolt - EV	$31,000	$78,804	

**NOTE: 100% vehicle prices are surveillance/Law Enforcement.*

Source: General Services Administration 2021

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Driver:
OEM Corporate/Fleet Statements & Mandates

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Corporate & OEM ZEV Overview

Several US companies have made announcements moving towards electrified fleets and carbon neutral

Corporate	ZEV Announcement	OEM	Zev Announcement
Amazon	Pledging 10,000 vans delivering by 2022 and 100,000 by 2030	**General Motors**	Commitment to 30 new global EVs by 2025 Goal to have 100% of US plants run on renewable energy by 2030
FedEx	By 2030 100% FedEx ground vehicle purchasing will be ZEV	**Ford**	Goal of 40% over 100% sales to be 100% electric by 2030 Aspiration to sell only EVs by 2035
UPS	Roll out 10k Generation 2 EVs through 2024 across North American and European fleets	**Stellantis**	Pledging 55 electrified vehicles in the US and Europe by 2025 ➢ *40 BEV models and 15 PHEV models*
Walmart	Electrifying the entire fleet by 2040 ➢ *6.5k semi-trucks* ➢ *4k passenger vans*		

Amazons EV Goals and Aspirations

- Amazon dedicated $2B to its "Climate Pledge Fund" launched in June of 2020

- In 2019, Amazon's pledge is to be carbon neutral by 2040

- Since February of 2021, Amazon has been delivering in certain parts of Los Angeles with their EV vans
    - *2019 Amazon placed an order for 100,000 custom electric vans from Rivian*
    - *Plans to have 10,000 vans delivered by 2022 and 100,000 by 2030*

- Amazon has partnered with Rivian to provide its EV delivery fleet

FedEx EV Goals and Aspirations

- By 2040 FedEx's entire ground fleet will be zero-emission
- Purchasing of BEVs will ramp up to 50% in 2025
- By 2030 all FedEx ground vehicle purchasing will be zero-emission
- FedEx has announced an initial investment in GMs upcoming Brightdrop EV 600 BEV vans
- Pledge to transform supply chains with "carbon–neutral shipping offerings and sustainable packaging solutions,"
- Promised to invest in alternative fuels for aircrafts and vehicles costing ~$2B

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UPS EV Goals and Aspirations

- UPS set's goal to be carbon neutral by 2050

- January 2020 UPS took a minority stake in Arrival
    - *Purposed buying 10k Generation 2 EVs to add to its North American and European fleets*
        - Plan is to have them rolled out through 2024

- UPS has ordered 10 EV aircraft to be delivered in 2024 to move cargo between facilities

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Walmart EV Goals and Aspirations

- Walmart's goal is to electrify its entire fleet by 2040
  - *Includes more than 10,000 vehicles:*
    - ~6,500 semi-trucks
    - ~4,000 passenger vehicles

- Walmart has partnered with Ford and Argo AI to deliver an all-electric AI short distance delivery service

- Electrify America and Walmart are partnered and have more than 300+ EV charging stations

General Motors EV Goals and Aspirations

- Commitment to 30 new global EVs by 2025
- Aspiration to exclusively offer EVs by 2035
- GM aims to be 100% carbon neutral by 2040
- GM to launch Brightdrop EV600 Q4 2021
  - *BEV e-commerce delivery solution*
- Introduction of Factory ZERO
  - *Formally known as Detroit-Hamtramck*
  - *First built in 1985, GM has transformed into an EV assembly plant*
  - *BEV Hummer, SUV, Silverado, and Cruise origin will be manufactured there to start*
- Goal to have all US plants to run on renewable energy by 2030

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Ford EV Goals and Aspirations

- Goal of 40% overall sales to be all electric by 2030
- Aspiration to sell only EVs by 2035
- Invested $500M into Rivian
- Plan to have all plants run in renewable energy by 2035
- Goal to be 100% carbon neutral by 2050
- Introducing the F-150 Lightning
  - *BEV pickup coming in 2022*
- Opening of a new plant in Tennessee
  - *Plans to be operational by 2025*
  - *Plans to be Fords first carbon neutral plant*
  - *Assembling the F-150 Lightning*

