

# Strategic Metals & Rare Earths Letter

## INTERNATIONAL

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

### Special Report – October 2017

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

### Growing number of country bans on gas and diesel cars will boost demand for lithium-ion batteries; cobalt recognized as essential component

Compared to lithium, **cobalt** is a shiny, grey, brittle metal that is best known for creating an intense blue color in glass and paints. It is not a rare element even though pure cobalt is not found in nature.



**Cobalt** occurs in conjunction with other elements in such metals as carrollite, a copper-cobalt-(nickel) sulphide; skutterudite, a cobalt-nickel arsenide and asbolane, a nickel-cobalt-manganese oxide.

**Cobalt** is obtained from the following three main types of ore deposits: (1) Sediment-hosted stratiform copper deposits such as those in the Central African copper belt in the Democratic Republic of Congo (DRC) and Zambia; (2) magmatic nickel sulphide deposits, such as those found at Sudbury Canada and at Norilsk, Russia; and (3) nickel laterite deposits, which are found in such tropical regions as New Caledonia (overseas territory of France).

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**Cobalt** is frequently used in the manufacture of rechargeable batteries and to create alloys that maintain their strength at high temperatures. It is also one of the essential trade elements (or “vitamin micro-nutrients”) that humans and many other living creatures require for good health (essential element in B2).



The **Democratic Republic of Congo (DRC)** produces roughly 60% of total global cobalt supplies estimated at around 100,000 tonnes this year. Canada (6%) Russia (5%), Australia (5%) and Zambia (4%) are also major sources.

**Most cobalt is mined as a by-product of copper and nickel production.** About 50% of refined cobalt is produced from nickel ores, 44% from copper ore, and about 6% from primary production.

The current production capacity of lithium is approximately **75 GWh globally**. However, once **Tesla's gigafactory** and other facilities built by BYD, LG Gem, Foxconn and Boston Power are completed, **the total capacity is estimated to reach 285 GWh by 2020.**

At the company level, the market is dominated by Glencore, which produced more than 28,000 tonnes last year. Reuters recently reported that Glencore had signed a major deal to sell up to 20,000 tonnes of cobalt produced to a Chinese firm, a move that would help **VW** secure car batteries for its shift to electric vehicles.

**With artisanal mining in the DRC, where individuals mine independently to produce metal often illegally under inhuman health and safety conditions, buyers of cobalt are looking for sustainability of supply making sure that cobalt does not come from child labor in the DRC.**

**With future cobalt production anticipated to shift from the DRC to traditional countries, including Canada, the USA and Australia, in the light of the earlier commenced lithium rush, this is expected to result in booming cobalt share prices.**

In this respect, it is noteworthy that First Cobalt, which has a binding merger with Cobalt One and CobalTech announced to pull out of DRC by cancelling its planned acquisition of 7 copper-cobalt exploration properties, due to the rising risks of operating in the country.

In stead, First Cobalt will focus its efforts on its Canadian Cobalt camp in northern Ontario.



**China** is the world's leading producer of refined cobalt, accounting for 50% of global production, and the leading supplier of cobalt imports to the United States. Much of China's production is from ore and partly refined cobalt imported from DRC; scrap and stocks of cobalt materials also contributed to China's supply.

In 2015 and 2016, China's State Reserve Bureau purchased cobalt for its stockpile, increasing its grip on the global cobalt market.

**China is the world's leading consumer of cobalt, with nearly 80% of its consumption being used by the rechargeable battery industry.**

#### Top-10 cobalt mine producers (Mt)

	2016	2015	Reserves
Congo (Kinshasa)	66,000	63,000	3,400,000
China	7,700	7,700	80,000
Canada	7,300	6,900	270,000
Russia	6,200	6,200	250,000
Australia	5,100	6,000	1,000,000
Zambia	4,600	4,600	270,000
Cuba	4,200	4,300	500,000
Philippines	3,500	4,300	290,000
Madagascar	3,300	3,700	130,000
New Caledonia *	3,680	3,680	64,000
Other countries	11,420	15,620	746,000
<b>World total</b>	<b>123,000</b>	<b>126,000</b>	<b>7,000,000</b>

\* Overseas territory of France

source: US Geological Survey

In 2016, global cobalt mine production decreased from 126,000 tons to an estimated 123,000 tons, mainly due to a lower production from nickel operations.

