The Geopolitics of Battery Supply Chains: The IRA and the Implications for Canada

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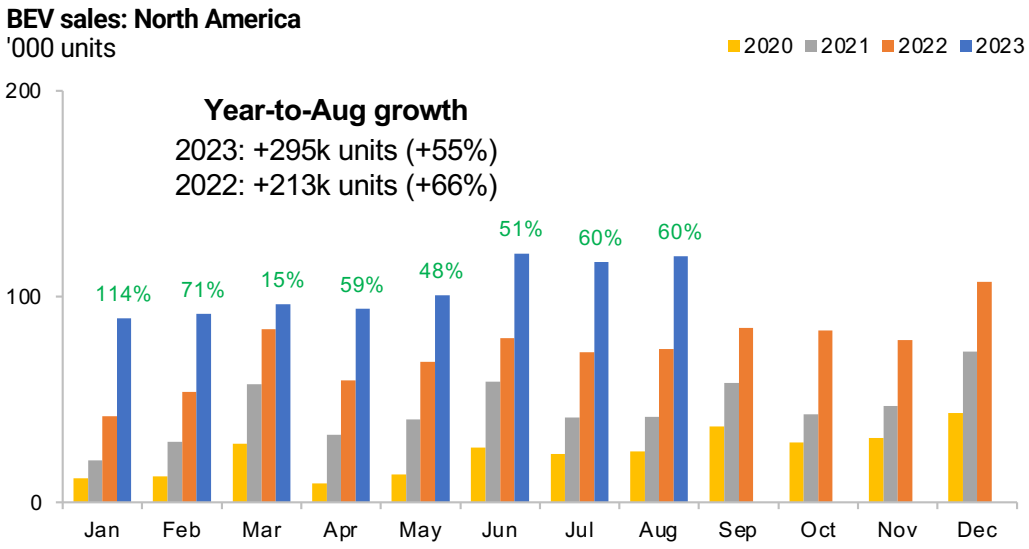
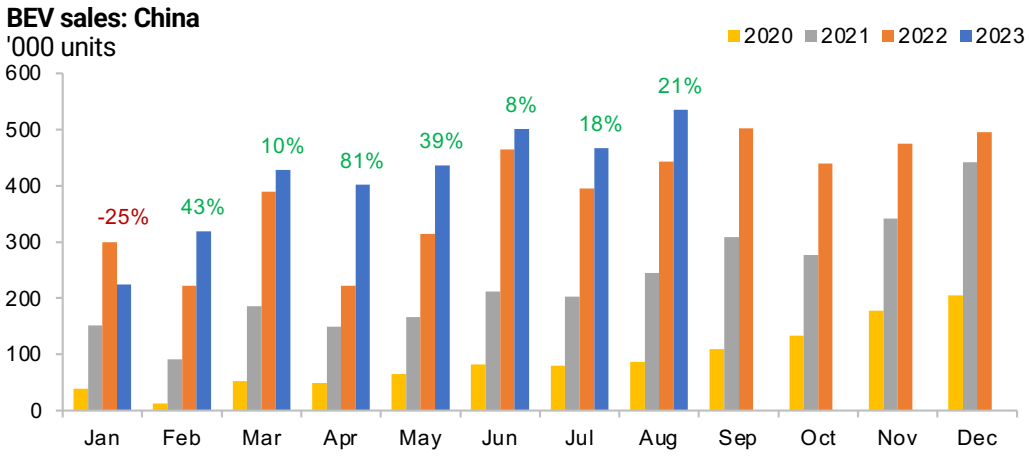
The IRA and other initiatives are long overdue to boost industry development

The Inflation Reduction Act (IRA) aims to invest over $389 billion through to 2032 to encourage domestic battery and EV production in addition to the $15 billion provided by the Bipartisan Infrastructure Act.

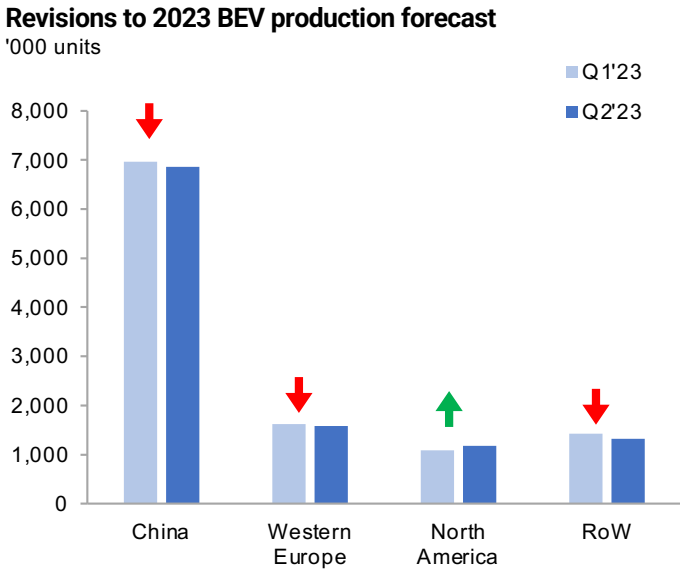
- **For buyers to receive the full tax credit of $7,500:**
  - The vehicles will need to be assembled with 50% of their battery components sourced in North America.
  - More importantly, 40% of the value of critical minerals used must be extracted, processed, and/or recycled domestically or from one of the countries with a free trade agreement (FTA).
- **Canada and Mexico immediately benefited from the passing of the IRA, but most plans are about meeting the vehicle assembly criteria.**