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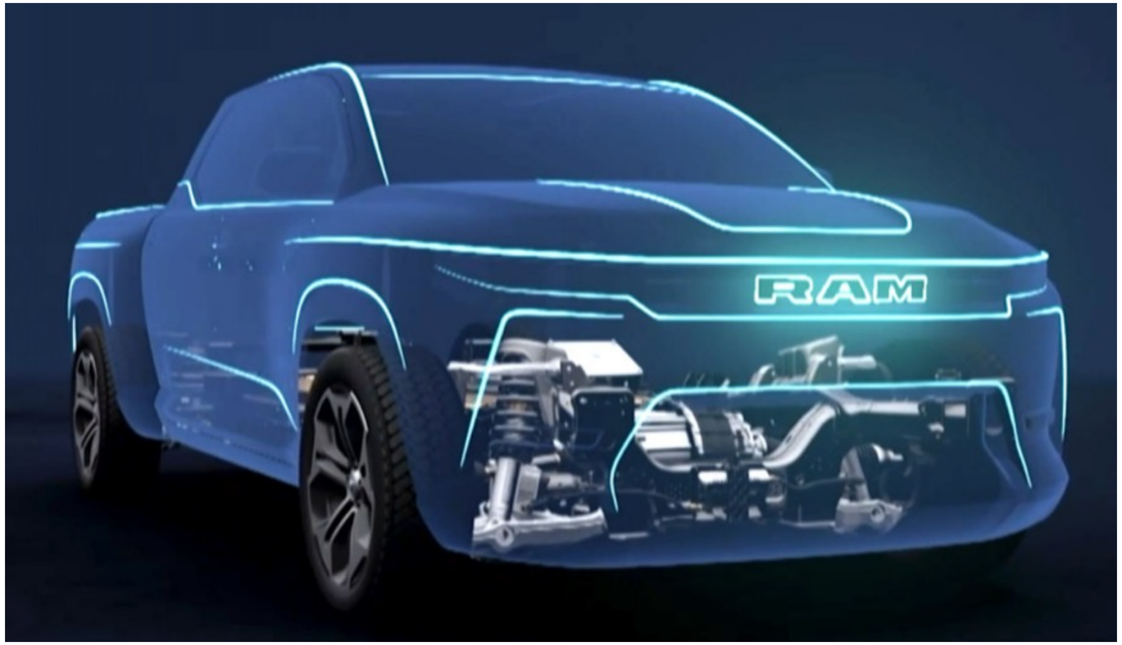
Stellantis EV Goals and Aspirations

- Stellantis to invest at least $35.5 billion in vehicle electrification and new SW/tech through 2025

- Anticipates 55 xEV models in portfolio in the US and Europe by 2025
  - *40 BEV models and 15 PHEV models*
  - *2030: At least one BEV version for every model in the US*
  - *Models will offer ranges from 300 - 500 miles*

- Aims to increase BEV sales in the US from 4% to 35%

- Plans to have (5) battery production facilities between the US and Europe



Barriers:
Key Takeaways

BEV Market Barriers Overview

Martec has analyzed a variety of barriers both domestically and globally that will be challenges to an accelerated growth rate of vehicle electrification

- Mining capital investment:
  - *Investment from exploration to commercial production can range from $500M to >$1.5B*

- Current US Mining Regulations:
  - *In the US it takes ~10 – 20+ years to get a mine up and commercially producing*
  - *US has some of the longest wait times for mining permits compared to other countries*
    - Other countries such as China, Australia, Chile, and Canada have a more expedited process

- US has a lower degree of available reserves and resources compared to other leading nations
  - *Significant investment will need to be provided to reach future BEV growth targets set by the US Government*

- US Civilian Court Injunctions:
  - *Many mining locations have experienced significant delays due to legal challenges thus increasing not only time but required investment*

BEV Market Barriers Overview *(continued)*

- Material Pricing/Volatility:
  - *Increased demand is having an impact on material pricing*
    - Lithium carbonate, Nickel, Cobalt, Copper, Neodymium, and Aluminum have all seen price increases over the past year ranging from 24% up to 414% increases (depending on material)
    - Lithium and Copper have seen significant growth above forecasted trends
      - *Lithium carbonate demand has seen YOY growth of 138% due to demand for BEVs*
    - Large increases have been experienced due a combination of demand from the BEV battery market on top of markets recovering from lows experienced during COVID pandemic

- US Government Contract Scoping:
  - *"Buy American" Executive Order*
    - Murky situation often requiring unionized labor could create challenges in the future….significant number of announcements are targeting investments where unions are not as prevalent

Barrier:
Speed of Capture of Mined Minerals

Mining Timeline – General Overview

Timeline can vary significantly from exploratory to actual commercial production for a mine*

Timeline can range from ~10 to 20+ years in total

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Time Range	~2 – 10 years	~2 – 5 years	~2 – 7 years	~10 – 40 years	~2 – 10+ years
Avg. Time by Stage	~5 years	~3 – 5 years	~2 – 3 years	~20 years	3 – 5+ years
Comments	• China and Australia 1 – 3 years • US 5 – 10 years • Many times started by smaller companies and then acquired later	• China, Australia and Canada have more expedited processes • US process varies by state and legal challenges	• 2 – 3 years is the norm unless legal challenges or unplanned issues arise • REO mines can take longer due to extraction & mkt. risk	• Some mines have gone beyond 50 years • Mining companies prefer not to design mine to be <10 years due to poor ROI	• Varying req. by country • If radioactive materials will be longer • China, Russia, SE Asia and South American countries tend to have lower standards
Key Steps by Stage	• Prospecting • Reconnaissance • Survey mapping • Sampling • Geochemical analysis • Resource estimation • Permitting	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation • Planning & investment • Final permitting	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase • Construction	• Ore extraction • Milling / Ore separation • Processing • Grade control • Waste rock/tailings & wastewater mgmt. • Near mine exploration • Expansion life of mine	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

**Note: Timing and cost will vary significantly by material and region globally.*
Martec is still finalizing some specific results by material type and region.

