

Strategic Metals & Rare Earths Letter

INTERNATIONAL

the independent information and advisory publication on investing in Strategic Metals & Rare Earths

December 2020



Marino G. Pieterse,
publisher and editor

Critical Metals and Special Minerals		Heavy Rare Earths Oxides (HREO)		Light Rare Earth Oxides (LREO)
lithium (Li)	yttrium (Y)	europium (Eu)	erbium (Er)	lanthanum (La)
cobalt (Co)	scandium (Sc)	gadolinium (Gd)	thulium (Tm)	cerium (Ce)
graphite (C)	niobium (Nb)	terbium (Tb)	ytterbium (Yb)	praseodymium (Pr)
vanadium (V)	tantalum (Ta)	dysprosium (Dy)	lutetium (Lu)	neodymium (Nd)
magnesium (Mg)	beryllium (Be)	holmium (Ho)		promethium (Pm)
tungsten (W)	gallium (Ga)			samarium (Sm)
titanium (Ti)	indium (In)			
zirconium (Zr)	germanium (Ge)			
hafnium (Hf)				
antimony (Sb)				

Electric car revolution offers unrivalled investment opportunities in crucial energy battery markets

3

Li

Lithium
6.941

Lithium (chemical symbol: Li) is the lightest of all metals. It does not occur as a pure element in nature but is contained within minerals in a range of hard rock types or in solution in brine bodies, with salt lakes ("salars"), in sea water or geothermal brines.

The continued concentration of lithium is generally low and there are only a limited number of known resources where lithium can be economically extracted and be processed to form a variety of different chemicals depending on its end-use.

Lithium and its chemical components exhibit a broad range of beneficial properties, including the highest electrochemical potential of all metals; an extremely high co-efficient of thermal expansion; fluxing and catalytic characteristics; and acting as a viscosity modifier in mills. As a result of these properties, lithium is used in numerous applications, including ceramics and glass, batteries, greases, aluminium, air treatment and others.

Lithium supply

Commercial lithium production currently comes from two sources, both representing approximately 50% of total output:

- **Brines:** lithium-rich brines from salt lakes or salars; and
- **Minerals:** pegmatic rock deposits containing lithium bearing minerals

The process of producing lithium from brines is generally much lower cost than that from hard rock minerals.



There are **three lithium minerals** commercially mined today: spodumene, petalite and lepidolite. Spodumene is the most important commercially mined lithium mineral given its high inherent lithium content. Both open-pit and underground mining methods are used to extract lithium minerals.

Typically, the mineralized rock contains approximately 12% to 20% spodumene, or approximately 1% to 1.5% lithium oxide.

Operating costs at mineral concession plants are largely dependent on the prices of key raw materials (namely spodumene, sulphur acid and soda ash). Soda ash in particular is an energy extensive chemical.

Although lithium markets vary by location, global end-use markets are estimated as follows: **batteries 65%, ceramics and glass 18%, lubricating greases 5%, polymer production 3%, continuous casting mold flux powders 3%, air treatment 1% and other uses 5%.**

Lithium consumption for batteries has increased significantly in recent years because rechargeable lithium batteries are used extensively in the growing market for portable electronic devices and increasingly are used in electric tools, electric vehicles and grid storage applications. **Lithium minerals** were used directly as ore concentrates in ceramics and glass applications.

► **Worldwide lithium production**

Excluding **U.S. production**, which is withheld to avoid disclosing company proprietary data, worldwide lithium production in 2019 decreased by 19% to 77,000 tons of lithium content from 95,000 tons of lithium content in 2018, in response to lithium production exceeding consumption and decreasing lithium prices.

Global consumption of lithium in 2019 was **estimated to be about 57,700 tons of lithium content**, an increase from 18% from 49,100 tons of lithium content in 2018. However, consumption was lower than anticipated by the lithium industry owing to **China** scaling back subsidies on electric vehicles, consumers reducing lithium inventories and lower electric vehicle sales volumes.

Six mineral operations in **Australia**, two brine operations each in **Argentina** and **Chile**, and one brine and one mineral operation in **China** accounted for the majority of world lithium production. Owing to overproduction and decreased prices, several established lithium operations postponed capacity expansion plans.

Junior mining operations in **Australia**, **Canada** and **Namibia** ceased production all together.

► **Worldwide resources of lithium**

Owing to continuing exploration identified lithium resources have increased substantially worldwide and **total about 80 million tons**. Lithium resources in the **United States** – from **continental brines, geothermal brines, hectorite, oilfield brines** and **pegmatites** are **6.8 million tons**.

Lithium resources in other countries have revised to **73 million tons**, of which **21 million tons** applies to **Bolivia**, **17 million tons** to **Argentina**, **9 million tons** to **Chile**. Located in the **Lithium Triangle**, these three countries have a combined resource of 47 tons or 64% of the world's total lithium resources.



► **Battery grade Lithium prices**

BATTERY GRADE LITHIUM PRICES					
	New price (midpoint)	w-o-w % change	Month to date average	Previous month average	Quarter to date average
Lithium carbonate 99.5% Li2CO3 min, battery grade, spot price exw domestic China, yuan/tonne	43,500	▲ 3.6	43,500	41,000	40,550
Lithium carbonate 99.5% Li2CO3 min, battery grade, spot price cif China, Japan & Korea, \$/kg	6.75	0	6.75	6.75	6.75
Lithium hydroxide 56.5% LiOH.H2O min, battery grade, spot price exw domestic China, yuan/tonne	43,500	0	43,500	44,000	45,400
Lithium hydroxide monohydrate 56.5% LiOH.H2O min, battery grade, spot price cif China, Japan & Korea, \$/kg	9.00	0	9.00	9.00	9.00

Source: Fastmarkets

source: *Fastmarkets*

► Global lithium demand anticipated to triple by 2025

The growth in lithium demand is projected to continue due to increased demand for lithium-ion batteries for use in electric vehicles and battery-based energy storage for renewable energy sources, such as solar and wind.

As a result, global demand for lithium carbonate is anticipated to rise to more than 500,000 mT by 2025 from 163,000 mT in 2015.

Lithium-ion batteries have become the most important storage technology in the area of portable and mobile applications (e.g. laptops, cell phones, smartphones, tablets, power tools, medical devices, electric bicycles, and electric cars, since around 2000.