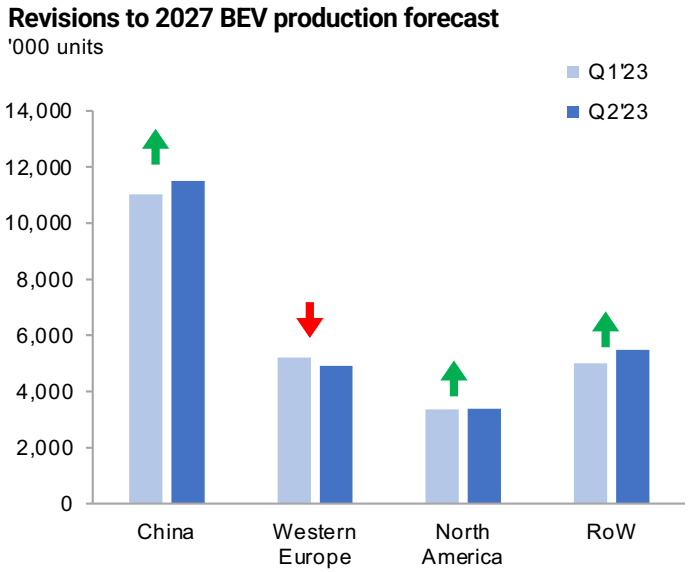




Source: SFA Oxford, USGS

China will continue to dominate EV production as more vehicles are exported



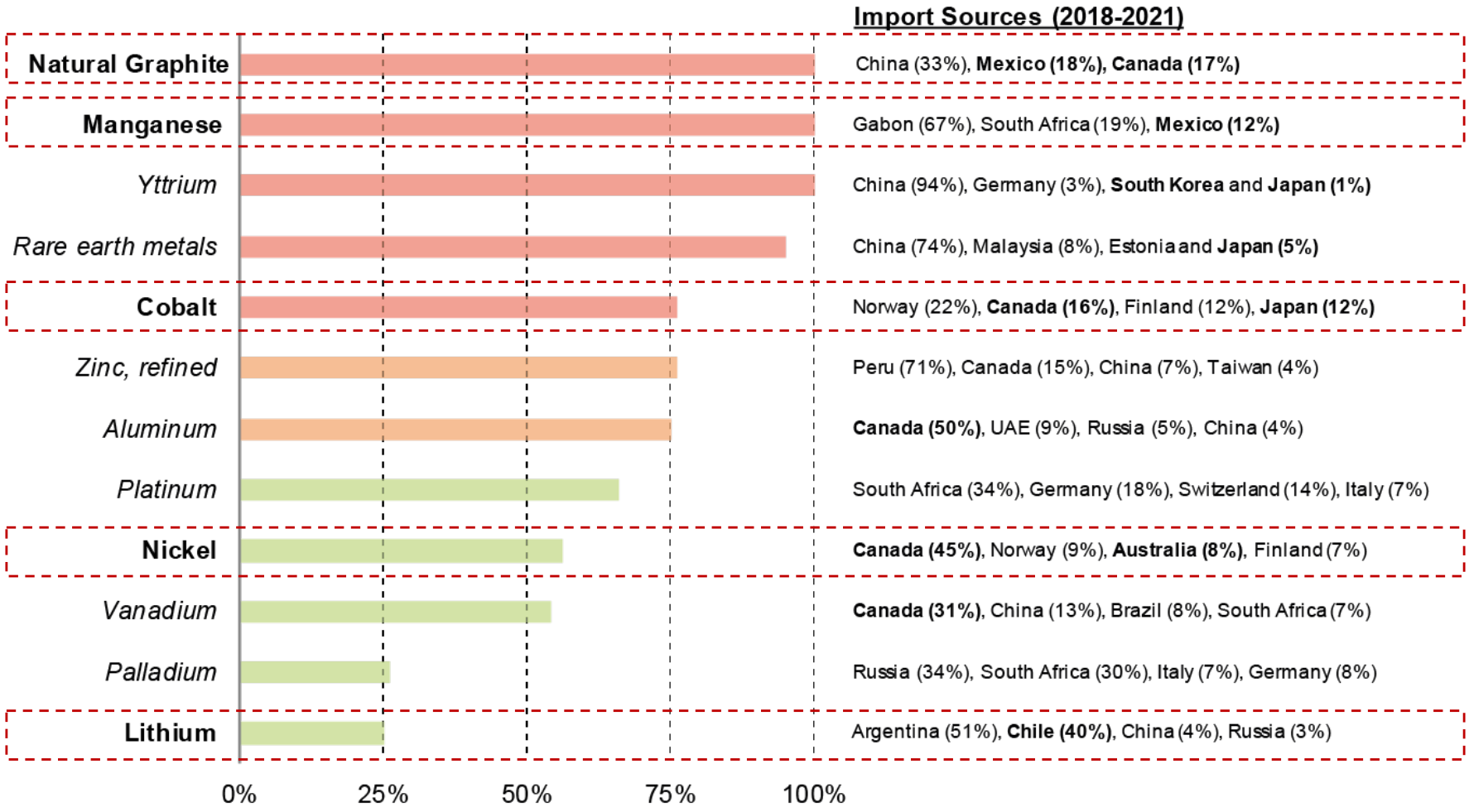


BEV production market share (Q2'23)	2022	2023	2024	2025	2026	2027
China	65%	63%	59%	54%	49%	45%
Western Europe	15%	14%	15%	17%	18%	19%
North America	10%	11%	10%	12%	13%	13%
RoW	10%	12%	15%	18%	20%	22%

- **China:** Expected to dominate global market of at least 45% through to 2027 and vehicle stock is expected to become increasingly manufactured for export.
- **Europe and the U.S.:** Europe will continue to exceed the U.S. in EV production and new car sales through to 2030 while the U.S. continues to catch up and buildout its battery industry.

Source: SFA Oxford

Supply chain resilience is at an all time low as the U.S. is highly dependent on imports of key materials



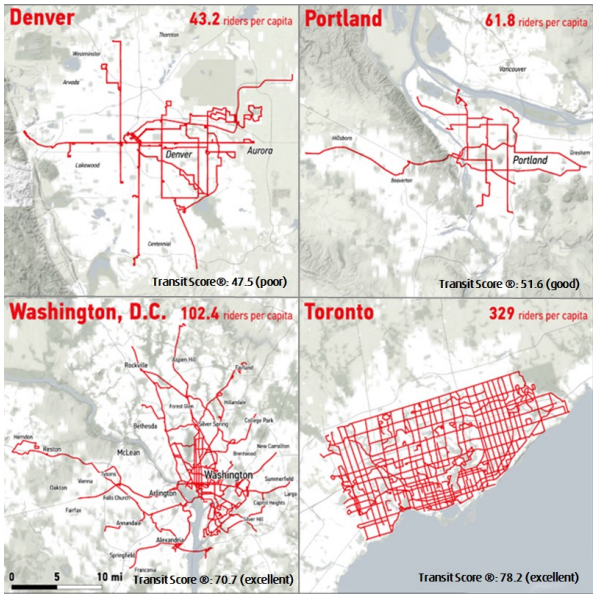
- **Only 14 vehicles in the US qualified for the full $7,500 tax credit in 2023 and President Biden announced the formation of the Council on Supply Chain Resilience. The goal is to onshore critical materials including battery material and support development in trade friendly nations.**

Source: SFA Oxford, USGS

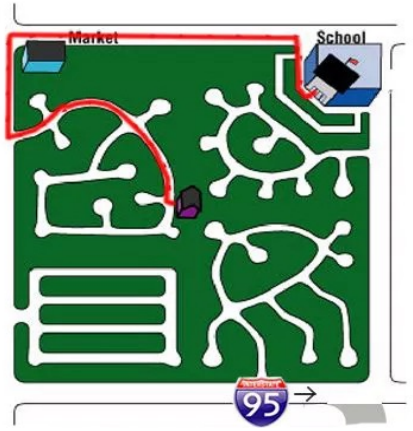
Only way to reduce emissions from transport is EV Adoption

Very low population density, the highest vehicle km travelled per capita, and very low public transit ridership:

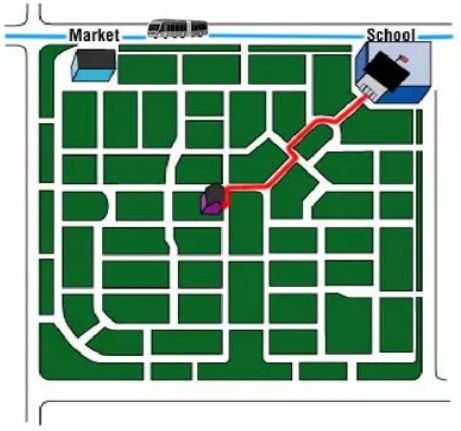
- **Upfront costs and vehicle availability:** Consumers are sensitive to upfront costs and wait times due to two-car households.
- **Range anxiety is real in this market:** Driving conditions, traffic, temperatures below or above optimal and battery ageing reduces that amount.
- **Lack of cohesive public charging infrastructure:** Most public charging points are in urban areas along the ocean coasts and ex-Tesla drivers must rely on third-party charging networks.
- **Consumers prefer SUVs and pick-up trucks:** There are limited EV options and the few SUV and pick-up truck models available are too expensive for the average consumer.



Inadequate public transport exists across routes in most US cities



Car-centric community planning makes it difficult to walk/cycle



Pre-war urban planning made it easier to live without a car

Why has it taken so long to support Industry growth?

California – rebates of up to $2,000 for BEVs and $1,000 for PHEVs (can be increased to $5,500 for low to moderate-income families) + many other benefits

Colorado – $5,000 tax credit + an additional $2,500 on vehicles below $35,000 starting in 2024.

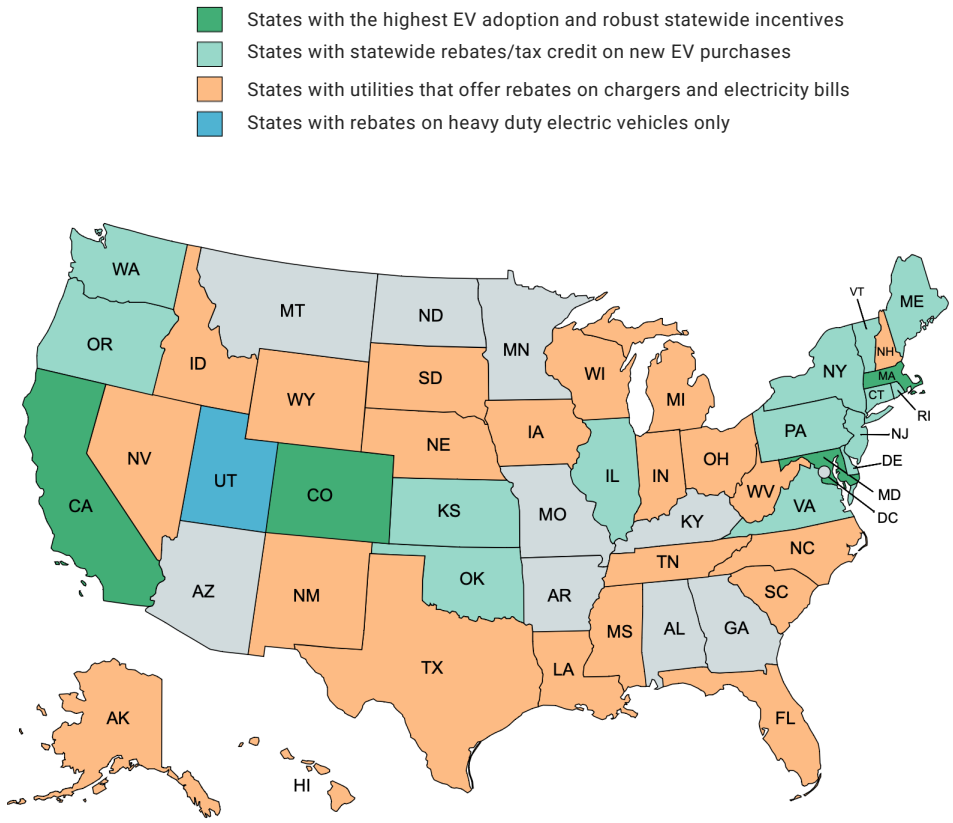
Kansas – Tax credits of up to $2,400 for alternative energy vehicles

Oklahoma – tax credit of up to $5,500 for new alternative fuel vehicle below 6,000lbs + $200 electricity bill rebate

Oregon – Rebate of $2,500 + an additional $5,000 to low-income families

Utah – No rebates for LDV drivers but rebates of $3,000 to $15,000 for alternative fuel heavy-duty vehicles

Washington – Sales tax exemption of up to $15,000 for a new BEV + $400 rebate for charging installation



Connecticut – Rebates of $750 to $7,500 depending on the type of alternative fuel vehicle

Delaware – Rebates of $1,000 to $2,500

Illinois – Rebate of $4,000 for the purchase of a new EV

Massachusetts – Rebate of $3,500 on vehicles $55,000 or less on or after November 10, 2022

Maine – Rebates of $1,000 to $7,500 depending on income

Maryland – Tax credit of up to $3,000 for vehicles $50,000 or less after July 1, 2023