Growth in world refined cobalt operations was forecasted to increase at a lower rate than that of world cobalt consumption, which was driven mainly by strong growth in the rechargeable battery and aerospace industries.

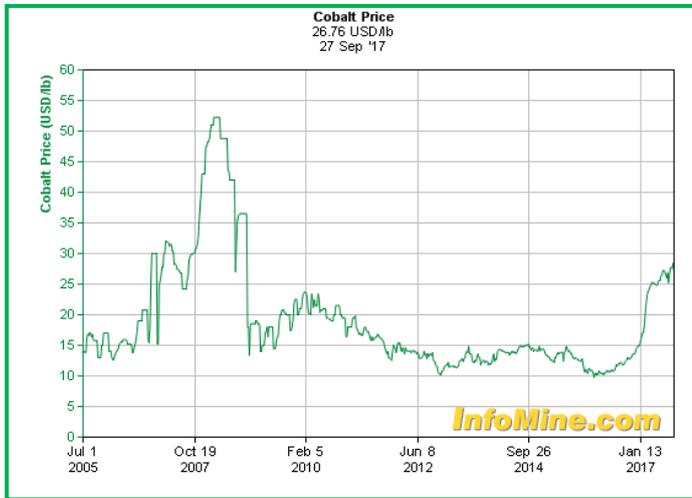
**CRU Group** estimates electric car and plug-in hybrid vehicle sales reach approximately 14.2 million by 2025 (up from 0.77 million in 2016), reflecting a combined annual growth of 38% per annum from 2016 to 2025.

The United States Geological Survey ("USGS") estimates that total global reserves of cobalt are approximately 7 million tons. The DRC holds about 48% of these reserves, followed by Australia (14%), Canada is estimated to hold 0.27 million tons or 4% of the total and the US 0.2 million tons (0.3%).

**The CRU Group estimates that the battery sector will need more than 75,000 tonnes of cobalt a year up from 41,000 tonnes this year.**

**As a result, the global cobalt market is expected to shift from surplus to deficit by next year.**

## ► Cobalt market price



In 2016, the cobalt price started to rise responding to increased demand and reduced supply. It was rising from its lows around US\$ 10/lb to around US\$ 15/lb by year-end, for about a 50% rise and is expected to more than double to US\$ 30/lb by year-end 2017.

The current cobalt price is around US\$ 27.00.

The International Energy Agency estimates a global increase to 40 million hybrid cars by 2024, with the batteries of all these cars requiring 7 kilos of cobalt. This alone would push the demand for cobalt to 280,000 tonnes by that time, which represents more than two times today's global cobalt production.

In 2014, Tesla announced that it was building a \$ 5 billion lithium-ion battery manufacturing facility called the "gigafactory" in Nevada, USA, in partnership with Panasonic. Opened in 2016, this preluded the lithium rush.

Having planned an annual production of 500,000 EV cars at some point in 2018, uses NCA (nickel-cobalt-aluminium) lithium batteries in their electric vehicles (EVs). The raw material by cost for NCA batteries is higher for cobalt than for lithium and are usually a combination of 80% nickel, 15% cobalt sulphides and 5% aluminium. NCA has the highest specific energy or power per kilogram.

Many traditional nickel manganese cobalt oxide NMC batteries, which are typically used in power tools and many electric cars, in energy storage use one-third equal parts nickel, manganese and cobalt.

NMC and NCA are the dominant batteries used in EVs and stationary storage cells and contain between 10% or 20% cobalt by weight.

## Lithium-ion battery technology the leapfrog technology for electric power tools

The lithium-ion battery technology is already in use for low power applications such as consumer electronics and power tools. Extensive research and development has enhanced the technology to a stage where it seems very likely that safe and reliable lithium-ion batteries will soon be on board hybrid electric and electricity vehicles and connected to solar cells and windmills.

The focus of the U.S. Development of Energy's (DOES's) Vehicle Technology Program is on lithium-ion based electrochemical energy storage due to the electrochemical potential and theoretical capacity provided by that system. Lithium-ion batteries can provide a reliable rechargeable storage technology. Developments in this program include lithium-ion, lithium-ion-polymer and lithium-metal technologies.

The DOE program is focused on overcoming the technical barriers associated with hybrid electric vehicles (HEV's) battery technology, namely cost, performance, safety and life.

Current lithium-ion based battery cost per kilowatt is approximately a factor of 2 too high. The main costs are associated with the high cost of raw materials and materials processing, as well as the costs of the cell, packaging and manufacturing.