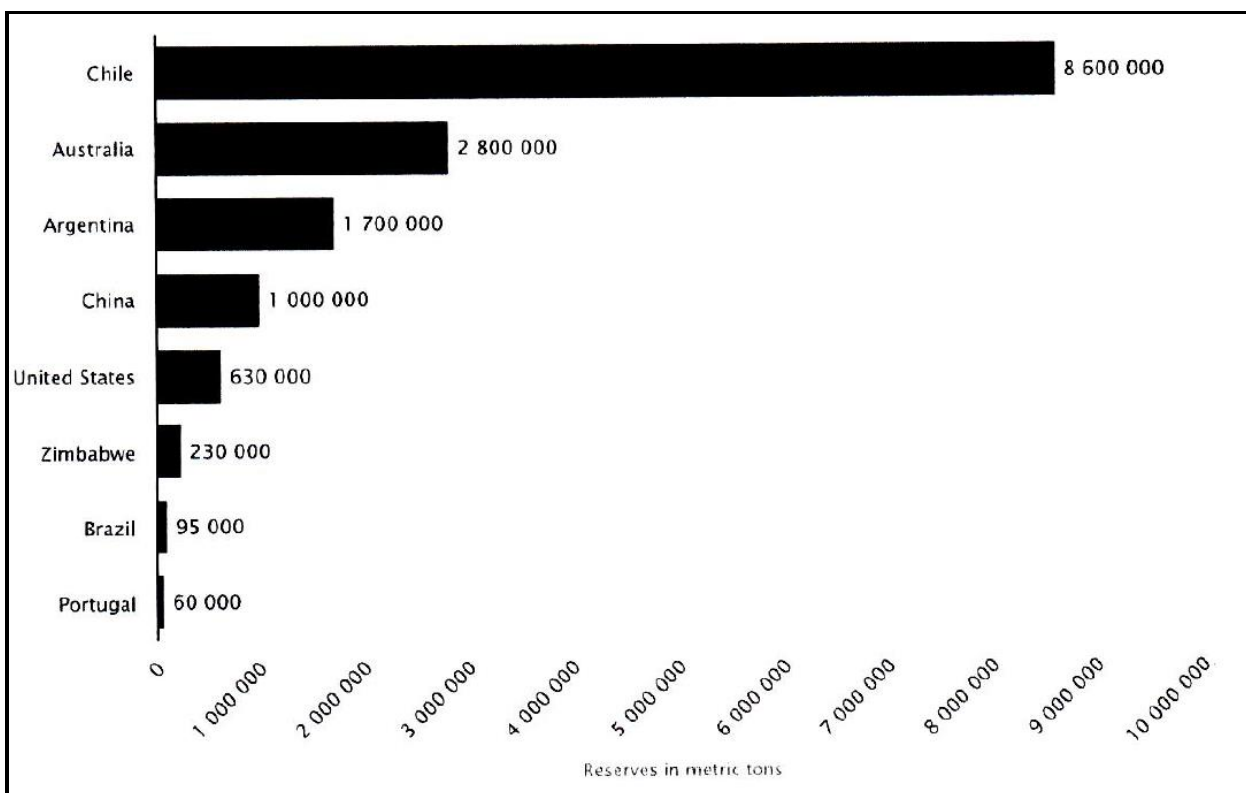
Lithium's high electrochemical potential: it has the highest electric output per unit weight of any battery material, making it the standard material for lithium-ion (high energy-density rechargeable) batteries.

Lithium ion batteries generally have a very high efficiency, typically in the range of 95-98%.

In the **automotive sector**, the advent of lithium-ion hybrids ("HEV"), plug-in hybrids ("EV") require large format batteries.

While portable consumer goods alone continue to provide impressive growth in demand for lithium batteries, the start of mass production of hybrid, plug-in hybrid and electric vehicles presents the most significant upside "step growth potential" for lithium demand.

Countries with the largest lithium reserves worldwide as of 2019 *(in metric tons)*



► Roskill's Lithium-ion changed batteries outlook to 2029

The supply of the raw and refined materials needed for the manufacturing of lithium-ion batteries has become as strategic as oil supplies, changing the landscape for the automotive energy and electronics industries and their supply chains globally.

To meet expected battery demand by the end of the decade cell makers are constructing additional manufacturing capacity.

Major battery producers plan to invest over US\$ 150 billion in expanding manufacturing capacity over the next 10 years in China, the USA and Europe. This is expected to increase annual battery capacity to over 27 Wh by the end of the decade almost 1 TWh more than previously expected by Roskill.

To meet such production, the upstream supply chain is responding accordingly with new manufacturing plants dedicated to precursors, cathodes, anodes, separators and electrolytes, especially outside Asia.

With almost 80% of future car sales falling under jurisdictions with CO₂ and fuel-efficiency regulations, the auto industry is undergoing a complete restructuring in both power train technology and manufacturing process to accommodate EV/Electronic Vehicle manufacturing platforms and approve ease of assembly.

Additionally, governments are subsidizing new manufacturing facilities in **Europe** and the **USA** to revert job losses in a rapidly evolving auto industry.

Roskill's 4th Edition incumtents in the supply chain to future commercial relationships accordingly, changes in battery components.

The increased size, capacity power, longevity and safe requirements from automotive applications compared to other-end users resulted in a shift in the battery materials required, most notably in cathode materials. According to Roskill's report the increase demands on **nickel-cobalt-aluminum (NCA)** and **Nickel-cobalt-manganese (NCM) in automotive applications has seen chemistries shift to higher nickel ratios, such as NCM 6:2:2 and BCM 8:1:1**, increasing energy density at the expense of some cycle life and increase cost for battery management systems.

Similarly, anode materials have also evolved to maximize battery performance and longevity within increasing amounts of silicon doping.

As demand for lithium-ion batteries continues to grow, **Roskill** concludes the strain upon the raw material supply is expected to be significant and the wide range of raw materials required, including **lithium, cobalt, graphite, nickel, sulphide, copper** and **aluminum**, and changes to supply chains to be inevitable.

► Tesla begins construction of world's largest battery storage factory

In August 2020, **Tesla** and **PG&E** broke ground on a record-setting energy storage system in Moss Landing (Monterey), California that, once complete, will be the largest such installation in the world. **The battery park will be able to dispatch up to 730 megawatt hours (Meh) of energy to the electrical grid at a maximum rate of 182.5 MW** for up to four hours using 250 of **Tesla's lithium-ion (Li-ion) Megapacks**.

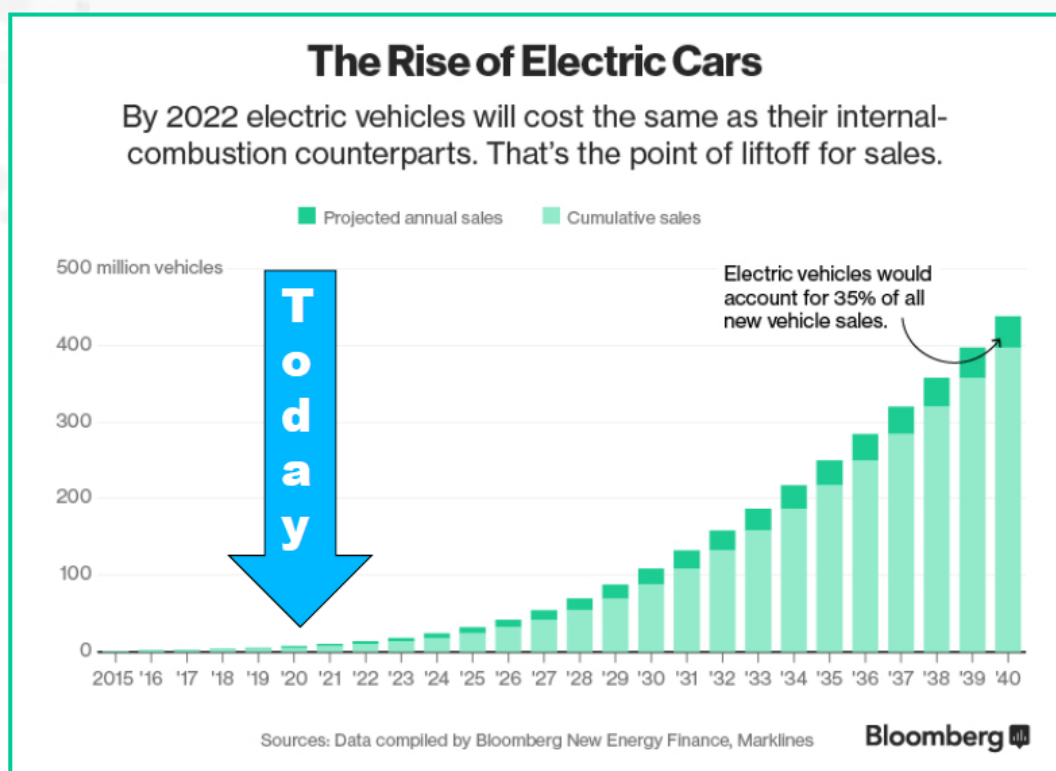
The facility is expected to come online in 2021 and will be designed, constructed and maintained by both companies, with **PG&E** retaining ownership.