New Jersey – Exempt from sales tax and rebate of $2,000 to $4,000 depending on vehicle price

New York – Rebate of $2,000

Pennsylvania – Rebate of $500 to $2,000 depending on family income

Rhode Island – Rebate of up to $2,500 on vehicle $60,000 or less

Vermont – Rebates of $1,500 to $4000 depending on income

Virginia – Credit of $2,500 with an additional $2,000 for low to moderate-income families

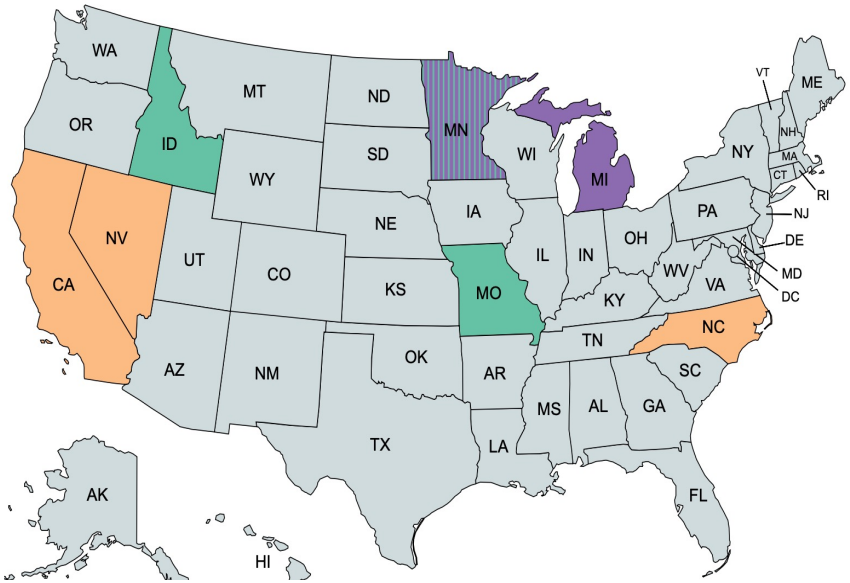
States that penalize EV drivers with extra fees: Alabama, Arkansas, California (road improvement tax), Georgia, Hawaii, Iowa, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Missouri, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Virginia, Washington, West Virginia, Wisconsin, Wyoming and Utah.

Source: mapchart.net, US News, DOE

Mine production of critical battery materials is non-existent

NICKEL AND COBALT

- **Jervois** is planning to begin production of a primary cobalt plant this year, but halted development. However, the mine site resumed development with $15 m in funding from the US DOE received in June.
- **Lundin** which operates Eagle Mine is the only domestic nickel mine in the US but will be decommissioned in 2027 (not eligible for IRA funding). Nickel concentrate is exported from Michigan to Canada for smelting and refining.
- **Nth Cycle** is planning to produce MHP in Ohio, an intermediate product from nickel laterites that can be used to make nickel and cobalt sulphate, which is mostly produced in Indonesia.
- **Talon Metals – Rio Tinto** is developing the Tamarack mine (nickel, copper, cobalt) in Minnesota started in early 2020 and is expected to supply 75 kt of nickel in concentrate to Tesla from 2026-2032. Received $115 m in US DOE funding to build a nickel processing plant in North Dakota.



US % of global mine production (2022):

- **Cobalt**: 0.4% of 190 kt
- **Nickel**: 0.5% of 3.3 mt
- **Graphite (natural)**: 0% of 1.3 mt
- **Lithium:** unknown of 130 kt
- **Rare Earths**: 14.3% of 300 kt
- **Phosphate:** 9.5% of 220 kt

LITHIUM

- **Albemarle** is planning a 100 ktpa LiOH plant in South Carolina, receiving $147 m in US DOE funding. The company's restarted Kings Mountain mine in North Carolina is set to provide feed material. The company also has an established plant in Nevada.
- **American Battery Technology (ABTC)** plans to develop facilities for mining and producing battery-grade LiOH in Nevada along with developing mineral sites that received $57 m in US DOE funding.
- **Lilac Solutions** is planning to build a direct lithium extraction (DLE) pilot plant in Nevada and received $50 m in US DOE funding.
- **Lithium Americas** began construction at Thacker Pass, Nevada, with a $650 m equity investment from GM.

  Livent recently completed the expansion of its LiOH facility in North Carolina.

  Piedmont Lithium is planning to build LiOH plants in North Carolina and Tennessee. Received $142 m in US DOE funding.
- **Tesla** is building a $375 m LiOH processing plant in Texas.

RARE EARTH METALS

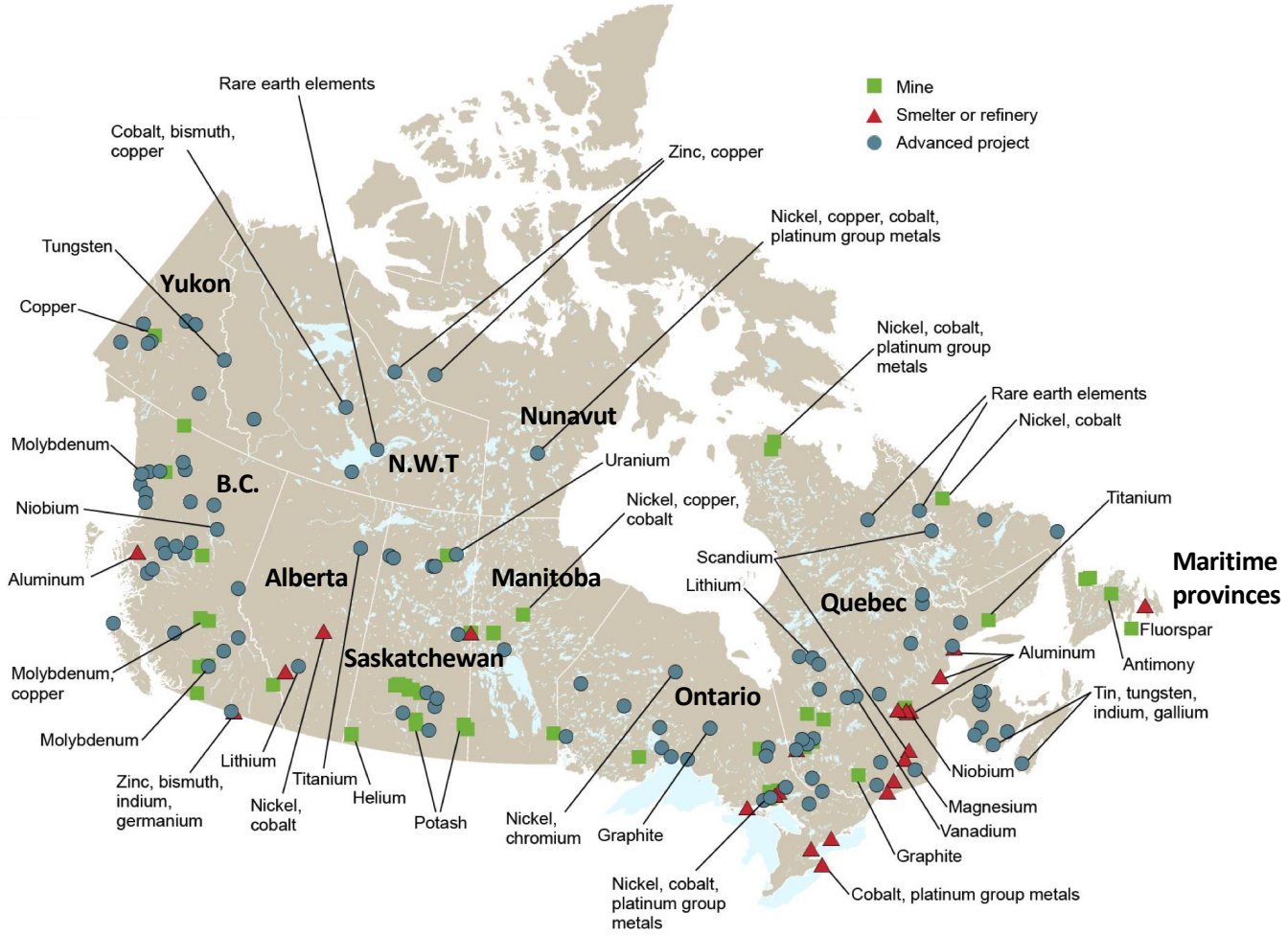
- **MP Materials**: Operates the only rare earths mining and processing facility in the US in California's Mojave Desert.