Barrier:
Cap-Ex/Investment by Mining & Processing Community

Mining Investment Timeline – General Overview

Investment can vary significantly from exploratory to actual commercial production for a mine*

Investment for a mine can range from ~$500M to $1,500M+ in total

	Exploration	Discovery	Development/ Construction	Production	Reclamation
Low to High Invmt. Cost	$10M - $200M	$50M - $500M	$50M - $1,500M	$10M - $300M/yr.	$20M - $200M
Avg. Investment Cost by Stage	~$50M - $100M+	~$200M - $300M	$300M - $1,000M	~$100M/yr.	~$50M - $100M
Comments	• Costly engineering surveying & studies are conducted to determine feasibility	• Need to determine what makes best sense for which zones to mine first, size of mine & extraction rate • Once decisions are made, there is limited to no flexibility	• Type of mine has significant cost impact (open pit/surface, underground, in-situ/brine) • Li has high cost if brine • If size of mine is changed need to restart permit process (design to capacity)	• Size and type of production will have significant impact on annual costs • Can typically only expand production if target better grade zones	• US & Europe known for being more expensive than other regions • Type & size of mine will have impact as well as location
Key Steps by Stage	• Prospecting • Reconnaissance • Survey mapping • Sampling • Geochemical analysis • Resource estimation • Permitting	• Targeted drilling • Trenching • Sampling & analysis • Quality geological modeling • Resource estimation • Planning & investment • Final permitting	• Resource conversion to reserve • Mine design & schedule • Plant design • Pre-construction phase • Construction	• Ore extraction • Milling / Ore separation • Processing • Grade control • Waste rock/tailings & wastewater mgmt. • Near mine exploration • Expansion life of mine	• Mine closure • Site clean up • Maintenance • Rehabilitation • Environmental monitoring

**Note: Timing and cost will vary significantly by material and region globally. Martec is still finalizing some specific results by material type and region.*

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Barrier: Material Pricing Volatility

BEV Materials Price Volatility – Key Takeaways

Pricing for key BEV materials have experienced significant increases over past 12 months and expected to continue

- All key BEV materials have experienced significant price increases over the last 12 months YoY
    - ➢ *Tightness in both material supply and longer lead-times have contributed to these increases*
    - ➢ *COVID-19 pandemic has also played a role in decreased volumes and pullback in the market*

- <u>YoY Price increases by key BEV material (Nov.-2020 through Nov.-2021)**:</u>
    - ➢ *Lithium Carbonate = +414%*
    - ➢ *Cobalt = +80%*
    - ➢ *Nickel = +24%*
    - ➢ *Neodymium (REE Nd) = +99%*
    - ➢ *Copper = +36%*
    - ➢ *Aluminum = +35%*