If the Moss Landing site is upgraded to the 1.2 GW capacity as anticipated, its storage capacity will be approximately 10 times larger than **Australia's Hornsdale Power Station**, the previous record holder and another Tesla project. The next largest Li-ion storage system in the world is the **United Kingdom's Stocking Pelham** station at 50 MW ("GM").

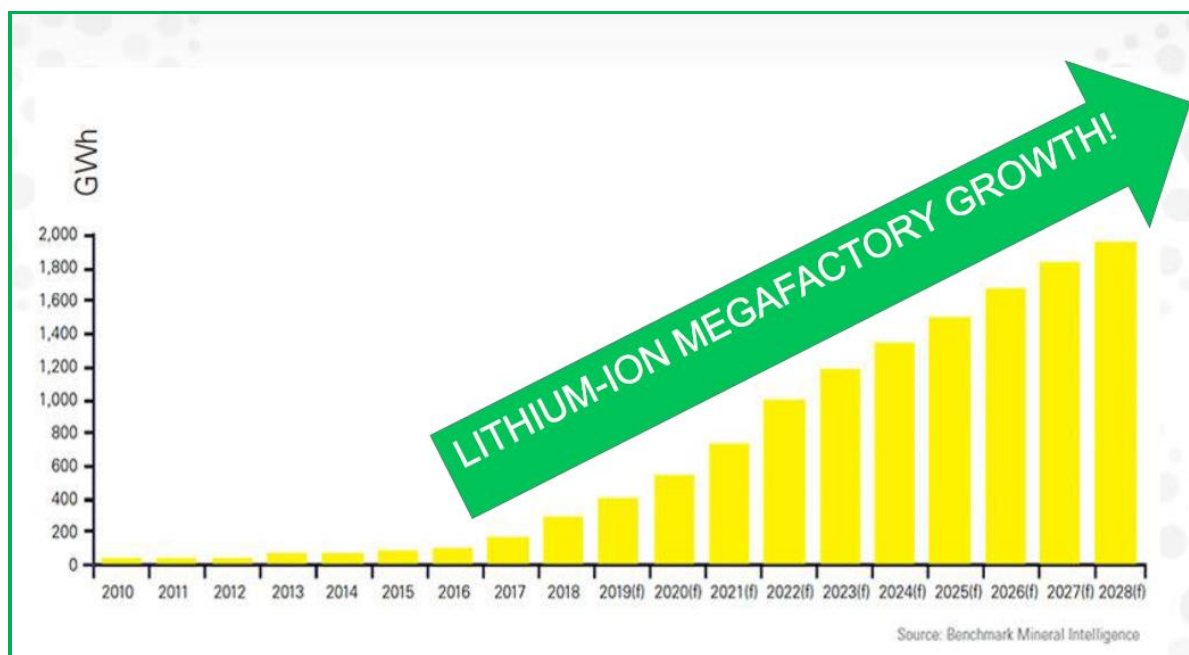
In July 2020, **General Motors ("GM")** said that construction of its new 3 million-square foot battery plant is building in Lordstown, Ohio, is right on schedule. The new **\$ 2.3 billion Ultium Cells LLC** battery cell manufacturing facility, a joint venture between **GM** and **South Korea's LG Chem**, is expected to be operational early 2022.

Also in July 2020, **SK Innovation** has started construction of its second lithium-ion battery cell factory in the **US**, which was designed for 11.7 GWh annually (starting in 2023). The first 9.8 GWh factory at the same site in Commerce, Jackson County, Georgia, has been under construction since March 2015 and will start production in 2022. The combined output to be 21.5 GWe annually. Within several years, **SK Innovation** intends to reach manufacturing capacity of 100 GWh of electric vehicle batteries per year.

► **Opportunity of the next decade**



► **100+ Lithium-ion Megafactories planned worldwide**



► Breakthrough Energy supports geothermal processing innovation

For years, companies had tried and failed to finish a cost-effective way in California's **Imperial Valley** to pull lithium from the naturally heated deep beneath the **Salton Sea geothermal area**.

Simbol Materials claimed it had developed extraordinary technology to extract lithium from the geothermal brine by the Salton Sea's southern share, about which Elon Musk was so excited that **Tesla Motors** offered to buy the start-up for \$ 325 million. However, Simbol failed to secure other financing and the Tesla deal fell through.

In 2015, Bill Gates, as founder and a coalition of private investors concerned about the impacts of accelerating climate changes, established **Breakthrough Energy** to support the innovations that will lead the world to net-zero emissions.

Now, **Energy Source**, backed by a Texas Investment group who bought a 38.5% ownership of the company, has invested additional money to fund more thorough testing of the extraction lithium process based on a relatively simple **geothermal technology**. Developers drill into underground rock formations filled with naturally heated water, then pump the super-heated water through pipes, methodically lowering the pressure in the fluid to create steam. That steam is used to turn turbines and generate electricity. Eventually the brine starts to cool down and the water and condensed steam are re-injected into the underground reservoir.

Considered to be a reliable process that doesn't emit plant-warming greenhouse gasses, **Salton Sea** has not proven to be economically viable to date.

Controlled Thermal Resources, an **Australian** company, has proposed a **280-megawatt geothermal project**, which would be more than five times bigger than any of the existing plans in the area. The idea is to bring down costs through economies of scale.

Overview of listed LITHIUM focused companies (by market capitalization)										
December 1, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market cap. million	
			Dec. 1 2020	year-end 2019		H	L		local	US\$
			US\$	US\$		US\$	US\$		US\$	
FMC	NYSE	FMC	118.93	99.82	19	119.27	56.78	129.8	15,437.1	15,437.1
Albemarle Corp.	1) NYSE	ALB	135.88	73.04	86	138.20	48.90	106.5	14,471.2	14,471.2
SQM	NYSE	SQM	46.78	26.69	75	48.64	15.20	263.2	12,312.5	12,312.5
			Euro	Euro		Euro	Euro		Euro	
ERAMET	Euronext	ERA:FP	38.00	45.84	-17	47.18	18.67	26.6	1,010.8	1,213
			CNY	CNY		CNY	CNY		CNY	
Tianqi Lithium	2) Shenzhen	002466	25.52	30.18	-15	38.38	15.18	1,480.0	37,769.6	5,665
			A\$	A\$		A\$	A\$		A\$	
Pilbara Minerals	ASX	PLS	0.75	0.28	168	0.77	0.14	2,230.0	1,672.5	1,237.7
Orocobre	3) ASX	ORE	4.09	2.65	54	4.25	1.83	344.0	1,407.0	1,041.2
Galaxy Resources	ASX	GXY	2.15	0.93	131	2.26	0.68	409.5	880.4	651.5
Piedmont Lithium	ASX	PLL	0.39	8.26	-95	0.66	0.06	1,380.0	538.2	398.3
IoNeer	ASX	INR	0.29	0.19	53	0.30	0.07	1,680.0	487.2	360.5
Liontown Resources	ASX	LTR	0.27	0.09	200	0.30	0.05	1,740.0	469.8	347.7
AVZ Minerals	ASX	AVZ	0.09	0.04	125	0.11	0.04	2,850.0	256.5	189.8
Altura Mining	ASX	AJM	0.07	0.05	40	0.07	0.03	2,990.0	209.3	154.9
Neometals	ASX	NMT	0.24	0.19	26	0.255	0.14	545.4	130.9	96.9
Lithium Power International	ASX	LPI	0.28	0.25	12	0.45	0.11	263.0	73.6	54.5
Argosy Minerals	ASX	AGY	0.07	0.08	-13	0.09	0.03	1,020.0	71.4	52.8
Core Lithium	ASX	CXO	0.07	0.04	75	0.09	0.01	994.3	69.6	51.5
Prospect Resources	ASX	PSC	0.15	0.18	-19	0.28	0.06	332.1	48.2	35.6
Lithium Australia	ASX	LIT	0.06	0.06	-5	0.09	0.03	792.3	45.2	33.4
European Lithium	ASX	EUR	0.05	0.08	-41	0.13	0.04	718.2	33.8	25.0
Sayona Mining	ASX	SYA	0.01	0.01	-20	0.02	0.01	2,970.0	23.8	17.6