Source: SFA Oxford, company announcements

Canada: Plentiful battery metal resources offers a lifeline

The provinces and territories (except Nunavut) have jurisdiction over the mining industry and own majority of mineral rights:

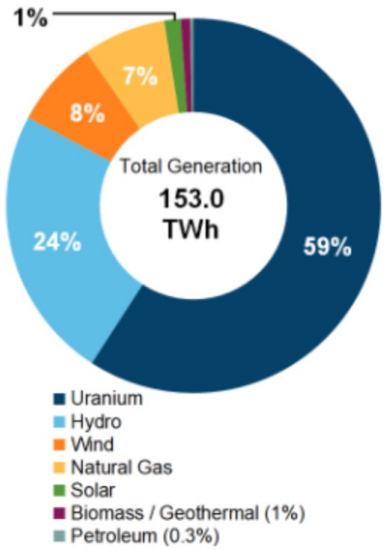
- The federal government's jurisdiction over First Nations rights, trade (internationally and provincially), railways, nuclear energy and environment has led to conflict
- The provinces and territories essentially compete with one another and deal with NIMBY sentiment
- Existing energy infrastructure (governed by the province) is largely in conflict with the decarbonization plans of the federal government



Source: SFA Oxford , Natural Resources Canada

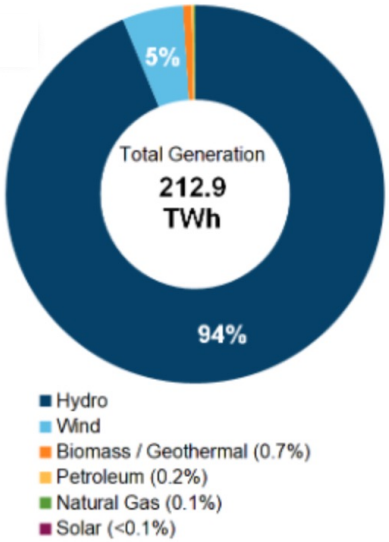
Quebec and Ontario is attracting the most investment

Ontario: Third largest auto industry in North America and home to Canada's Ring of Fire.



Problem → Lack of stakeholder management especially with First Nations, and 59% nuclear energy generation (under federal)

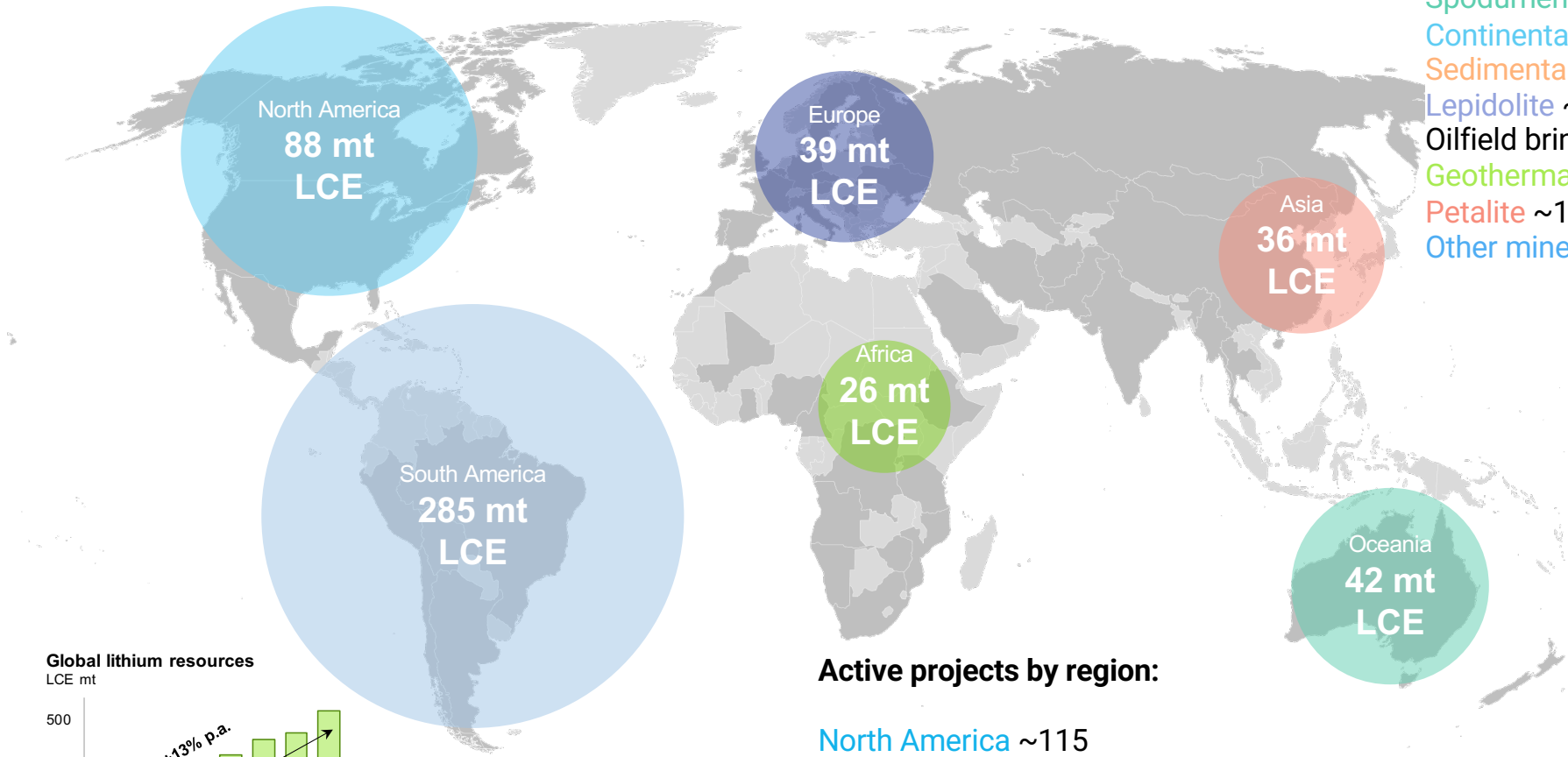
Quebec: State-owned Hydro-Quebec supplies 99% of the electricity (cheapest in the country) and offers numerous incentives



Problem → French language laws, different civil code, and lack of road infrastructure in the north

Source: SFA Oxford , Natural Resources Canada

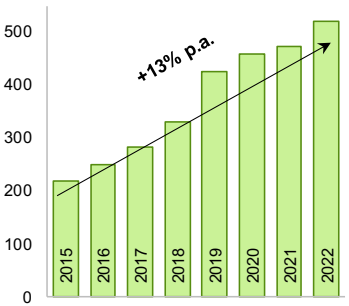
Lithium: South America represent 47% of proven reserves



Active projects by deposit:

Spodumene ~120
Continental brine ~80
Sedimentary incl. clay ~35
Lepidolite ~30
Oilfield brine ~25
Geothermal brine ~15
Petalite ~10
Other minerals ~10

Global lithium resources
LCE mt



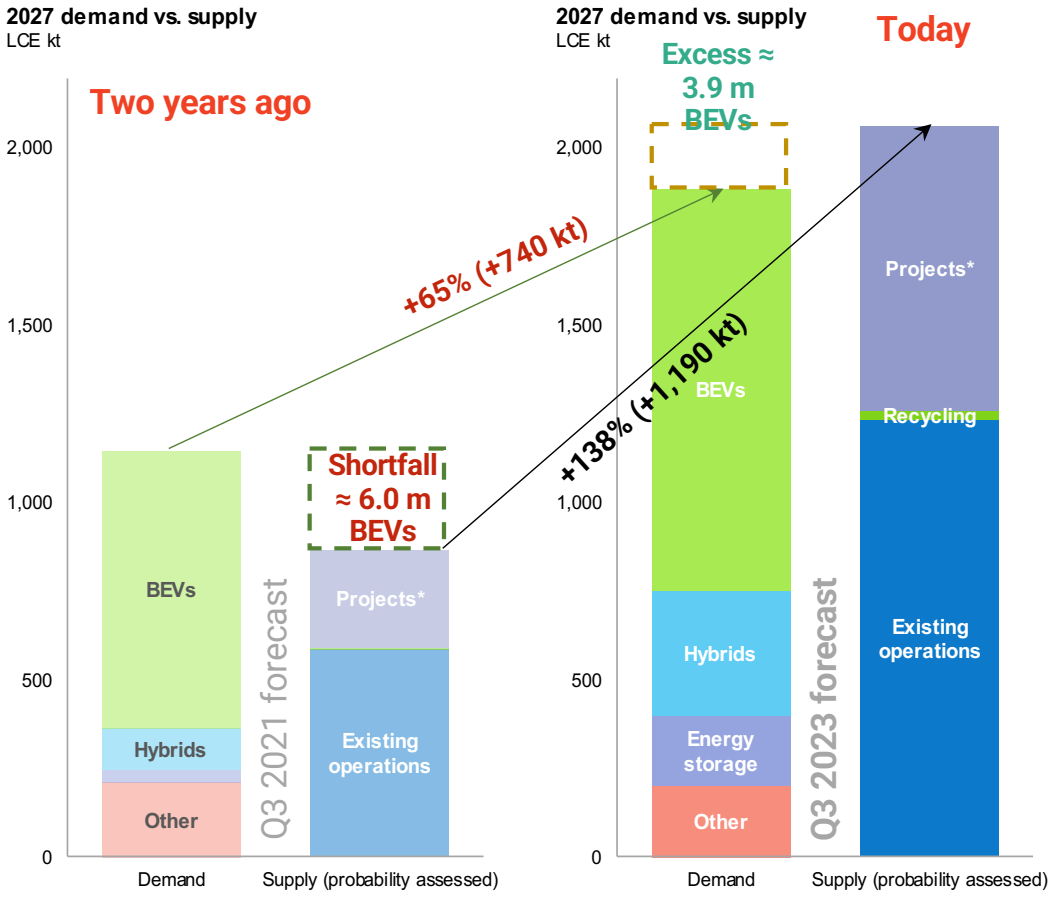
Active projects by region:

