
# Battery Metals Report 2021

**Everything you need to know about the battery metals lithium, nickel, cobalt, copper and vanadium!**

SRC swiss resource capital ag

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# Preface

Dear Readers,

It is with pride and pleasure that we enter the sixth year of publication of our Battery Metals Report.

Our special report series started with lithium, as we see this metal, along with cobalt, nickel, copper and vanadium, as one of the great energy future metals and as a great opportunity with great potential. E-mobility is on the advance and since 2020, the eagerly awaited new models of German manufacturers but also of international volume manufacturers are finally coming onto the market. In addition, there are hybrid versions that have batteries on board in addition to the combustion engine. The ranges are increasing and with them the acceptance of the end customers, i.e. the car buyers. Volkswagen alone is planning around 70 models by 2030 in the e-sector, as are Mercedes, Audi and BMW. The electric car is now established and has won a place among consumers. At the end of 2019, there were over 8 million electric cars on the road worldwide. By the end of 2020, we should be able to break the 10 million mark despite corona. Lithium, nickel and cobalt are the main components of all batteries and accumulators available in large series and are therefore the main link in the electric car dream. Interesting are the movements in Germany, where Tesla is building a factory (Gigafactory).
Even though many do-gooders have taken up arms against the car, an automobile is still indispensable for commuters, commercial travelers and people who are active in business; not to mention personal freedom. 2020 is the year of the breakthrough for e-mobiles on a grand scale worldwide, as all major manufacturers - especially the Germans - are launching massive new e-models on the market. Away from the concept car and the study to mass production and day-to-day e-cars. All these will be enormous drivers of the demand for lithium, cobalt, nickel and vanadium, but above all for copper. In general, copper is currently being played as a recession barometer on the futures exchanges. However, according to the German government, another 30,000 charging points are to be added by 2030. That means millions of tons of copper which are not only needed for cars but especially for the charging infrastructure. 2020 should not only be the beginning of a new decade, but it looks like a decade for raw materials, as these are – and will remain – the basis of our economic activities. Supply will barely keep pace with the demand that will set in once the corona virus is overcome.

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My team and I hope you enjoy reading the Battery Metals Special Report and we hope to provide you with a lot of new information, impressions and ideas.

Yours, Jochen Staiger

Jochen Staiger is founder and CEO of Swiss Resource Capital AG, located in Herisau, Switzerland. As chief-editor and founder of the first two resource IP-TV-channels Commodity-TV and its German counterpart Rohstoff-TV, he reports about companies, experts, fund managers and various themes around the international mining business and the correspondent metals.

Tim Rödel is Manager Newsletter, Threads & Special Reports at SRC AG. He has been active in the commodities sector for more than 15 years and accompanied several chief-editor positions, e.g. at Rohstoff-Spiegel, Rohstoff-Woche, Rohstoffraketen, the publications Wahrer Wohlstand and First Mover. He owns an enormous commodity expertise and a wide-spread network within the whole resource sector.

# The electrical revolution is unstoppable! –
## A story of „weirdoes“, bottlenecks and the „new gold“

### Elon Musk‘s obsession is unstoppable – but who invented it?

Who would have thought in the year 2000 that in no less than 36 months, a „weirdo“ from South Africa would emerge and turn the entire automotive industry upside down within 20 years? Elon Musk, the eccentric South African, who as a child had been bullied and beaten to unconsciousness because of his fancy ideas and who first made headlines by inventing and selling the payment system PayPal to eBay, had the vision of a purely electric locomotion at the beginning of the 21st century and then, together with some other „weirdoes“, founded Tesla Motors on July 1, 2003. He was supposed to trigger a revolution like there has rarely been a similar one in the history of mankind. Within a very short period of time, „weirdoes“ became visionaries and Musk became the second richest person on the globe. He is one of the very few who changed or will change the world with their ideas.
But he was „only“ the one who gave the impetus for the revolution of locomotion; the actual idea of locomotion by means of an electric motor had already been put forward by some before him.
Because even before 1840, Scottish inventor Robert Anderson developed the first electric vehicle. The first known German electric car was built in 1888 by Maschinenfabrik A. Flocken in Coburg, Franconia. Although electric vehicles were considered superior at the time, vehicles with combustion engines initially prevailed. From 1910 on, driven by the strong oil industry, they were considered a cheaper alternative and eventually prevailed.