1) owns 51% of [Talison Lithium](#)

2) owns 49% of [Talison Lithium](#)

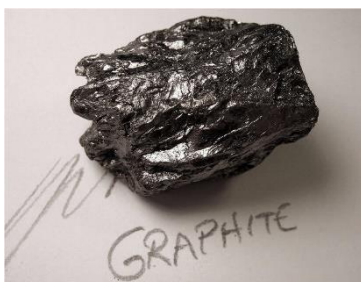
3) completed acquisition of [Advantage Lithium](#) on April 20, 2020; full payment in 15.1 million shares at a price of A\$ 2.24 (C\$ 0.28 per Advantage share)

Overview of listed LITHIUM focused companies (by market capitalization) - continuation

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market cap. million	
			Nov. 30 2020	year-end 2019		H	L		local	US\$
			C\$	C\$		C\$	C\$		C\$	£
Lithium Americas	TSX	LAC	14.64	4.16	252	22.47	2.90	91.5	1,339.6	1,031.5
Standard Lithium	TSX.V	SLL	2.64	0.85	211	3.03	0.39	107.4	283.5	218.3
Millennial Lithium	TSX	ML	2.85	1.02	179	3.18	0.61	83.3	237.4	182.8
Neo Lithium	TSX	NLC	1.67	0.50	234	1.74	0.38	117.5	196.2	151.1
American Lithium	TSX.V	LI	1.26	0.13	908	2.98	0.10	114.9	144.8	111.5
Critical Elements Lithium	TSX.V	CRE	0.83	0.38	118	1.02	0.17	168.8	140.1	107.9
Frontier Lithium	TSX.V	FL	0.37	0.25	48	0.41	0.14	175.2	64.8	49.9
McArthur Minerals	TSX.V	MMS	0.45	0.23	93	0.67	0.07	136.9	60.9	46.9
Avalon Advanced Materials	TSX	AVL	0.10	0.05	100	0.12	0.03	348.4	34.8	26.8
Pure Energy Minerals	TSX	PE	0.96	0.30	220	1.41	0.18	32.0	30.7	23.7
Power Metals	TSX.V	PWM	0.25	0.06	317	0.54	0.04	104.7	26.2	20.2
Wealth Minerals	TSX.V	WML	0.11	0.23	-54	0.38	0.07	158.1	16.6	12.8
Dajin Lithium	1) TSX.V	DJI	0.05	0.02	150	0.08	0.02	161.2	8.1	6.2
Lithium South Development	2) TSX.V	LIS	0.28	0.54	-48	0.66	0.21	27.8	7.8	6.0
Aberdeen International	TSX	AAB	0.05	0.04	13	0.10	0.02	112.1	5.0	3.9
Ultra Resources	3) TSX.V	ULT	0.05	0.08	-38	0.09	0.02	95.8	4.8	3.7
Argentina Lithium and Energy	TSX	LIT	0.07	0.05	40	0.13	0.04	33.1	2.3	1.8
			GBp	GBp		GBp			£	
Bacanora Lithium	4) AIM	BCN	46.50	35.00	33	46.94	15.00	223.8	104.1	138.4
European Metals Holdings	AIM	EMH	41.00	15.50	165	45.00	8.90	139.9	57.4	76.3

1) name change from [Dajin Resources](#) effective January 20, 2020
2) name change from [NRG Metals](#) effective October 19, 2020
3) name change from [Ultra Lithium](#) effective December 2, 2019; also gold assets in [Australia](#)
4) NewView Capital of China holds a 19.89% equity interest

▶ Graphite - one of the vital battery metals to benefit from surging shortage



There are 3 types of graphite: **Flake**, **Amorpeus** and **Vein**.

Because of its unique structure graphite has a stellar combination of properties: for example, it is flexible, highly refractory, chemically inert and has high thermal and electrical conductivity.

Today, **Flake graphite** is the type of graphite that has the most interest of the industry, because it is the type of graphite that the [Tesla 3 model](#) requires for its [lithium-ion battery giga-factory](#) and also to be used by international prominent makers.

[Benchmark Mineral Intelligence](#) has said that if it reaches its target capacity of 35 GWh by 2020, it may need 25,000 tonnes per year of lithium, 12,500 tonnes per year of flake graphite, 45,000 tonnes per year of spherical graphite and 7,000 tonnes per year of cobalt.

[Fuel cells](#) use even more graphite than lithium-ion batteries and might replace combustion engines as a more efficient means of converting fuel to energy. Fuel cells of all sized are also making their way into the personal electronics sector and even into the utilities sector.

[Flake graphite](#) is also an essential part of [vanadium-redox](#) battery technology, with nearly 300 tonnes of flake graphite per 1,000 megawatts of required storage,

[Fine- and medium-flake graphite](#) are typically used to produce [Spherical Graphite](#). [Large-flake graphite](#) is used in expandable graphite and rose by 25% in October 2017 to average \$ 98 per tonne.

For the first time in over 5 years consistent increases in pricing due to supply-side pressures are seen. At the same time, the emergence of new demand from value-added applications such as [expandable graphite](#) and [spherical graphite](#) for [lithium-ion](#) batteries are seen.

► History Graphite pricing

Like uranium, there is a posted price for graphite which provides a guideline with respect to longer term trends, but there are no spot or future markets. Transactions are largely based on direct negotiations between the buyer and seller.

Graphite prices are also a function of flake size and purity with large (+80 mesh) and particularly XL flake (+50 mesh) and 94% plus carbon varieties commanding premium pricing.

Prices for +80 mesh large flake exceeded US\$ 1,300/t in the late 1980s, but crashed to US\$ 600-700/t in the late 1990s as Chinese producers dumped product on the market. During this period there was essentially no exploration and no new mines were built in the west.