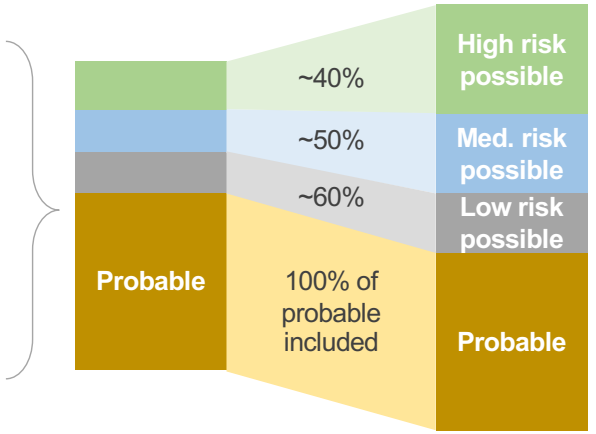
North America ~115
South America ~75
Oceania ~40
Africa ~40
Europe ~35
Asia ~30

Australia, Chile, China and Argentina are collectively responsible for over 95% of global lithium mine production

Source: SFA (Oxford), USGS

Supply has grown considerably over the past two years





Not all projects are included in probability assessed supply estimates

Earlier-stage quantifiable projects

0% included but an extra 1.8 mt LCE in potential supply

Major new mines and restarts in 2022-23

Wodgina	Arcadia
Ngungaju	Sabi Star
Finniss	Zulu
Cauchari-Olaroz	Bernic Lake
Grota do Cirilo	La Corne

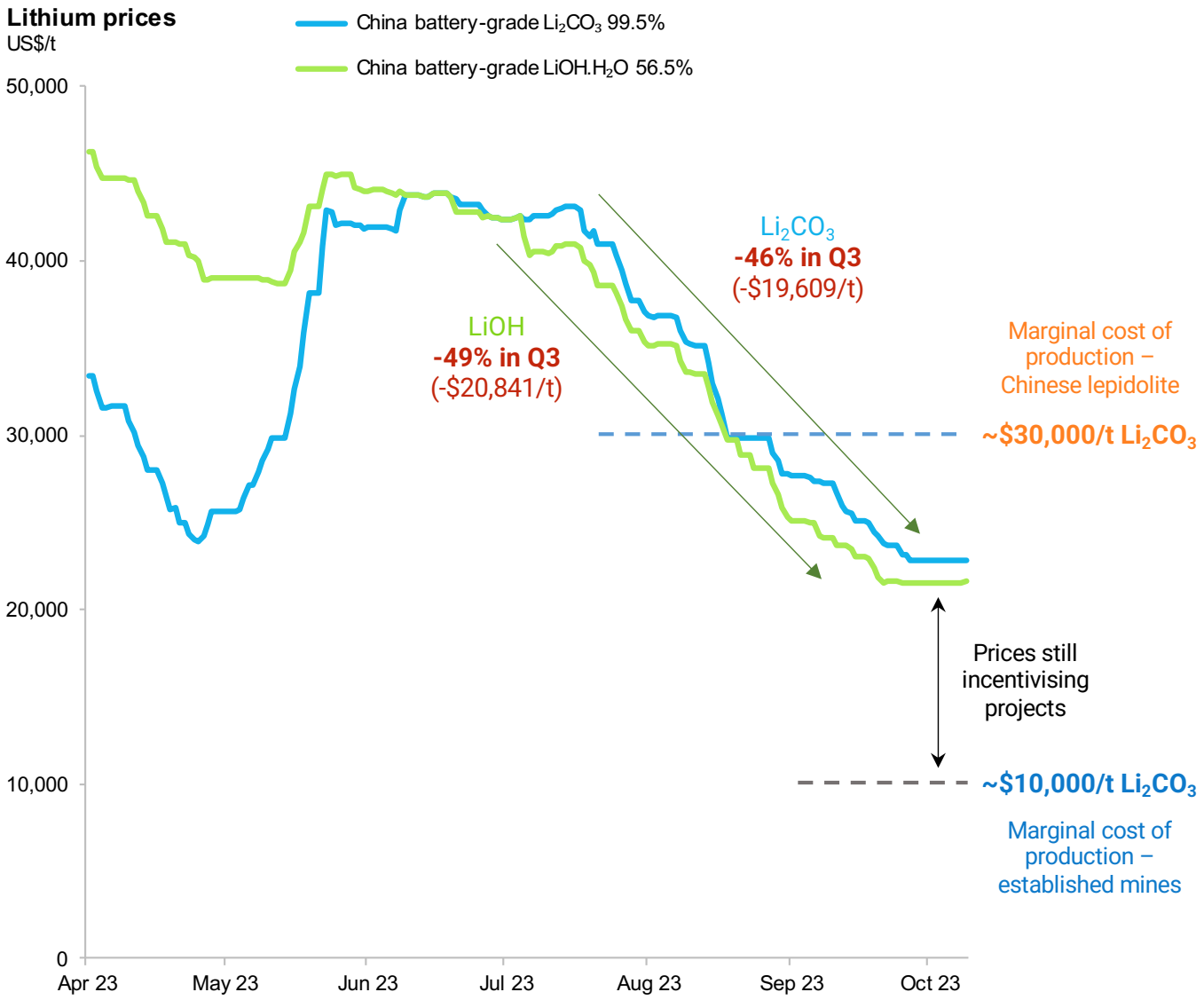
Major new mines in 2024: Mt Holland (Australia), Centenario-Ratones and Sal de Vida (Argentina) and Kamativi and Goulamina (Africa)

Note: *Assumes 100% of probable, 60% of low-risk possible, 50% of medium-risk possible and 40% of high-risk possible projects reach production.

Source: SFA (Oxford)

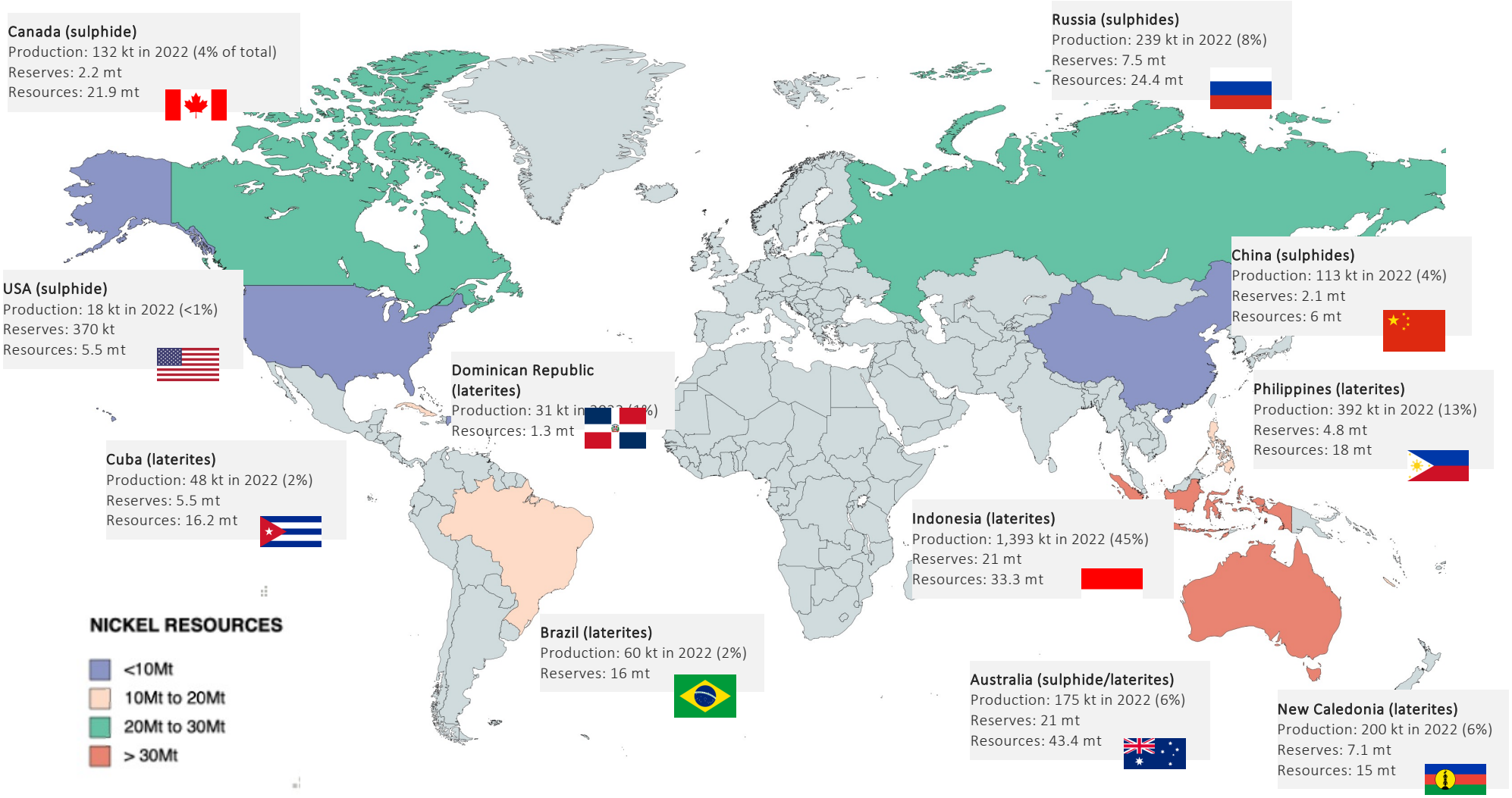
Lithium prices have hit a 2-year low

- **Incentive pricing is still high enough** to encourage the development of new projects despite being below marginal cost of production in China.
- **New extraction methods are needed** to meet growing EV demand through to 2040, reduce geopolitical risks and price volatility.