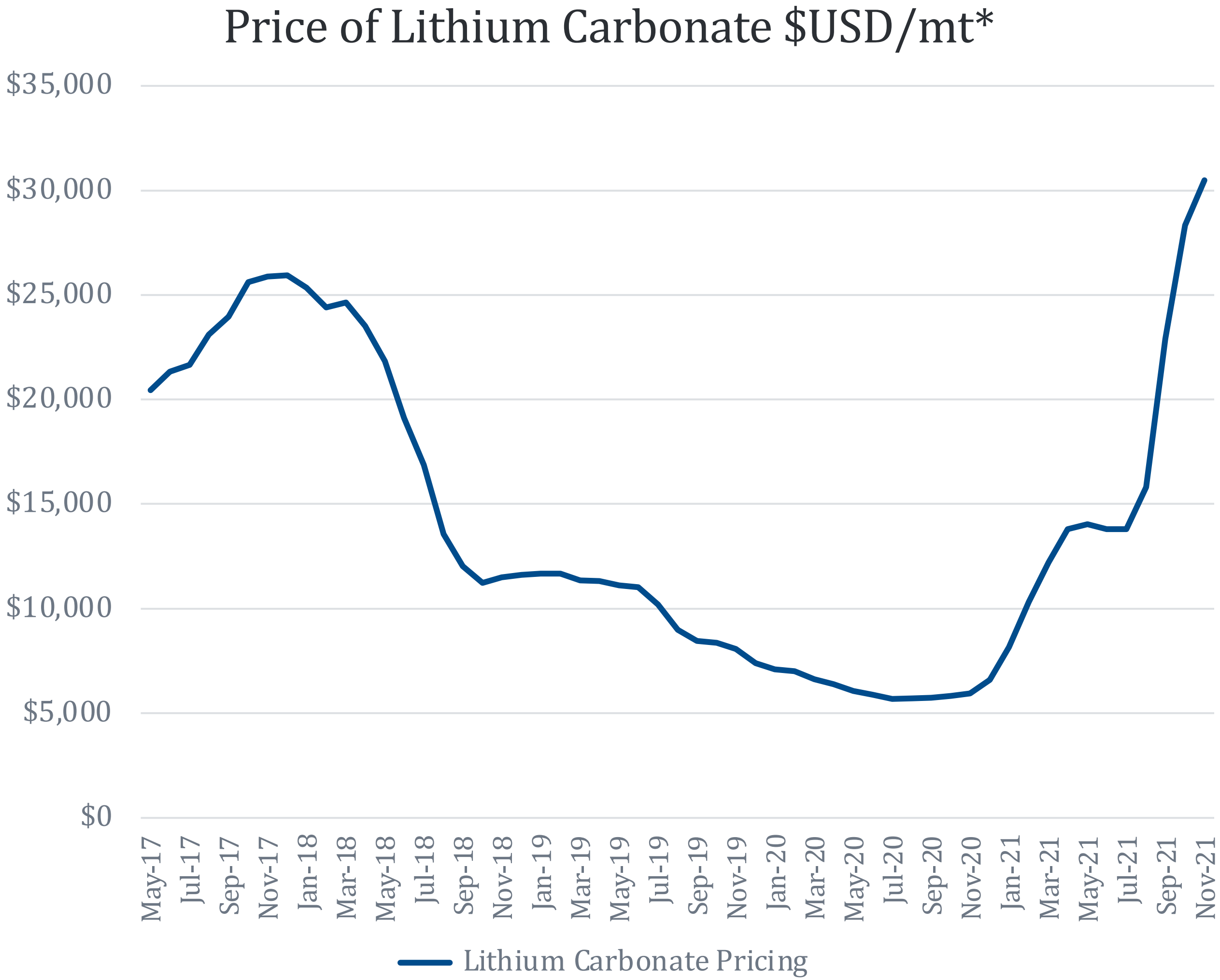



- Experts believe price volatility will continue as demand for BEVs continue to grow over the next decade
    - ➢ *If costs are passed on to the consumer this will only create delays in BEV adoption*

**Source: Pricing data and trends from Trading Economies (monthly tracking).*
***Note: Pricing for is not representative of refined battery grade materials.*

Historical Lithium Carbonate Pricing

Pricing from May 2017 – Nov. 2021

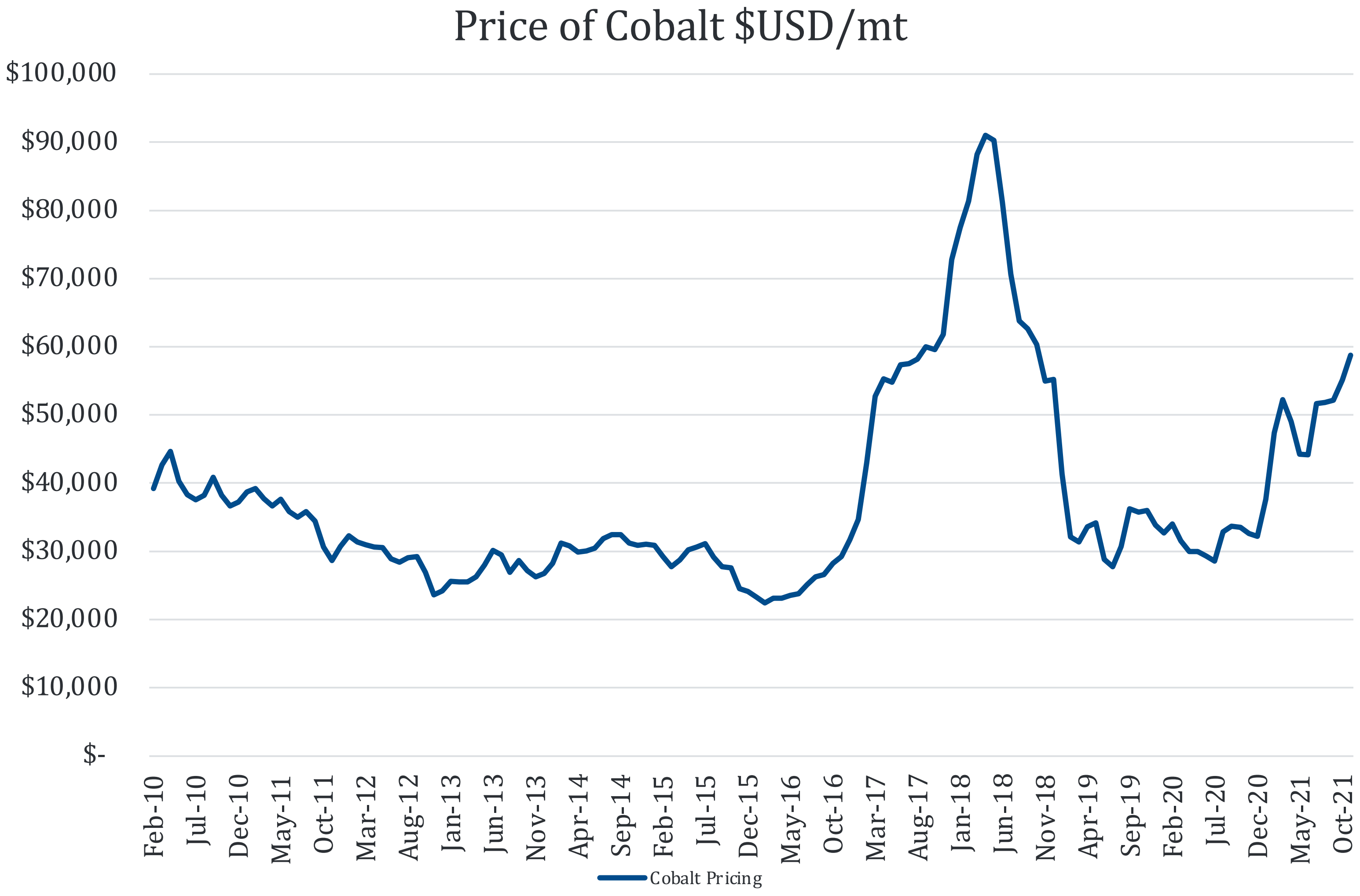


Source: Trading Economies (monthly tracking).
***Note: Quote from GlobalData report in Forbes article "Lithium Shortage May Stall Electric Car Revolution And Embed China's Lead".*