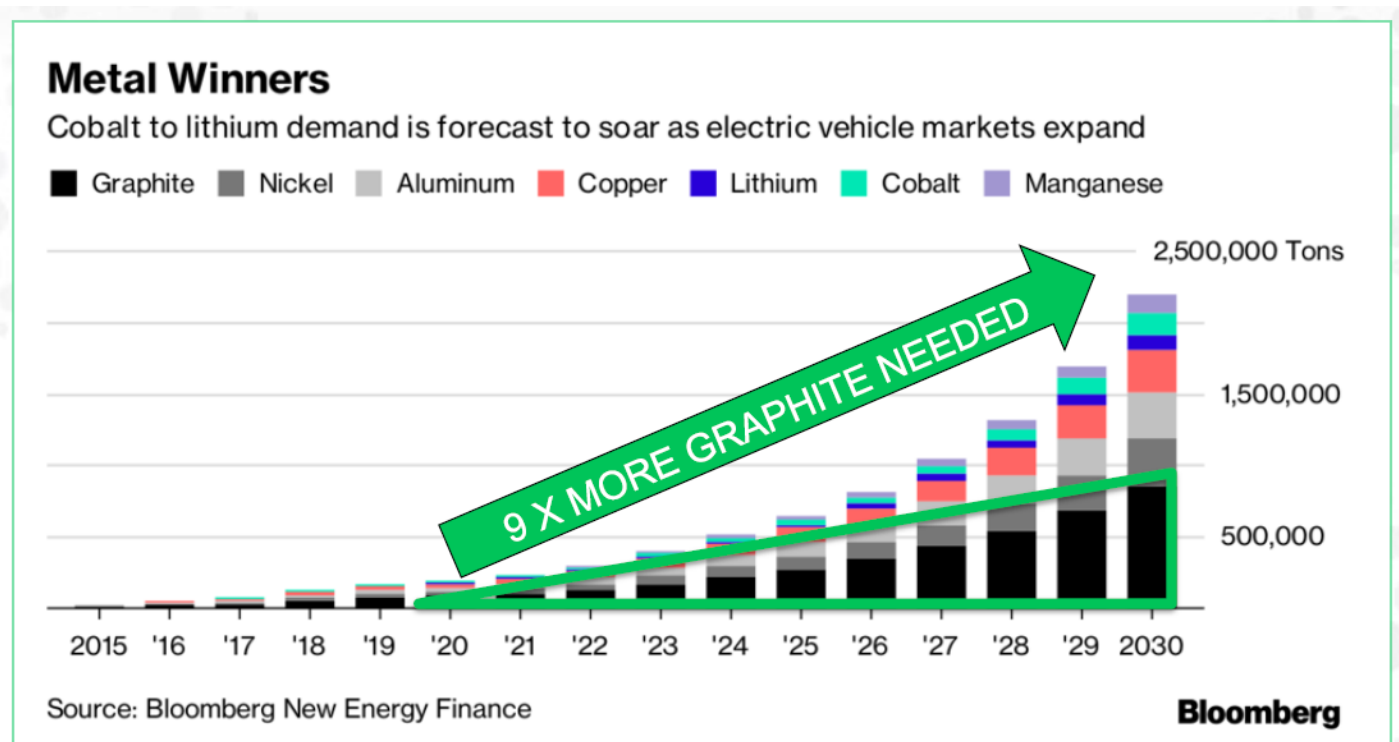
Graphite prices did not start to recover until 2005 and well surpassed US\$ 1,300/t with large flake selling for up to US\$ 3,000/t in early 2012, with some shortages reported. Price appreciation was largely a function of the commodity super cycle and the industrialization of emerging economics as new, high growth applications such as Li-ion batteries (“LiBs”) had not yet had an impact on demand and consumption. Graphite prices subsequently again declined to the \$ 750/t area for large flake graphite due to the strength in the U.S. dollar, the slowdown in China and the lack of growth in the U.S., Europe and Japan.

LiB batteries were a small part of the markets until the year 2000, but have been growing at over 20% annually due to the explosion in the issue of cellphones, laptops cameras power tools, etc.

LiB batteries now account for approximately 25% of the graphite market and are expected to continue growing rapidly due to the increasing sales of electric and hybrid electric vehicles, as well as grid storage solutions.

These applications use much larger batteries, are much larger markets than the small device market and are still in their infancy. While China has surplus small flake production capacity, which is used to make the anode material for lithium-ion batteries, the potential demand from LiB manufacturing capacity that is currently under construction is significantly higher than the extra capacity. This should lead to higher prices in the future.

► 15x More graphite than lithium in a EV battery – 92 kgs in a Tesla



► **China** produced more than 60% of the world's graphite

During 2019, **China** produced more than 60% of the world's graphite. Approximately 40% of production was amorphous. China does produce some large **flake graphite**, but the majority of its flake graphite production is very small, in the 200+ mesh range.

North America produced only 4% of the world's graphite supply, with production in **Canada** and **Mexico**.

No production of **natural graphite** was reported in the **United States**, but two companies were developing graphite projects – one in Alabama and one in Alaska.

► **No domestic production United States**

In 2019, **natural graphite** was not produced in the **United States**; however, approximately 95 U.S. firms primarily in the Great Lakes and Northeastern regions and Alabama and Tennessee consumed 52,000 tons at an estimated \$ 44 million.

The major uses of natural graphite were brake things, lubricants, powder metals, refractory applications and steelmaking.

During 2019, U.S. **natural graphite imports for consumption were an estimated 58,100 tons**, which were about **65% flake** and **high-purity**, **34% amorphous** and **1% lump and chip graphite**; **exports amounted to 6,600 tons**. **Import sources** (2015-2018) were: **China 33%**, **Mexico 24%**, **Canada 16%**, **India 9%** and **other 18%**.

Large graphite deposits were developed in **Madagascar**, northern **Mozambique**, **Namibia**, and south-central **Tanzania**.

Some mines in **Madagascar** began ramping up production in 2018, and a mine in **Tanzania** started sampling production beginning in 2017. A graphite mine project in **Mozambique** commenced operations at the start of 2018 and was ramping up production during 2018 and 2019 at a high-grade deposit, which was reportedly the largest natural mine globally.

The mine cut back production during 2019 in an effort to stabilize graphite prices. The mine is expected to operate for 50 years.

During the first half of 2019, crystalline flake project prices declined to levels similar to those of midyear 2017. The price decline was the result of oversupply and some graphite mining companies cut back production in an effort to stabilize and increase graphite prices.

Tesla continued to build a large plant to manufacture **lithium-ion electric vehicle batteries**. The plant's completion was projected for 2020. A portion of the plant was operational and battery packs were being assembled in 2018 and 2019.

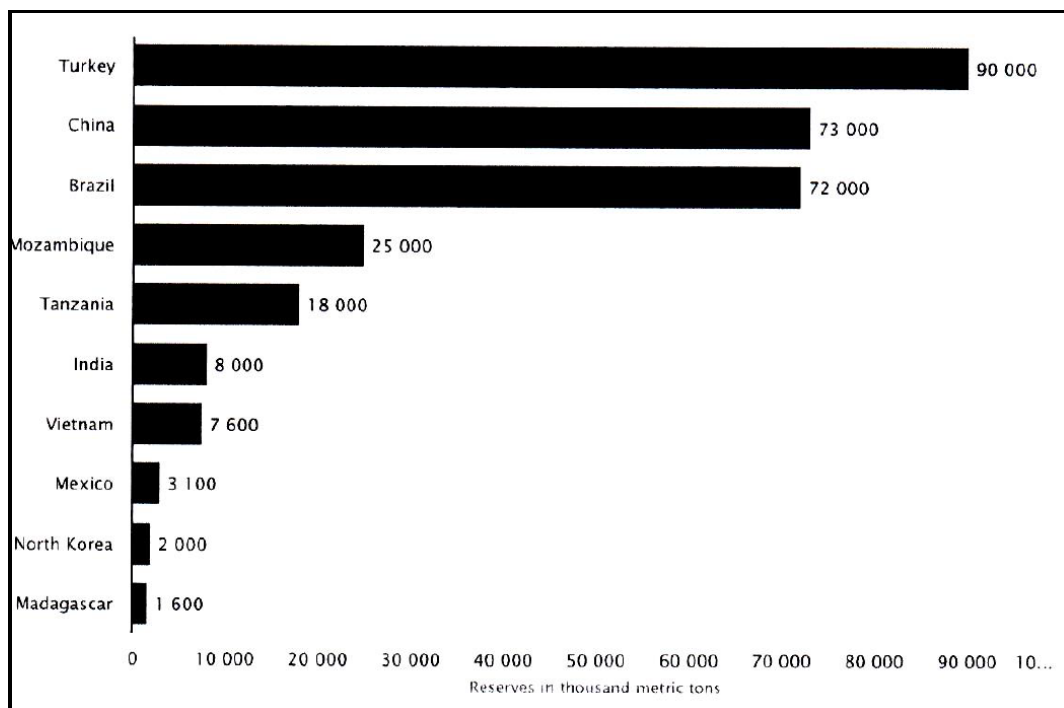
When the plant is complete, it was expected to require 35,200 tons per year of **spherical graphite** for use as anode material in lithium-ion batteries.