Performance barriers are mostly related to the reduced discharge power at low temperature and loss of power due to use and the ageing.

Actual lithium-ion battery technology is not intrinsically safe. Short circuit, overcharge, over-discharge crush and high temperature can lead to thermal; runaway, fire and explosion.

Hybrid engine systems have an estimated 15-year life time. Battery technology needs to meet this target with a goal of 300,000 charging cycles.

#### ► Cathode materials

State-of-the-art cathode materials include **lithium-metal oxides** - such as  $\text{LiCoO}_2$ ,  $\text{LiMn}_2$ ,  $\text{LiMnO}_4$  and  $\text{Li}(\text{Ni}_x\text{Mn}_{1-x})\text{O}_2$ , **vanadium oxide**, **olivine**, and **rechargeable lithium oxides**.

Layered oxides containing **cobalt** and **nickel** are the most studied materials for lithium-ion batteries. They show a high stability in the high-voltage range, but cobalt has limited availability in nature.

**Manganese** offers a low-cost substitution with a high thermal threshold and excellent rate capabilities but limited cycling behaviour.

**Therefore, mixtures of cobalt, nickel and manganese are often used to combine the best properties and minimize the drawbacks.**

#### ► Anode materials

Anode materials are **lithium**, **graphite**, **lithium-alloying materials**, **intermetallics**, or **silicon**. Lithium seems to be the most straightforward material but shows problems with cycling behaviour and dendritic growth, which creates shortcut circuits. Carbonaceous anodes are the most utilized anodic material due to their low-cost and availability. However, the theoretical capacity is poor compared with the charge density of lithium.

Some efforts with novel graphite varieties and carbon nanotubes have tried to increase the capacity but have come with the price of high processing costs.

Alloy anodes and intermetallic compounds have high capacities, but also show a dramatic volume change, resulting in poor behaviour.

Efforts have been made to overcome the volume change by using nanocrystalline materials and by having the alloy phase (with Al, Bi, Mg, Sb, Sn, Zn and others in non-alloying stabilization matrix (with Co, Cu, Fe and Ni).

### **World EV market**

Electric vehicles EVs are divided into battery electric vehicles (BEVs) that run only on batteries and plug-in hybrids and combine battery power with internal combustion engines (PHEVs).

Cumulative sales of highway legal EVs reached 2 million units, of which 38% were sold in 2016. Sales of light-duty EVs achieved a 0.86% of market share of new car sales, up from 0.62% in 2015 and 0.38% in 2014.

The global ratio between BEVs and PEVs was 61:39 at the end of 2016.

As of 2016, **China** had the largest stock of highway legal light-duty plug-ins with cumulative sales of more than 645,000 EVs or 43% of global stock. China's FV bus market reached 173,000 vehicles in 2015.

**BYD Auto** was again the world's top-selling plug-in manufacturer with over 100,000 units. However, in terms of sales revenue, **Tesla's** vehicle sales of US\$ 6.35 billion topped BYD at US\$ 1.38 billion.

More than 647,000 light-duty passenger EVs had been registered in **Europe** representing 31.4% of global sales. Sales in the European light-duty EV segment were led by Norway (135,000 units), followed by the Netherlands (113,000) and France (108,000).

As of September 2016, 66,674 plug-in cars had been registered in **Germany** since 2010. The country is Europe's largest passenger market, but ranks only fifth in EVs.

During the first three quarters of 2016, PHEVs sales first surpassed BEVs, 17,074 BEV's were registered consisting of 7,675 BEVs and 9,396 PHEVs.

The top selling model in 2016 was the Renault Zoe (1,836).



**Germany's Volkswagen aims to make up to 3 million electric vehicles (EVs) a year by 2025 and plans to invest more than 20 billion Euros (\$ 24 billion) in zero-emission vehicles by 2030 to challenge pioneer Tesla creating a mass market.**

Planning to roll out 80 new electric car models across the VW-Group, up from a previous goal of 30, this also includes the Audi, Seat, Skoda and Porsche branch. The group wants to offer an electric version of its 300 group models by 2030.

Cobalt industry sources have told VW is moving to secure long-term supplies of cobalt. This allows automakers to offer guarantees between 8 and 10 years.