- Lithium carbonate has seen a YOY increase of 414% (Nov. 2020 – Nov. 2021)
  - ➢ *Avg. price/mt has increased from $5.9k up to $30.5k*
  - ➢ *Market low was in the July – August 2020 time frame when Lithium Carbonate was as low as $5.6k - $5.7k range*
    - – Volatility was primarily due to COVID-19 impact and excess inventory due to some new mines that came online in 2017 - 2018
- The world is living through a lithium shortage at the moment driven by one major area of demand: BEV batteries
  - ➢ *"With Lithium prices set to rise throughout the next decade, the EV sector in the West will have to face rising battery costs. If they pass costs on to the consumer, EV adoption will likely accelerate at a slower rate than previously expected,"***
- Lithium Carbonate pricing is anticipated to continue to rise through 2022 and beyond primarily due to ever increasing demand from Li-ion automotive battery growth

Historical Cobalt Pricing

Pricing from 2010 – Nov. 2021



**Source: Trading Economies (monthly tracking).*

- Cobalt pricing has increased 80% YoY from Nov.-2020 through Nov.-2021
- Supply uncertainty and increased EV production raised 2017 - 2018 prices
  - ➢ *Cobalt prices reached their all time high in May-2018 surpassing $90k/mt*
  - ➢ *2021 Cobalt prices are rising from COVID-19 lows largely in part due to EV production*
  - ➢ *Analysts anticipate prices to rise more slowly over the next 6 - 12 months (from Oct-2021)*
- Another mine (Mutanda) coming back online in the DRC will provide much of the new supply to meet growing demand
  - ➢ *Mutanda mine expected back online in late 2021 or early 2022*

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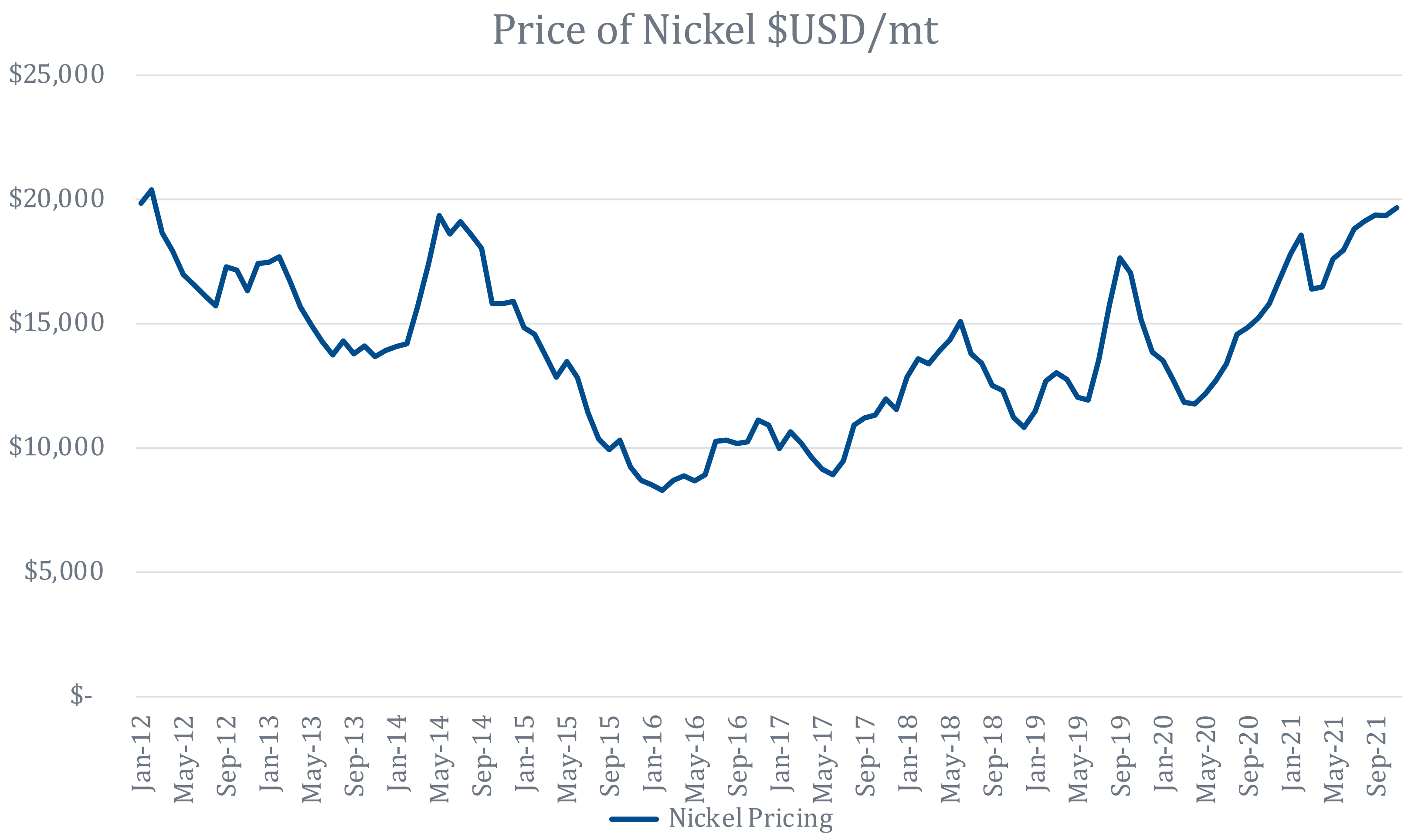
Historical Nickel Pricing