New **thermal technology** and acid-leaching techniques have enabled the production of higher **purity graphite powders** that are likely to lead to development of new applications for graphite in high-technology fields. Innovation refining techniques have made the use of graphite possible in **carbon-graphite composites**, **electronics**, **foils**, **friction materials** and **specialty lubricant applications**.

Flexible graphite product lines are likely to be the fastest growing market. Large-scale fuel-cell applications are being developed that could consume as much graphite as all other uses combined.

Price overview imports United States					
<i>(average dollars per ton at foreign ports)</i>					
	2015	2016	2017	2018	2019
Flake	1,710	1,920	1,380	1,520	1,300
Lump and chip (Sri Lanka)	1,800	1,880	1,900	1,890	2,370
Amorphous	454	571	451	310	438

Countries with the largest graphite reserves worldwide as of 2019 (in metric tons)



Overview of listed GRAPHITE focused companies (by market capitalization)

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market capitalization (million)	
			Nov. 30 2020	year-end 2019		H	L		local	US\$
			A\$	A\$		A\$	A\$		A\$	
Talga Resources	ASX	TLG	1.93	0.48	301	2.15	0.18	264.1	508.4	376.2
Syrah Resources	ASX	SYR	0.95	0.47	101	1.06	0.15	414.9	392.1	290.1
Magnis Energy Technologies	ASX	MNS	0.18	0.08	125	0.28	0.05	707.1	127.3	94.2
Ecograf	1) ASX	EGR	0.17	0.08	113	0.30	0.03	364.0	61.9	45.8
Bass Metals	ASX	BSM	0.004	0.01	-60	0.008	0.002	886.7	3.5	2.6
			C\$	C\$		C\$	C\$		C\$	
Nouveau Monde Graphite	TSX.V	NOU	0.72	0.20	269	1.00	0.13	263.0	189.4	145.8
Zen Graphene Solutions	TSX.V	ZEN	1.73	0.36	381	2.23	0.26	84.6	146.4	112.7
Mason Graphite	TSX.V	LLG	0.40	0.20	98	0.57	0.12	136.2	53.8	41.4
SRG Mining	TSX.V	SRG	0.55	0.76	-28	0.94	0.22	79.8	43.9	33.8
NextSource Materials	TSX.V	NEXT	0.06	0.05	33	0.08	0.02	598.1	35.9	27.6
Ceylon Graphite	TSX.V	CYL	0.23	0.15	59	0.32	0.06	122.3	28.1	21.7
Canada Carbon	TSX.V	CCB	0.23	0.07	229	0.39	0.07	120.7	27.8	21.4
Northern Graphite	TSX.V	NGC	0.27	0.12	121	0.35	0.06	65.1	17.3	13.3
Graphite One	TSX	GPH	0.42	0.28	48	1.04	0.15	40.6	16.8	13.0
Focus Graphite	TSX.V	FMS	0.04	0.02	167	0.05	0.01	380.9	15.2	11.7
Lomiko Metals	* TSX.V	LMR	0.05	0.03	67	0.07	0.02	129.8	6.5	5.0
Eagle Graphite	TSX.V	EGA	0.05	0.04	25	0.08	0.02	37.8	1.9	1.5
			US\$	US\$		US\$	US\$		US\$	
Westwater Resources	2) NASDAQ	WWR	6.42	2.11	204	14.50	0.25	19.0	122.0	122.0

* featured a **Special Situation** and included in 2 020 Shortlist of investment recommendations

1) name change, formerly Kibaran Resources effective November 29, 2019

2) also lithium and uranium properties

Overview of listed COBALT focused companies (by market capitalization)

November 30, 2020		Trading symbol	Share price Nov. 30 2020	Share price year-end 2019	Change in %	12 months prices		Total shares issued million	Market cap. million local	US\$	
			CNY	CNY		CNY	CNY		CNY		
		Zhejiang Huayou Cobalt	Shanghai 603799	52.35	39.39	33	58.61	28.35	1,140.0	59,679.0	8,892.2
			C\$	C\$		C\$	C\$		C\$		
		Canada Silver Cobalt Works	1) TSX.V CCW	0.55	0.63	-13	0.73	0.25	119.8	65.9	50.7
		First Cobalt	TSX.V FCC	0.13	0.14	-11	0.18	0.08	404.1	50.5	38.9
		Conic Metals	2) TSX.V NKL	0.37	0.46	-20	0.46	0.12	83.5	30.5	23.5
		Fortune Minerals	TSX.V FT	0.07	0.08	-7	0.10	0.04	359.6	25.2	19.4
		Cobalt Blockchain	TSX.V COBC	0.07	0.08	-7	0.08	0.03	215.4	15.1	11.6
		Sienna Resources	3) TSX.V SIE	0.07	0.03	133	0.11	0.03	108.8	7.6	5.9
		Global Energy Metals	TSX.V GEMC	0.29	0.15	93	0.45	0.05	18.4	5.3	4.1
		Cruz Cobalt	CNX CRUZ	0.06	0.04	38	0.07	0.03	83.5	4.6	3.5
		Bolt Metals *	4) CNX BOLT	0.33	0.14	136	0.63	0.09	12.2	4.0	3.1
		Fjordland Exploration	5) TSX.V FEX	0.08	0.04	100	0.12	0.03	49.1	3.9	3.0
		Fuse Cobalt	6) TSX.V FUSE	0.03	0.02	50	0.14	0.02	74.7	2.2	1.7
		Quantum Cobalt	CNX QBOT	0.03	0.02	25	0.06	0.01	60.4	1.5	1.2
		Power Group Projects	TSX.V PGP	0.07	0.08	-50	0.10	0.03	15.9	1.0	0.8
			A\$	A\$		A\$	A\$		A\$		
		Jervois Mining	7) ASX JRV	0.34	0.21	60	0.38	0.12	772.1	258.7	191.4
		Ardea Resources	ASX ARL	0.46	0.51	-10	0.69	0.17	127.7	58.7	43.5
		Cobalt Blue Holdings	8) ASX COB	0.10	0.14	-29	0.18	0.08	237.4	23.7	17.6
		A-Cap Energy	9) ASX ACB	0.02	0.01	100	0.03	0.004	871.9	17.4	12.9

* featured a **Special Situation** and included in 2 2020 Shortlist of investment recommendations; name change from Pacific Rim Cobalt effective Feb.26,2020

1) name change from Canada Cobalt Works effective May 19, 2020

2) Cobalt7 Capital acquired by Pala Investments for a total value of appr. C\$ 49.4 million; completion of arrangement approved on October 16, 2019 trading on November 15, 2019 at a price of C\$ 0.39

3) cobalt-nickel-copper project in Sweden

4) name change from Pacific Rim Cobalt effective February 26, 2020

5) Nickel-copper-PGE project in Manitoba, USA and Nickel-copper-cobalt project in Newfoundland and Labrador, Canada