Volkswagen would need more than 150 gigawatt hours of battery capacity annually by 2025 for its electric vehicles. This would mean major purchases of necessary materials. "The procurement project is one of the largest in the history of the automotive industry, with a total order volume of over 50 billion Euros" VW said in a statement.

With the wording of the tender, it will probably also go to lithium producers, chemical producers and battery makers.

The **VW** tender specifies the chemistry for the battery will initially be 6 parts nickel, 2 parts cobalt and 2 parts manganese or 6:2:2, but that it could at the same stage switch to 8:1:1.

Analysts estimate each battery uses between 8-12 kg of cobalt. That would mean VW will need 24-36 million kg a year for 3 million EVs, which at current prices would total \$ 1.6 - \$ 2.4 billion.



On September 7, 2017, **BMW** which includes the Mini and Rolls Royce brands, announced that 12 all-electric cars and 13 hybrids will be on the market by 2025. The Company will equip all of its factories to handle combustion engines, hybrid cars and electric cars by 2020.



**Daimler (Mercedes Benz)** announced that it is accelerating its EV production program and would have 10 new EVs to market by 2022.

## German government incentives

Under its National Platform for Electric Mobility, Chancellor Angela Merkel in 2010 set the goal of putting one million EVs on German roads by 2020. The Bundestag passed the Electric Mobility Act in March 2015 that authorised local government to grant non-monetary incentives.

An incentive scene was approved in April 2016 including purchase subsidies, with a target of 400,000 EVs. Premium cars, such as the Tesla Model 3 and BMW i8, were not eligible.

As of September 2016, BMW, Citroen, Daimler Benz, Hyundai, Kia, Mitsubishi, Nissan, Peugeot, Renault, Toyota, Volkswagen and Volvo had signed up to participate in the scheme.



## Volvo cars to go all electric

Volvo cars, the premium car maker of Sweden has announced on 5 July 2017 that every Volvo it launches from 2019 will have an electric motor, making the historic end of cars that only have an internal combustion engine (ICE) and placing electrification at the core of its future business, paving the way for a new chapter in automotive history.

Volvo cars will introduce a portfolio of electric cars across its model range, embracing fully electric cars, plug-in hybrid cars and mild hybrid cars.

It will launch 5 fully electric cars between 2019 and 2021, three of which will be Volvo models and two of which will be high performance, electrified cars from Polestar Volvo cars performance car arm. These five cars will be supplemented by a range of petrol and diesel plugs in hybrid and mild hybrid 48 volt options on all models, representing one of the broader electrified car offerings of any car maker.

Volvo has stated that it plans to have sold a total of 1 million electrified cars by 2025 and aims to have climate neutral manufacturing operations by that year.

Volvo cars is one of the most well-known and respected car brands in the world with sales of 534,332 cars in 2016 in about 100 countries. The Company has been under the ownership of Zhejiang Gaily Holding of China since 2010. It formed part of the Swedish Volvo Group until 1999, when the company was bought by Ford Motor Company of the US.



## France to ban sales of petrol and diesel cars by 2040

Early July 2017 it was announced by the Macron government that France will end sales of petrol and diesel vehicles by 2040 as part of an ambitious plan to meet its targets under the Paris climate accord. Just 0.6% of new car registrations across the EU last year were pure electric vehicles, compared with 1.1% of new cars sold in France.

French car manufacturers Peugeot, Citroën and Renault are ranked first, second and third on a 2016 list of large car manufacturers with the lowest carbon emissions, according to the European Environment Agency.

French-Japanese carmaker Renault-Nissan has been an early advocate for electric vehicles, taking 14.6% of the EU market share for battery-powered vehicles.

The firm has built 425,000 of the more than 2 million electric cars globally.



The **United States** had more than 570,000 EVs of which California accounted for approximately 48% of cumulative US plug-in sales at about 270,000 units in 2016.



**Tesla Model 3** designed to attain the highest safety ratings in every category achieves 220 miles of range while starting at a price of \$ 35,000 before incentives.

The Company its giant Powerwall automotive factory and bought CEO Musk's solar company Solar City to combine them to create integrated energy generation and storage and is expected by Musk to improve efficiency 5x to 10x by 2022 to make Tesla's vehicles affordable.

During the second quarter of 2017, **Tesla** was focused on the final stages of Model 3 development. The standard model 3 starting at \$ 36,200 base price with 220 miles of range, should be available in the United States in November 2017.

The Company intends to plan 10,000 vehicles per week at some point in 2018.