Source: SFA (Oxford)

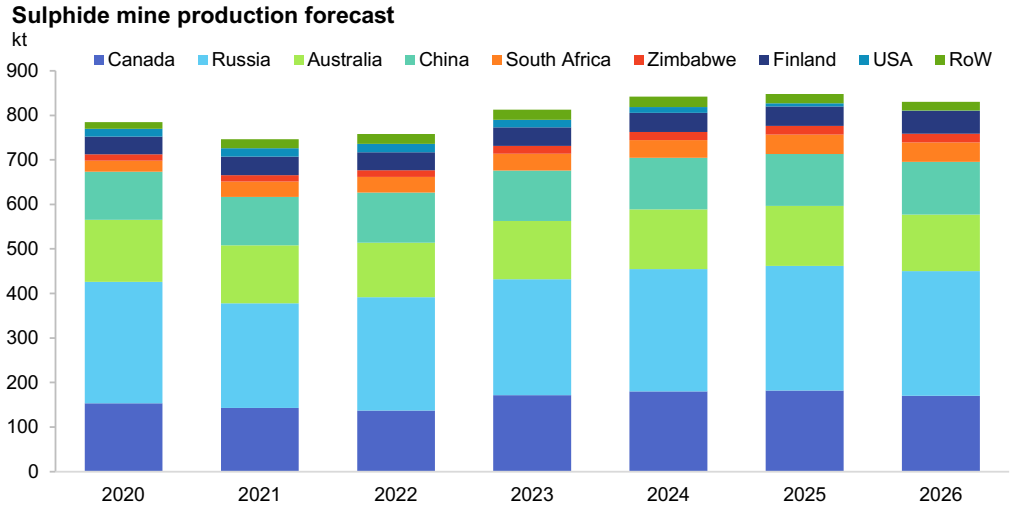
Nickel: Indonesia responsible for 48% of mine production

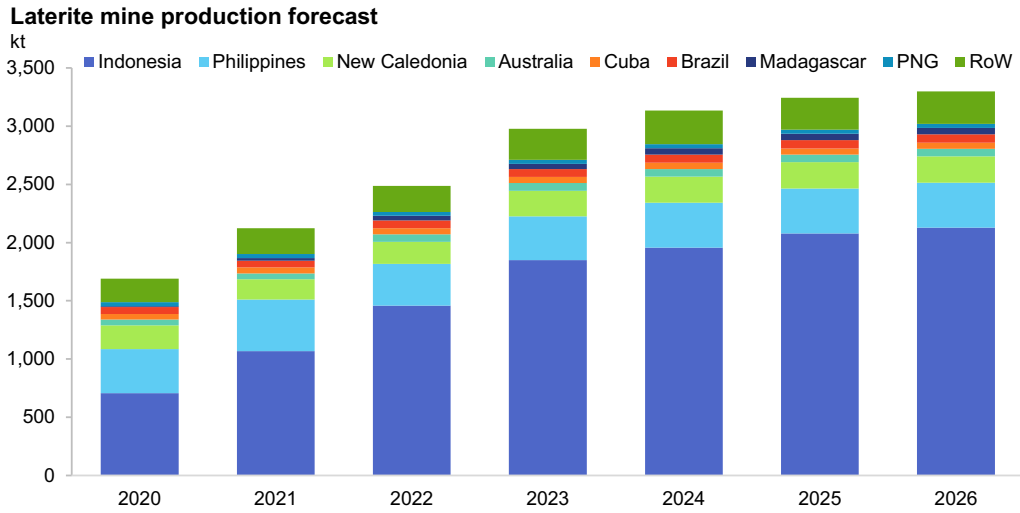


Source: SFA Oxford, USGS

EV growth = Higher dependency on lower grade nickel laterites

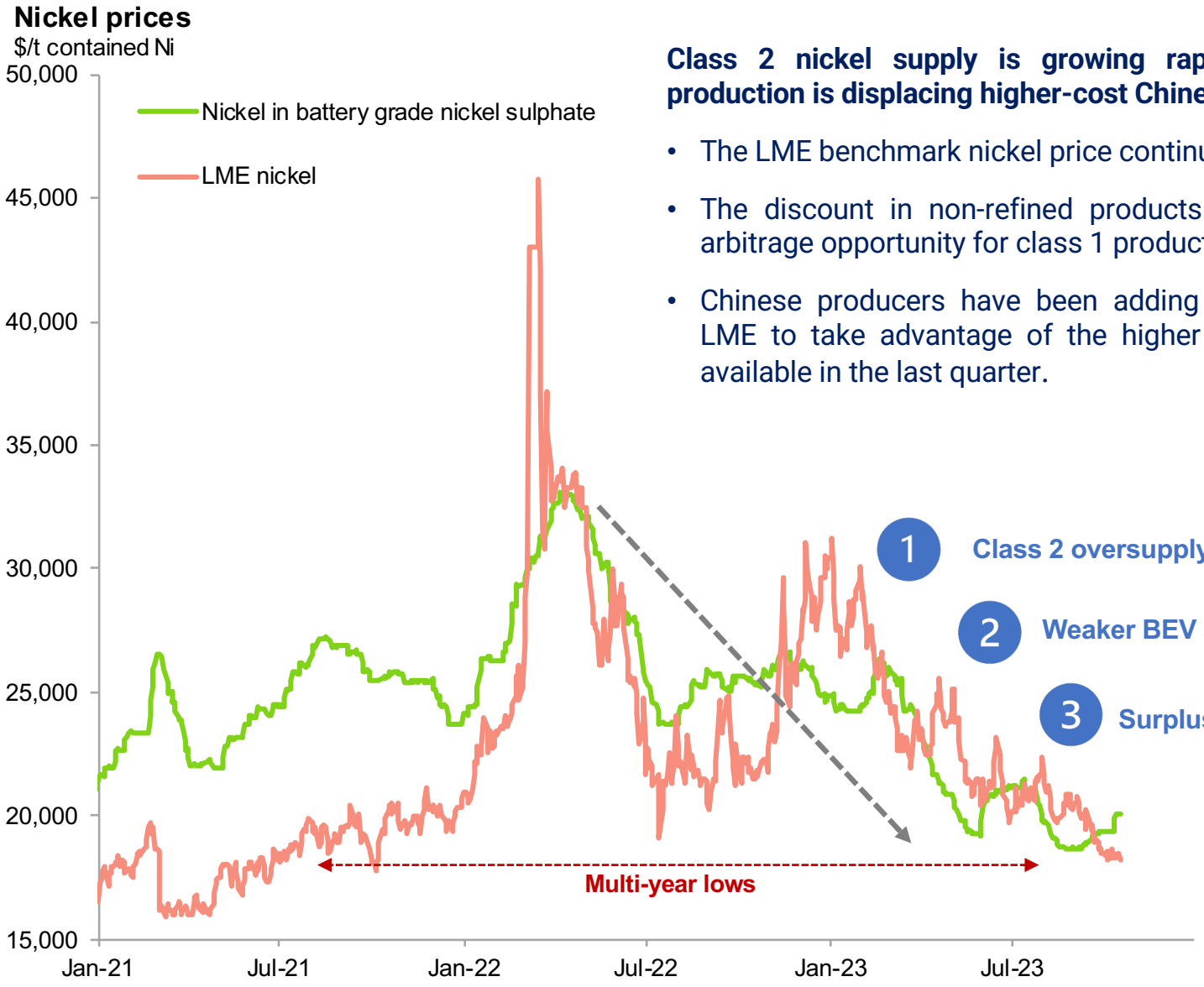
- **High performance batteries require class 1 nickel (minimum of 99.8% nickel):** Battery grade nickel is currently produced from electrolytic nickel, powders, briquettes and carbonyl nickel that is generated from increasingly scarce sulphide deposits
- **EV demand is expected to exceed global supply from nickel sulphide deposits:** There will be an increased dependency on lower grade nickel laterite deposits and HPAL found near the equator in Indonesia, The Philippines, Brazil, New Caledonia and Cuba





Source: SFA Oxford, USGS, Brookings

Rising supply from Indonesia pressuring nickel price



Class 2 nickel supply is growing rapidly as Indonesian NPI production is displacing higher-cost Chinese equivalents.

- The LME benchmark nickel price continues its downward trend.
- The discount in non-refined products has opened up a price arbitrage opportunity for class 1 products.
- Chinese producers have been adding deliverable metal to the LME to take advantage of the higher margins that have been available in the last quarter.