Pricing from 2012 – Nov. 2021

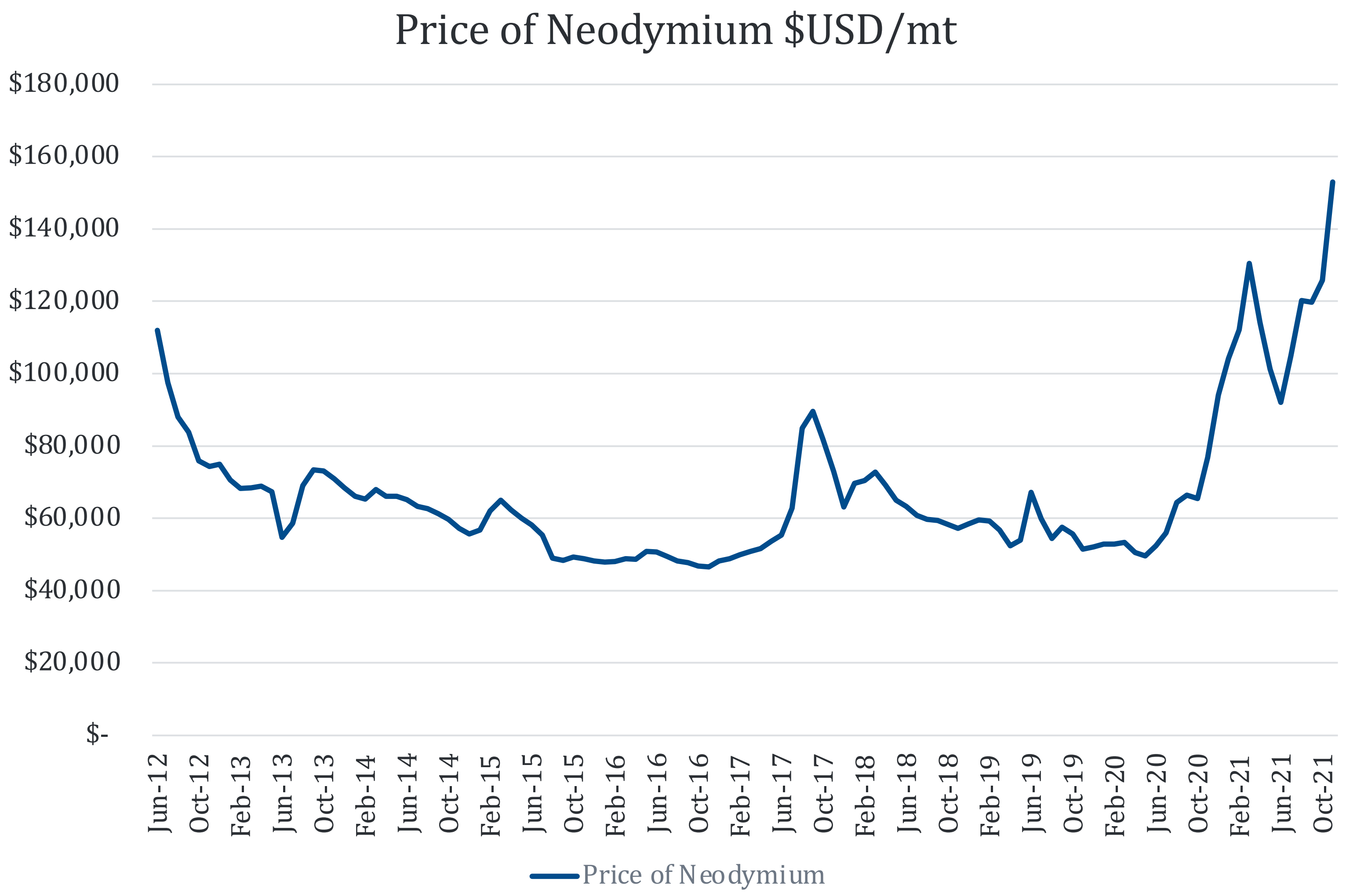


- Nickel has experienced a YoY price increase of 24% (Nov.-2020 through Nov.-2021)
- Nickel prices have continued to rise reaching a high of $19.6k in October-2021, close to what is it was in Jan.-2012
  - *Due to weak supply, tightening supply chain, and demand for BEVs*
  - *Experts have indicated producers are hoarding materials for 2022 due to speculation of supply shortages and delayed delivery times*
  - *Price increases have also been due to increases in stainless-steel demand in Asia*
    - China is the largest stainless-steel producer & consumer of Nickel globally