### The „electro-revolution“ prevails ...

But electric locomotion is only one of several aspects of the electrical revolution. The leap from the age of fossil combustion and the most immediate consumption possible to the decentralization of energy production, the corresponding need to store electrical energy on site and, ultimately, a true revolution in mobility has begun, but the electric boom will now really take off, and not only in automobile manufacturing. After more than 100 years of the combustion engine, the next stage of development is finally taking off, and it is called electric mobility and electric storage.

### ... and electric mobility in particular is picking up speed!

The automotive industry is clearly playing a pioneering role in this respect, because many countries have jumped on the electric mobility bandwagon, especially in order to achieve the climate targets they have set themselves, and have introduced measures that will further accelerate the move away from the combustion engine and the simultaneous shift to the electric motor.

The following states, provinces and individual cities have already formulated concrete goals:

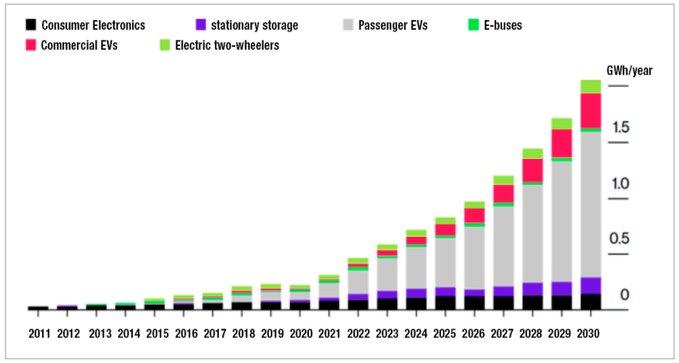
- **Canada**: End of sales of burners by 2050 - the province of Quebec wants to enforce this already by 2035, British Columbia by 2040
- **USA**: 9 states want to enforce an end to the sale of burners between 2030 and 2050, including the New England states of Connecticut, New Hampshire, Maine, Massachusetts, Rhode Island and Vermont as well as New York, California and Oregon.
- With the exception of security vehicles, **California** already no longer orders government vehicles with classic combustion engines.
- **San Francisco** is aiming for completely emission-free traffic by the year 2040. By 2025, half of all new passenger car registrations should be accounted for by electric cars. From 2030 onwards, only vehicles with electric drives are to be newly registered.
- As early as 2025, 25 percent of the cars in **Los Angeles** are to be purely electric, from 2028 only purely electric cabs will be allowed, likewise completely locally emission-free school buses from 2028, and from 2035 all delivery traffic in the city must be emission-free.
- **Mexico**: 30% electric vehicles sold by 2030
- **Brazil**: 30% electric vehicles sold by 2030
- **Great Britain:** End of sale of burners by 2030
- **Scotland**: End of sale of burners by 2032
- **France**: End of sale of burners by 2040
- **Paris**: Diesel ban until 2024, gasoline ban until 2030
- **Spain**: End of sale of burners by 2040
- **Mallorca**: End of sale of burners by 2035
- **Ireland**: End of sale of burners by 2030
- **Denmark**: End of sale of burners by 2030
- **Norway**: End of sale of burners by 2025
- **Netherlands**: End of sale of burners by 2035
- **Amsterdam**: Ban of all burners by 2030
- **Sweden**: End of sales of burners by 2035
- **Slovenia**: End of sale of burners by 2030
- **Germany**: End of sale of burners by 2050
- **Bavaria**: End of sale of burners by 2035
- **Italy**: 30% electric vehicles sold by 2030
- **EU**: 30% electric vehicles sold by 2030
- **Israel**: End of sale of burners by 2030
- **Egypt**: End of sale of burners by 2040
- **India**: End of sale of burners by 2030
- **Japan**: 30% electric vehicles sold by 2030
- **South Korea**: 30% electric vehicles sold by 2030
- **Singapore**: End of sale of burners by 2040
- **Sri Lanka**: End of sale of burners by 2040
- **China**: 20% electric vehicles sold by 2025 + end of sales of combustion engines by 2050
- **Hainan**: End of sale of burners by 2030