1. Class 2 oversupply
2. Weaker BEV sales in China
3. Surplus market expectations

Source: SFA (Oxford), Bloomberg

OEMs are actively securing nickel supply

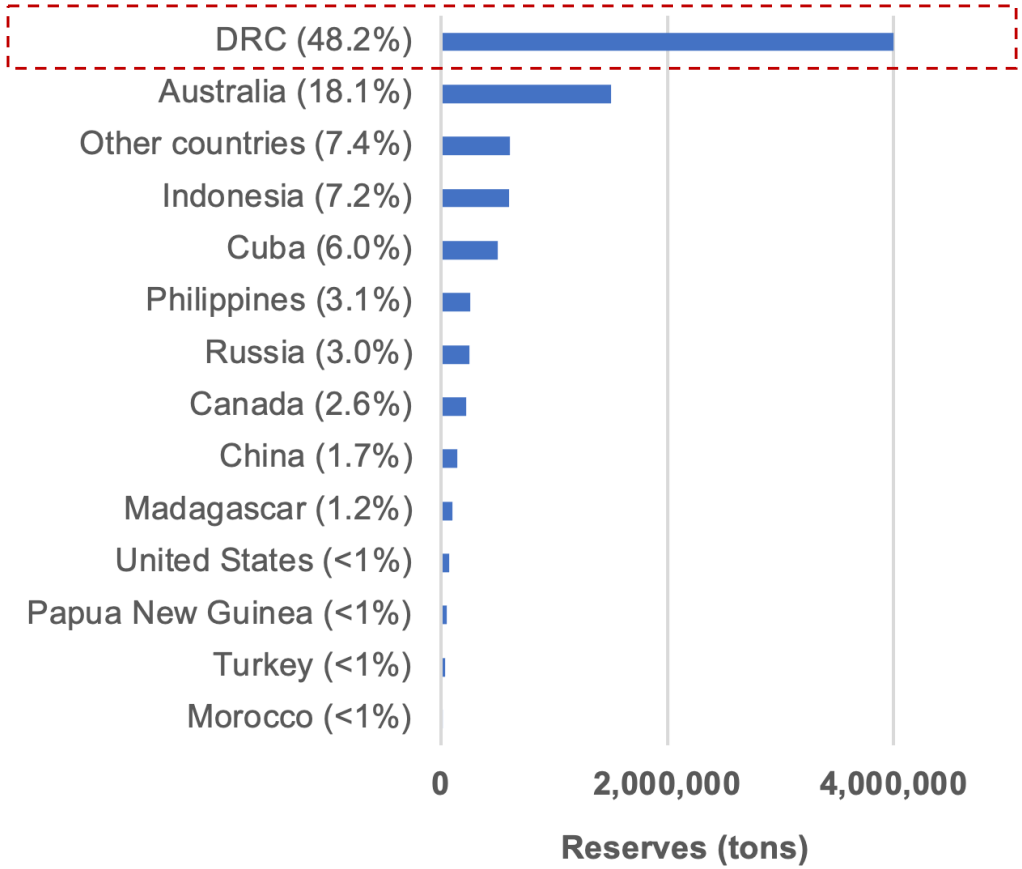
Buyer of nickel	Industry of buyer	Deal type	Date of deal	Seller of nickel	Form of nickel	Volume of nickel	Source	Start	Duration
AESC	Battery manufacturing	Supply deal	2023	Umicore	CAM	Unknown	TBC	2026	9 years
STELLANTIS	OEM	Offtake agreement	2023	Terrafame	Nickel sulphate	Unknown	Finland	2025	5 years
STELLANTIS	OEM	Offtake agreement, strategic investment	2023	Kunico	Nickel sulphate, cobalt sulphate	35% of future production	Norway	TBC	9 years
STELLANTIS	OEM	Offtake agreement, strategic investment	2023	Alliance Nickel	Nickel sulphate, cobalt sulphate	170 kt $NiSO_4$, 12 kt $CoSO_4$	Australia	TBC	5 years
gm general motors	OEM	Supply deal	2023	Vale Canada	Nickel sulphate	25 ktpa contained nickel	Canada	2H2026	TBC ("long-term")
Ford	OEM	Offtake agreement, strategic investment	2023	PT Vale Indonesia, Huayou Cobalt, Ford joint venture	MHP (likely to befurther refined by Huayou Cobalt**)	Total plant output: 120 kt contained Ni	Indonesia	2026	TBC
RENAULT*	OEM	MoU	2021	Terrafame	Nickel sulphate	Equiv. to 15 GWh of LiBs	Finland	TBC	TBC
umicore	pCAM producer	Supply deal	2023	Terrafame	Nickel sulphate	Unknown	Finland	2023	TBC
BASF	pCAM producer	Supply deal	2018	Nornickel	Nickel sulphate	Equiv. of 300k BEVs	Russia	2020	TBC
Trafigura	Trading	Strategic investment, marketing rights	2017	Terrafame	MSP/nickel sulphate	Unknown	Finland	2017	10 years
LG Energy Solution	Battery manufacturing	Offtake	2021	Australian Mines	MHP	71 kt Ni, 7 kt Co	Australia	TBC	6 years
LG Chem	Battery manufacturing	Supply deal	2022	Li-Cycle	Nickel sulphate	20 kt	Scrap	TBC	10 years
GEM 格林美 资源有限 循环无限	pCAM producer	Supply deal	2020	PT Halmahera HL	Nickel sulphate/MHP	9.3-22.3 ktpa Ni, 1.2-2.8 ktpa Co	Indonesia	2023	8 years

*Renault has partnered with Envision AESC and Verkor for battery supply.
**Claimed to be IRA-friendly metal so must be refined in an FTA country, S. Korea or Japan

Source: SFA (Oxford), company reports.

Cobalt: Price volatility and high geopolitical risk

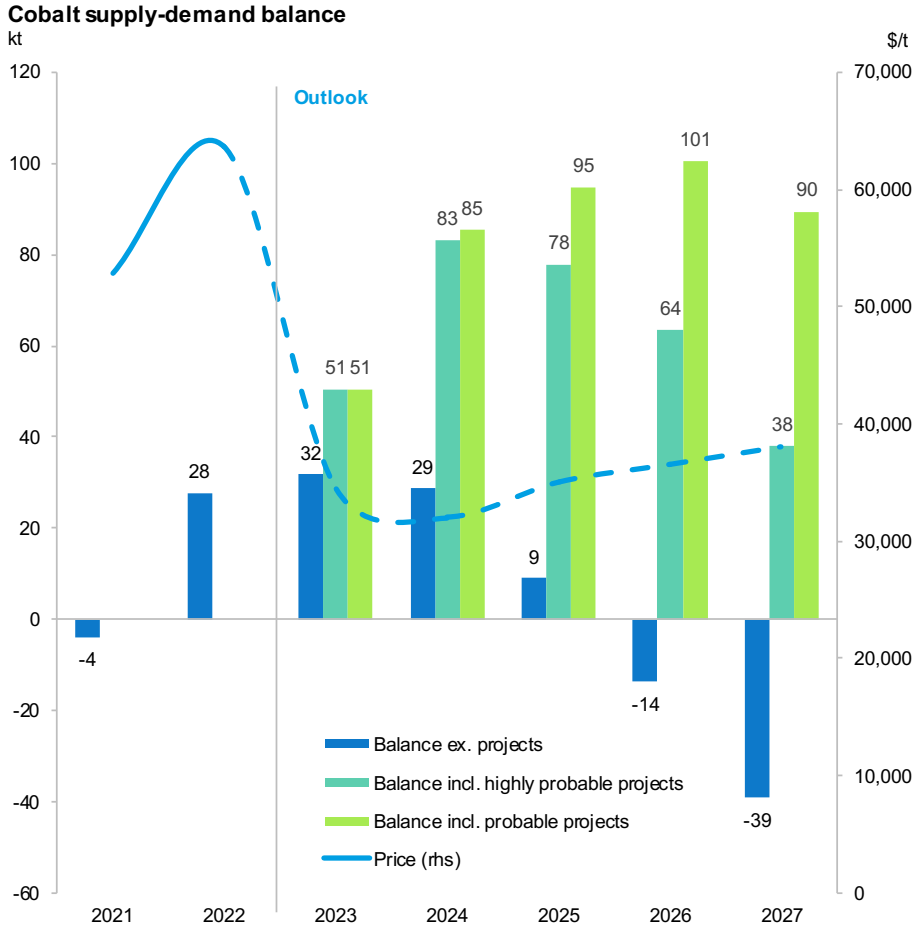
- The DRC accounts for 48% of proven reserves and was responsible for 68% of global mine production in 2022 and Indonesia's cobalt production quadrupled from 2.7kt 2021 to 10kt in 2022..
- Artisanal mining, dangerous conditions, political instability and lack of infrastructure = increased investment risk.
- The identified one million tons of cobalt resources in the U.S. are mostly in Minnesota, Idaho and Missouri that have deposits that do not have to mined with another metal (typically nickel and copper).
- The US signed an MOU with the DRC and Zambia to support battery value chain development, but there are no plans yet for investment or a formal trade agreement.
- The World Bank recently released its plans for regional development in southern Africa including a country report for regional battery value-chain development in the DRC



Source: SFA Oxford, USGS, Minnetti et al., 2022

Surplus conditions expected to continue to pressure prices

- The cobalt market is predicted to have **a 29 kt surplus next year** that may tighten to 9 kt in 2025 and move into deficit without additional supply from new projects.
- Global mine supply is forecast to increase by 7.3% to 202 kt in 2024, but output from existing operations is largely flat thereafter.
- BEVs continue to be the main driver of future cobalt demand, **rising from the 61 kt forecast this year to 88 kt in 2025**
- Cobalt prices are likely to face many headwinds moving into 2024 as CMOC continues to export stockpiles made during its dispute with its partner, state-owned Gecamines.