6) name change from Lico Energy Metals effective March 10, 2020

7) closed merger with eCobalt Solutions on July 24, 2019

8) spin-out of Broken Hill Prospecting

9) besides farm-in and Joint Venture Agreement with Blackham Resources to acquire a 75% interest in cobalt and nickel associated metals of the Wilconi Project in Western Australia, also major uranium project in Botswana

Overview of listed VANADIUM focused companies (by market capitalization)

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market cap. million	
			Nov. 30 2020	year-end 2019		H	L		local	US\$
Bushveld Minerals	AIM	BMN	GBP 13.30	GBP 20.00	-34	GBP 23.90	GBP 8.70	1,150.0	£ 153.0	203.4
TNG	1) ASX	TNG	A\$ 0.09	A\$ 0.09	0	A\$ 0.13	A\$ 0.04	1,120.0	A\$ 100.8	74.6
Technolpgy Metals Australia	ASX	TMT	0.34	0.14	139	0.48	0.06	123.2	41.3	30.5
Australian Vanadium	ASX	AVL	0.01	0.01	30	0.02	0.01	2,920.0	38.0	28.1
Vanadium Resources	2) ASX	VR8	0.02	0.03	-33	0.04	0.01	374.3	7.5	5.5
Aura Energy	3) AIM	AEE	GBP 0.33	GBP 0.01	3200	GBP 0.50	GBP 0.18	2,450.0	£ 8.1	10.8
Silver Elephant Mining *	4) TSX	ELEF	C\$ 0.40	C\$ 0.39	3	C\$ 0.59	C\$ 0.10	179.5	C\$ 71.8	55.3
First Vanadium	5) TSX.V	FVAN	0.47	0.24	96	0.61	0.13	57.6	27.1	20.8
Blue Sky Uranium	6) TSX.V	BSK	0.11	0.11	0	0.23	0.05	120.1	12.6	9.7
Vanadium One Iron	7) TSX.V	VONE	0.10	0.06	82	0.12	0.04	75.7	7.6	5.8
CellCube Energy Storage	CNX	CUBE	0.03	0.03	0	0.06	0.02	185.6	4.6	3.6
Vanadian Energy	8) TSX.V	VEC	0.05	0.02	233	0.08	0.01	42.3	2.1	1.6

* featured as a **Special Situation** and included in 2020 Shortlist of investment recommendations

1) vanadium-titanium-iron project

2) name change from Tando Resources effective July 29, 2019

3) also uranium project in Mauretania

4) name change from Prophecy Development effective March 19, 2020

5) name change from Cornerstone Metals effective September 25, 2018

6) uranium-vanadium project

7) vanadium-iron-titanium project; name change from Vanadium One Energy effective June 5, 2019

8) name change from Uracan Resources, effective October 5, 2018

Overview of listed MANGANESE focused companies (by market capitalization)

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market cap. million	
			Nov. 30 2020	year-end 2019		H	L		local	US\$
American Manganese	TSX.V	AMY	C\$ 0.20	C\$ 0.19	5	C\$ 0.28	C\$ 0.10	185.3	C\$ 36.1	27.8
Giyani Metals	TSX	EMM	0.26	0.15	76	0.28	0.04	112.4	28.7	22.1
Manganese X Energy	TSX.V	MN	0.25	0.13	92	1.11	0.06	106.5	26.6	20.5
MGX Minerals	CSE	XMG	0.06	0.05	22	0.15	0.04	140.4	7.7	5.9
Element 25	ASX	E25	A\$ 1.46	A\$ 0.17	759	A\$ 1.46	A\$ 0.10	128.7	A\$ 187.9	139.0

Overview of listed TUNGSTEN focused companies (by market capitalization)

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market cap. million	
			Nov. 30 2020	year-end 2019		H	L		local	US\$
Almonty Industries	TSX	All	C\$ 0.68	C\$ 0.42	62	C\$ 0.81	C\$ 0.28	183.5	C\$ 124.8	96.1
EQ Resources	1) ASX	EQR	A\$ 0.03	A\$ 0.06	-50	A\$ 0.06	A\$ 0.02	1,110.0	A\$ 33.3	24.6

1) formerly Carbine Tungsten; new name change from Specialty Metals effective December 2, 2020; also lithium assets in Chile and gold exploration licences in NSW, Australia

Overview of listed TITANIUM focused companies (by market capitalization)

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market cap. million	
			Nov. 30 2020	year-end 2019		H	L		local	US\$
			US\$	US\$		US\$	US\$		US\$	
Kronos Worldwide	NYSE	KRO	13.99	13.40	4	14.75	6.81	115.5	1,615.8	1,615.8
Tronox	NYSE	TROX	13.31	11.42	17	13.37	3.98	143.5	1,910.0	1,910.0
			A\$	A\$		A\$	A\$		A\$	
Iluka Resources	ASX	ILU	5.35	9.30	-42	10.58	4.88	422.8	2,262.0	1,673.9
			GBP	GBP		GBP	GBP		£	
BlueJay Mining	AIM	JAY	11.00	8.90	24	11.40	3.27	970.0	106.7	141.9

Overview of listed REE focused companies (by market capitalization) - traditional countries

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued million	Market cap. million	
			Nov. 30 2020	year-end 2019		H	L		local	US\$
US:			US\$	US\$		US\$	US\$		US\$	
Texas Mineral Resources		OTC US TMRC	1.65	1.23	34	2.66	0.25	72.7	120.0	120.0
Rare Element Resources	1)	OTC US REEMF	0.67	0.92	-27	1.25	0.34	104.4	69.9	69.9
			C\$	C\$		C\$	C\$		C\$	
Ucore Rare Metals		TSX.V UCU	0.09	0.23	-60	0.25	0.07	410.5	36.9	28.4
Canada:			C\$	C\$		C\$	C\$		C\$	
Appia Energy		CNSX API	0.39	0.16	152	0.57	0.11	73.8	28.8	22.2
Search Minerals		TSX.V SMY	0.07	0.04	63	0.07	0.03	262.1	17.0	13.1
Eagle Plains Resources		TSX.V EPL	0.15	0.11	43	0.18	0.07	99.3	14.9	11.5
Commerce Resources		TSX.V CCE	0.29	0.20	43	0.38	0.11	50.9	14.5	11.2
Canada Rare Earth	2)	TSX.V LL	0.07	0.07	8	0.08	0.03	202.0	14.1	10.9
Medaillon Resources		TSX.V MDL	0.22	0.09	159	0.41	0.05	63.2	13.9	10.7
Int. Montoro Resources	3)	TSX.V IMT	0.06	0.04	71	0.11	0.01	64.5	3.9	3.0
Australia:			A\$	A\$		A\$	A\$		A\$	
Lynas		ASX LYC	3.72	2.33	60	3.91	1.02	900.3	3,349.1	2,478.3
Alkane Resources	4)	ASX ALK	1.05	0.59	77	1.54	0.47	595.4	622.2	460.4
Hastings Technology Metals		ASX HAS	0.15	0.12	25	0.17	0.05	1,200.0	180.0	133.2
Northern Minerals		ASX NTU	0.04	0.06	-40	0.06	0.02	4,440.0	159.8	118.3
Arafura Resources		ASX ARU	0.10	0.09	11	0.12	0.05	1,170.0	117.0	86.6
Western Europe:										
Greenland:			A\$	A\$		A\$	A\$		A\$	
Greenland Minerals	5)	ASX GGG	0.24	0.13	85	0.35	0.07	1,200.0	288.0	213.1
			C\$	C\$		C\$	C\$		C\$	
Leading Edge Materials	6)	TSX.V LEM	0.27	0.09	218	0.34	0.01	146.5	39.6	30.5