**Source: Trading Economies (monthly tracking).*
***Note: Pricing is not representative of refined battery grade Nickel Sulphate.*

Historical Neodymium (Rare Earth) Pricing

Pricing from 2012 – Nov. 2021



- Key rare earth element Neodymium (Nd) has seen prices double YoY from Nov.-2020 through Nov.-2021
  - *Nd pricing went above $150k/mt in Nov.-2021*
- Rising demand from increased EV and wind energy production has been impacting Nd pricing
  - *Sharp increases in pricing coming out of pandemic lows*
- Decreased supply around the world has aided in the rising prices
  - *China has been the only exporter to maintain a high level of production*

**Source: Trading Economies (monthly tracking).*

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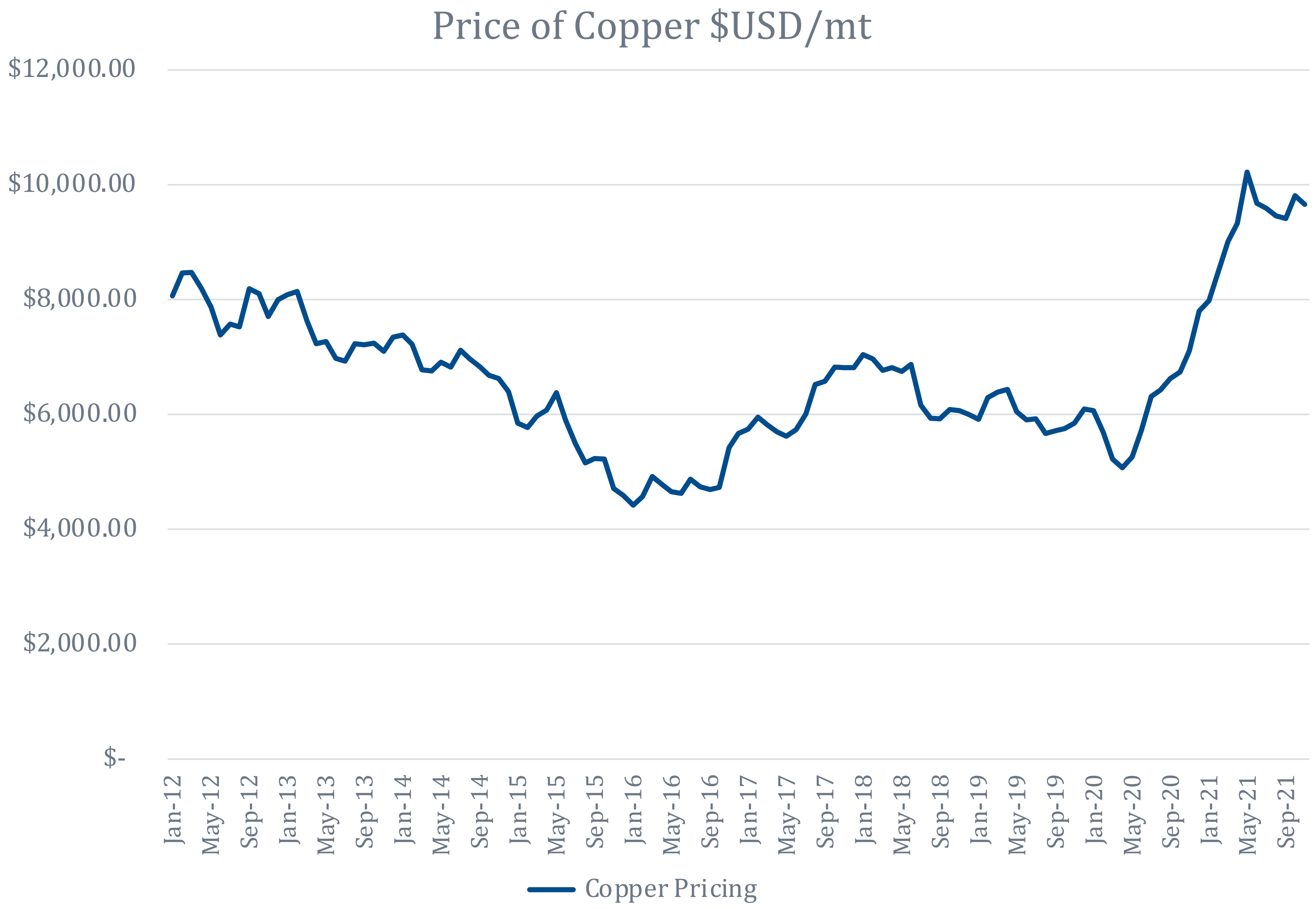
Historical Copper Pricing