Source: SFA Oxford

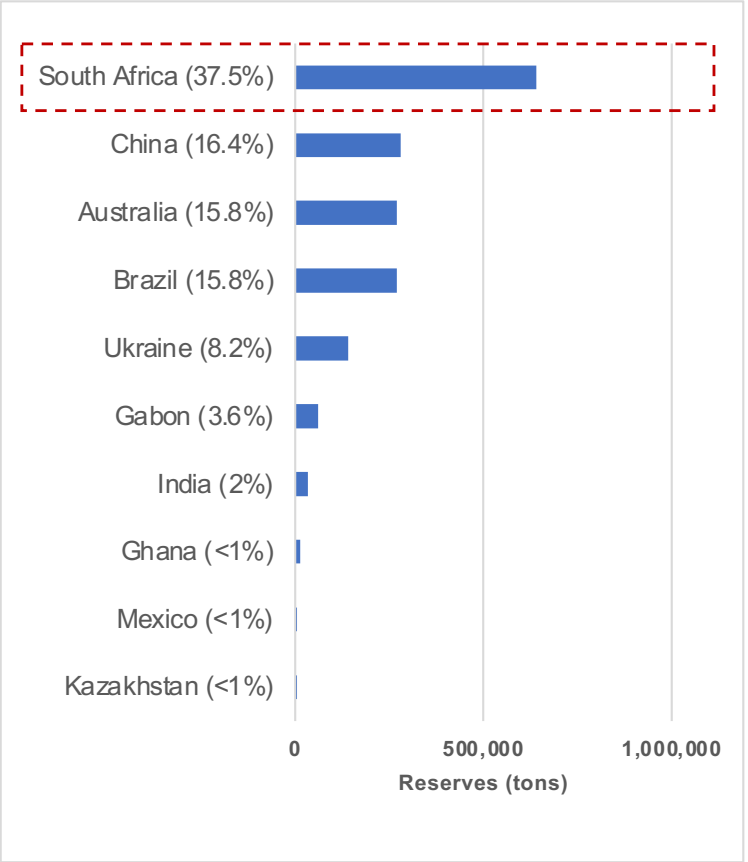
Manganese: Refining capacity outside of China lacking

China holds around 90% of global refining capacity: According to E-Source, demand for battery-grade manganese is expected to increase by 15 times to 1.2 million tonnes per year by 2031

The U.S. has an FTA with Australia and Mexico – only 16% of global reserves

- South Africa accounts for 36% of global mine production followed by Gabon (23%) and Australia (23%).
- Manganese resources may be large, but irregularly distributed in the United States and are low grade = increased extraction and processing costs

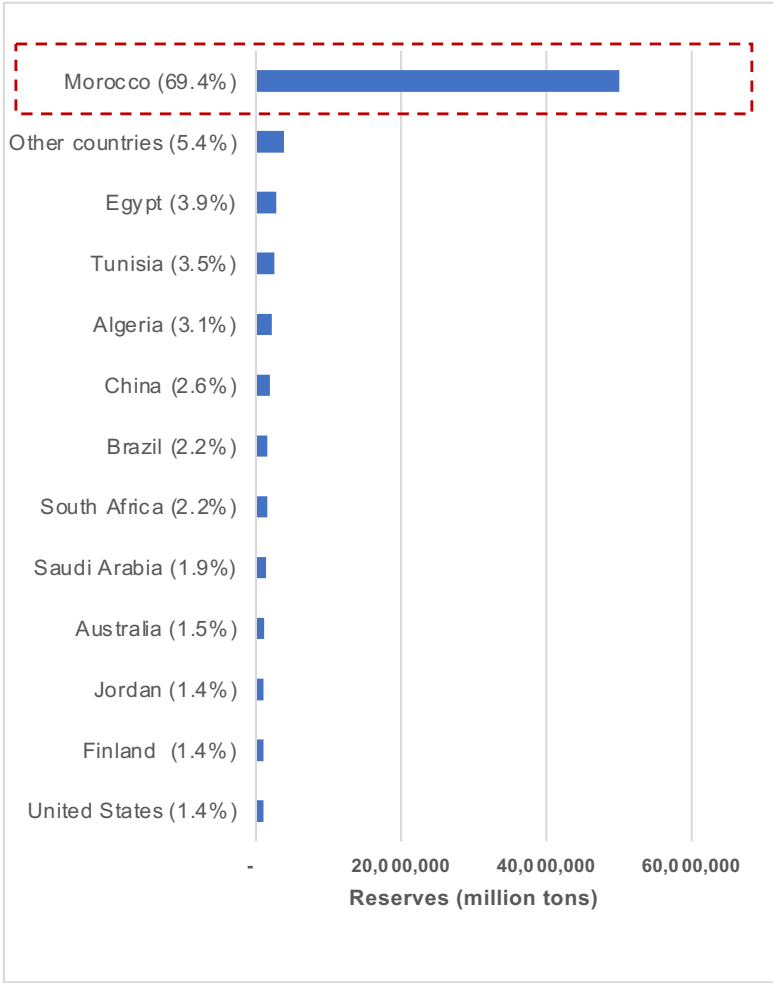
BUT! Manganese is an important industrial metal with no substitutions for these applications → more than 90% of global consumption is from the steel and construction sectors



Source: SFA Oxford, USGS

Phosphorus: Supply chains may not be more resilient

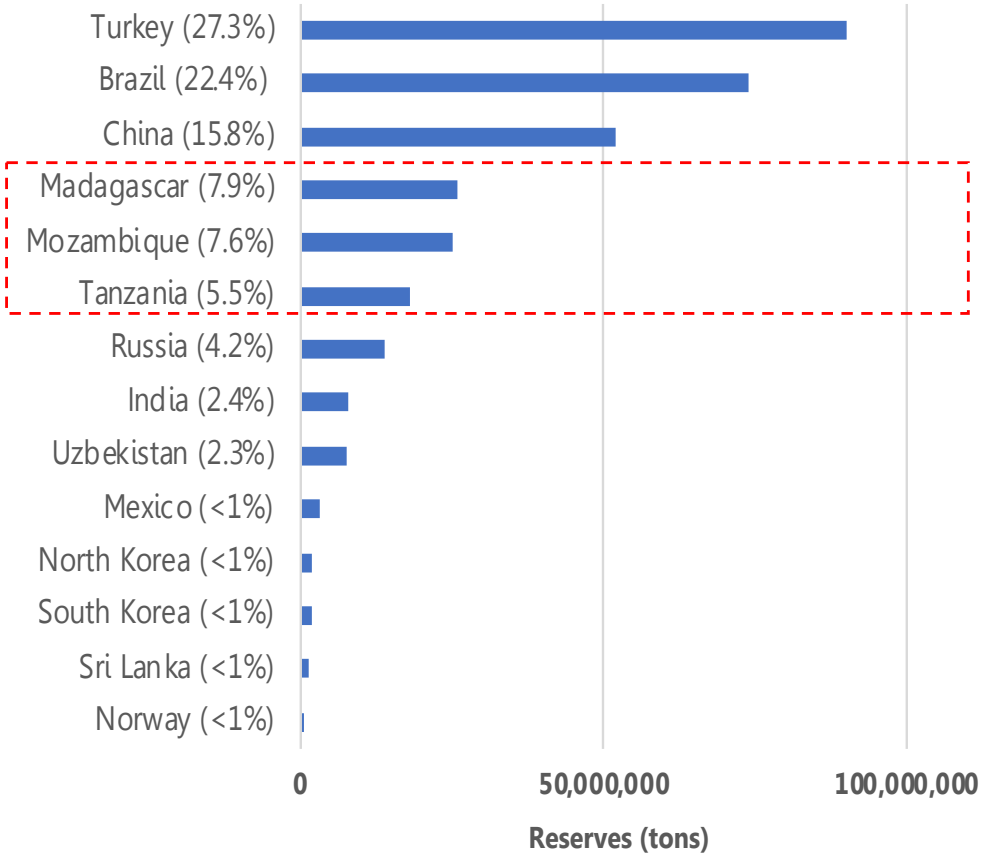
- **China and Morocco accounts for 39% and 18% of global phosphorus mine production.** There is an estimated 72Mt in proven phosphorus rock reserves globally and 69% is in Morocco and Western Sahara.
- **Morocco could become a global battery hub** given its close proximity to Europe and its FTA agreement with the U.S. meaning that exports would meet the critical metals component of the EV tax credit.
- **Overall picture: High potential for conflict between between future energy needs and food security**
  - Currently, mined phosphorus is earmarked for fertilizers (85%), animal feed supplements (10%) and other applications (5%) and most countries are reliant on imports to meet food demand
  - Even though phosphorus is abundant, there is geopolitical risk, possible trade barriers and other supply chain constraints to consider



Source: SFA Oxford, USGS

Natural graphite: Export restricted by China going forward

- **Natural graphite is used by a variety of industries such as refractories and lubricants.** Over the last decade, flake graphite (low cost and higher energy density) and synthetic graphite (longevity and fast charging) has been the key anode material in EV batteries
- **China controlled an estimated 65% of natural graphite mine production in 2022 and 100% of the refining process.** The government announced new export controls starting in December and companies will have to apply for permits to ship materials outside of the country
- The U.S. is 100% reliant on the import of natural graphite and Syrah Resources received a US$107 million grant to expand its Louisiana anode processing plant
- **Africa has increasing its stake in mine production over the last couple of years.** Production in Mozambique more than doubled to 170kt since 2021.



Source: SFA Oxford, USGS

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