1) approximately 49% held by Synchron, an affiliated General Atomics privately held group of companies

2) vertically integrated REE business

3) also uranium assets

4) also gold producer

5) world's largest undeveloped multi-element REE-uranium-zinc occurrence

6) also graphite and lithium properties in Sweden and cobalt-nickel project in Romania

Overview of listed REE focused companies (by market capitalization) - emerging countries

November 30, 2020	Trading symbol		Share price		Change in %	12 months prices		Total shares issued		market cap. million local	US\$
			Nov. 30 2020	year-end 2019		H	L	million	million		
Africa:											
Namibia:											
Namibia Critical Metals	6)	TSXV	NMI	C\$ 0.22	C\$ 0.18	26	C\$ 0.37	C\$ 0.10	185.3	C\$ 40.8	31.4
Angola:											
Pensana Rare Earths		ASX	PM8	A\$ 1.27	A\$ 0.18	606	A\$ 1.63	A\$ 0.10	188.3	A\$ 239.1	177.0
Tanzania:											
Peak Resources		ASX	PEK	A\$ 0.06	A\$ 0.04	50	A\$ 0.07	A\$ 0.02	1,520.0	A\$ 91.2	67.5
Burundi:											
Rainbow Rare Earths		AIM	RBW	GBP 10.90	GBP 3.25	235	GBP 9.90	GBP 1.45	422.0	£ 46.0	61.2
Malawi:											
Mkango Resources		TSXV	MKA	C\$ 0.23	C\$ 0.13	73	C\$ 0.25	C\$ 0.05	133.0	C\$ 29.9	23.0
Globe Metals and Mining		ASX	GBE	A\$ 0.03	A\$ 0.02	70	A\$ 0.03	A\$ 0.01	465.9	A\$ 15.8	11.7
Central Asia:											
Kyrgyzstan:											
Stans Energy		TSXV	HRE	C\$ 0.01	C\$ 0.02	-50	C\$ 0.02	C\$ 0.005	184.3	C\$ 1.8	1.4

6) heavy rare earths joint venture with JOGMEC of Japan

**2020 SHORTLIST of Strategic Metals and REE
investment recommendations as at November 30, 2020**

Company	Trading symbol		Share price		Change in %		Market cap. (US\$ mln)		
			Nov.30 2020	Year-end 2019	local	US\$	Nov.30 2020	Year-end 2019	
Lithium companies (8)									
US (2)			A\$	A\$					
Ioneer	ASX	INR	0.29	0.19	52.6	55.3	360.5	223.4	
			Cdn\$	Cdn\$					
Pure Energy Minerals	TSX.V	PE	0.96	0.30	220.0	220.0	23.7	5.9	
Canada (2)			Cdn\$	Cdn\$					
Frontier Lithium	TSX.V	FL	0.37	0.25	48.0	48.0	49.9	31.1	
Avalon Advanced Materials	TSX	AVL	0.10	0.05	100.0	100.0	26.8	12.5	
Australia (2)			A\$	A\$					
Neometals	ASX	NMT	0.24	0.19	26.3	27.6	96.6	72.4	
			Cdn\$	Cdn\$					
McArthur Minerals	TSX.V	MMS	0.45	0.23	95.7	95.7	46.9	18.0	
Argentina (1)			A\$	A\$					
Altura Mining	ASX	AJM	0.05	0.05	0.0	0.0	154.9	86.8	
Cobalt companies (5)									
USA (1)			A\$	A\$					
Jervois Mining	ASX	JRV	0.34	0.32	3)	6.3	6.6	191.4	150.0
USA/Congo (1)			Cdn\$	Cdn\$					
First Cobalt	TSX.V	FCC	0.13	0.14	-7.1	-7.1	38.9	40.7	
Australia (1)									
Ardea Resources	ASX	ARL	0.46	0.57	3)	-19.3	-19.3	43.5	49.5
Canada (1)									
Canada Silver Cobalt Works	TSX.V	CCW	0.55	0.63	-12.7	-12.7	50.7	38.9	
Indonesia (1)									
Bolt Metals	CNX	BOLT	0.33	0.14	135.7	135.7	3.1	7.1	
Graphite companies (4)									
Tanzania/Australia (1)			A\$	A\$					
Magnis Energy Technologies	ASX	MNS	0.18	0.08	125.0	131.3	94.2	34.9	
Tanzania (1)									
Ecograf	ASX	EGR	0.17	0.08	112.5	118.1	45.8	8.4	
Canada (1)			C\$	C\$					
Zen Graphene Solutions	TSX.V	ZEN	1.73	0.36	380.6	380.6	112.7	21.4	
Sweden (1)			C\$	C\$					
Leading Edge Materials	TSX.V	LEM	0.27	0.09	300.0	300.0	30.5	6.2	

Continuation of Shortlist on next page

Company	Trading symbol		Share price		Change			Market cap. (US\$ mln)	
			Nov. 30 2020	Year-end 2019	in % local	US\$	Nov. 30 2020	Year-end 2019	
Vanadium companies (3)									
Bushveld Minerals	AIM	BMN	<i>GBP</i> 13.30	<i>GBP</i> 20.00	-33.5	-32.5		203.4	303.1
Australian Vanadium	ASX	AVL	<i>A\$</i> 0.01	<i>A\$</i> 0.01	0.0	0.0		28.1	17.9
Silver Elephant Mining	TSX	ELEF	<i>C\$</i> 0.40	<i>C\$</i> 0.39	1)	2.6	2.6	55.3	36.4 1)
CellCube Energy Storage	CNX	CUBE	0.03	0.03	1)	0.0	0.0	3.6	3.6 1)
Tungsten companies (1)									
<i>Spain (1)</i>									
Almonty Industries	TSX.V	AI	<i>C\$</i> 0.68	<i>C\$</i> 0.42	61.9	61.9		96.1	58.9
REE companies (5)									
<i>US (1)</i>									
Rare Element Resources	OTC US	REEMF	<i>US\$</i> 0.67	<i>US\$</i> 0.92	-27.2	-27.2		69.9	95.5
<i>Australia (3)</i>									
Northern Minerals	ASX	NTU	<i>A\$</i> 0.04	<i>A\$</i> 0.06	-33.3	-35.0		118.3	109.2
Arafura Resources	ASX	ARU	0.10	0.09	11.1	11.7		86.6	66.2
<i>Namibia (1)</i>									
Namibia Critical Metals	TSX.V	NMI	<i>C\$</i> 0.22	<i>C\$</i> 0.19	2)	15.8	15.8	31.4	24.2 2)
<i>Angola (1)</i>									
Pensana Rare Earths	ASX	PM8	<i>A\$</i> 1.27	<i>A\$</i> 0.30	2)	323.3	339.5	177.0	19.3 2)
<i>Tanzania (1)</i>									
Peak Resources	ASX	PEK	<i>A\$</i> 0.06	<i>A\$</i> 0.04	50.0	52.5		67.5	36.7
1) included as per July 1, 2019									
2) included as at July 3, 2020									
3) included as per September 1, 2020									
Removed as at:			2020	2019	Change US\$				
			<i>July 1</i>	<i>Year-end</i>	in %				
Wealth Minerals	TSX.V	BML	0.08	0.23	-65				
Lomiko Metals	TSX.V	LMR	0.03	0.03	-17				
			<i>July 3</i>						
Alkane Resources	ASX	ALK	1.23	0.59	108				
Market performance as at Nov., 2020		68.3%							
Market performance 2019 (in US\$):		88.9%							
Market performance 2018 (in US\$):		-29.5%							
Market performance 2017 (in US\$):		44.7%							
Market performance 2016 (in US\$):		68.9%							