Pricing from 2012 – Nov. 2021

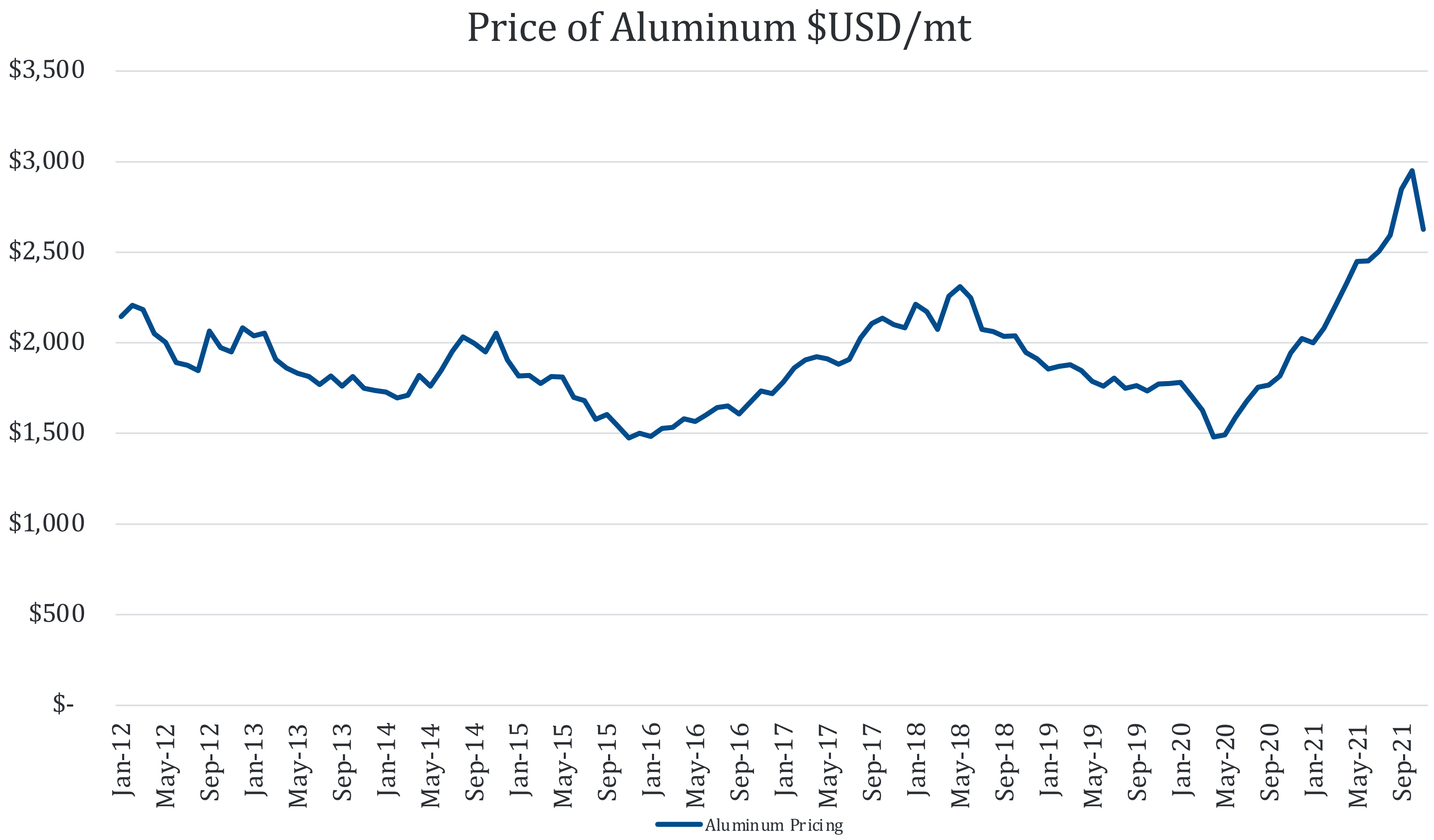


**Source: Trading Economies (monthly tracking).*

- Copper pricing YoY has increased 36% from Nov.-2020 through Nov.-2021
- Demand from China in late 2020 and early 2021 was the main driver for the most recent market price increases
  - ➢ *Now Asia's demand for copper has slowed down some in which prices are starting to recover*
- Experts have indicated supply chain has played a role in pricing, but has been offset by low interest rates and fiscal stimulus measures
- Experts contend that 2021 will be a year above forecasted trend growth
  - ➢ *This largely due to recovery in the market from the pandemic*

Historical Aluminum Pricing

Pricing from 2012 – Nov. 2021



- Aluminum pricing is 35% higher YoY (Nov.-2020 through Nov.-2021)
- Increased demand in homebuilding, aerospace, and EV markets
  - *Price increases building on pandemic highs*
- Political unrest in Guinea, a key market for the aluminum supply chain
  - *Guinea is a key supplier of Bauxite to China*
  - *Guinea is the second largest producer of Bauxite only behind Australia*
  - *Speculation is the political unrest in Guinea has helped contribute to some of this price volatility*

Sources: **Source: Trading Economies (monthly tracking).*

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Thank you

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