International Model 3 deliveries are planned to begin late 2018, contingent upon regulatory approvals.

At Tesla's Fremont factory, the new model 3 body welding line and multilevel general assembly line are highly dense and automated. This densification sets the stage for the Company to produce over 500,000 Model 3 vehicles annually.



In February 2017, **General Motors** announced that it is going all electric, which starts with two new, fully electric models in 2018 – then at least 18 more by 2023. With Americas leading car maker believing the future is all electric, it is far along in its plan to head the way to that future world.

Last year **General Motors** sold more cars in China (3.6 million) than it did in the US (3 million).



**Ford Motor** announced a commitment to invest US\$ 4.5 billion to bring 13 new EVs to its portfolio by 2020.



**China**, the world's largest carmaker, responsible for around 30% of global passenger vehicle sales, announces end to gas and diesel cars

On September 9, 2017, it became public that the Chinese government is working on a time table to end production and sales of traditional energy vehicles, and the policy to be implemented in the near future.

On September 9, 2017, it was announced that **Tencent** will team up with Guangzhou Mobile Group ("GMC") to develop smart cars in the latest series of deals with China's big technology companies competing to grab a big piece of the world's largest car market, which produced about 28 million vehicles last year, about 30% of the world's total. GMC said that the two companies would jointly develop internet-connected cars and artificial intelligence-aided driving.

Earlier this year, **Tencent** bought a 5% stake in **Tesla** for US\$ 1.78 billion.

#### Overview of listed COBALT focused companies (by market capitalization)

30 September 2017	Trading symbol	Share price		Change in %	12 months prices		Total shares issued million	Market cap. million		
		Current 2017	Year-end 2016		H	L		local	US\$	
		C\$	C\$	C\$	C\$	C\$	C\$			
Cobalt 27 Capital	1) TSX.V	KBLT	9.500	9.000	6	13.20	7.42	24.8	235.6	188.5
eCobalt Solutions	TSX.V	ECS	1.140	0.540	111	1.48	0.46	130.4	148.7	118.9
Fortune Minerals	TSX.V	FT	0.220	0.125	76	0.34	0.10	300.1	66.0	52.8
First Cobalt	3) TSX.V	FCC	0.620	0.390	59	0.92	0.22	57.3	35.5	28.4
US Cobalt	2) TSX.V	USCO	0.640	0.200	220	0.99	0.45	53	33.9	27.1
Cruz Cobalt	TSX.V	CUZ	0.235	0.130	81	0.31	0.11	63.1	14.8	11.9
CobaltTech Mining	3) TSX.V	CSK	0.135	0.240	-44	0.45	0.11	90.5	12.2	9.8
Lico Energy Metals	TSX.V	LIC	0.105	0.135	-22	0.24	0.08	106.7	11.2	9.0
Castle Silver Resources	TSX.V	CSR	0.190	0.070	171	0.30	0.02	55.9	10.6	8.5
Global Energy Metals	4) TSX.V	GEMC	0.125	0.160	-22	0.67	0.10	35.4	4.4	3.5
			A\$	A\$		A\$	A\$		A\$	
Cobalt One	3+5) ASX	CO1	0.110	0.050	120	0.19	0.02	682.0	75.0	58.5
Ardea Resources	6) ASX	ARL	0.890	0.180	394	1.15	0.17	80.7	71.8	56.0
Cobalt Blue Holdings	7) ASX	COB	0.170	0.180	-6	0.40	0.14	95.0	16.2	12.6

1) name change from Arak Resources - effective 10 April 2017; 1 for 20 shares consolidation as at 23 June 2017

2) name change from Scientific Metals - effective May 25, 2017

3) signed Definitive Agreement with CobaltTech Mining on August 21, 2017 and Letter of Intent to merge with Cobalt One on June 23, 2017; Cobalt One shareholders will receive 0.145 of a First Cobalt common share for each Cobalt One ordinary share, representing the equivalent of A\$ 0.11 per CO1 share, based on the last trading price (C\$ 0.76)

4) announced on September 25, 2017 the acquired option from Hammer Metals for the Millennium cobalt-copper project in the heart of Mt. Isa, Queensland, Australia

5) name change from Equator Resource - effective May 26, 2017; signed Letter of Intent to merge with First Cobalt on June 23, 2017

6) listed as at 9 February 2017

7) recent spin-out of Broken Hill Prospecting

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