### Car manufacturers plan to build many millions of electric vehicles

In the EU in particular, the planned Euro 7 standard is likely to bring about the end of many combustion engines very quickly and the corresponding car manufacturers will have to switch to electric vehicles more quickly. The following company targets from early 2020 are likely to have to be revised relatively quickly:

- **BMW**: By 2025, 15 to 25% of all vehicles produced are to be powered purely electrically, which means a total of about 300,000 to 600,000 vehicles;
- The now more than 170 **Chinese car** manufacturers want to put at least 4.5 million electric vehicles on the road from this year onwards;
- **Daimler**: Ten new electric models by 2022. 15 to 25% of all vehicles produced are to be powered purely by electricity by 2025, which means a total of about 300,000 to 600,000 vehicles;
- **Ford**: By 2022, at least 13 models are to be powered electrically, which is about 10 to 25% of the complete model range;
- **General Motors**: 20 new electric models by 2023 and complete conversion to electromobility - period still open;
- **Honda**: In 2030, two thirds of all models are to run on electric motors - around 3.3 million today;
- **Hyundai**: At least 10% electric vehicle share by 2025 - 800,000 vehicles;
- **Peugeot**: 80% conversion to electric drive by 2023;
- **Porsche**: conversion of 90% of the product range to electric drives;
- **Renault/Nissan**: 1.5 million vehicles from 2021;
- **Tesla**: 1 million vehicles from 2020;
- **Toyota**: 50% conversion to electric drive and hybrid by 2030 ;
- **Volvo**: 100% conversion to electric and hybrid drive by 2022 (500,000 vehicles);
- **VW Group**: By 2025, 20 to 25% of all vehicles produced are to be powered purely electrically, which means a total of about 2 to 3 million vehicles. By 2030, 300 electric models are to be brought onto the market.

Overall, the leading car manufacturers planned to produce over 20 million electric vehicles per year from 2025 alone. This should now be noticeably faster.




*Battery growth in the coming years*

*(Source: own presentation)*

## There is currently no way around the lithium-ion battery ...

In addition to the motor, the heart of every electric vehicle is the energy storage unit, i.e. a rechargeable battery (in short: battery). In order to be operated economically in the long term, electric vehicles, but also increasingly decentralized storage systems - for example for photovoltaic or wind power plants - require ever more powerful batteries. The lithium-ion battery has now emerged as the clear favorite. One reason for this is that within a lithium-ion battery the voltage is achieved by exchanging lithium ions. Because of their high energy density, lithium-ion batteries deliver constant performance over the entire discharge period and do not exhibit a so-called memory effect, i.e. a successive loss of capacity over many years of use or frequent partial discharge. The name „lithium-ion battery“ is only the generic term for a whole range of possible chemical structures, such as the lithium-cobalt (dioxide) battery, the lithium-manganese (dioxide) battery, the lithium-iron-phosphate battery and - less commonly used - the lithium-titanate battery and the tin-sulfur-lithium-ion battery. The most common battery is currently the lithium-nickel-manganese-cobalt (NMC) battery.

## ... but the development continues steadily!

Although not much has changed in the basic principle of the lithium-ion battery over time, the development continues. Efficiency and charging capacity (often referred to as range in electric vehicles) are at the center of attention, but also the use of metals and elements. To this end, there is currently a transformation away from high percentages of cobalt (NMC 111, where the numbers indicate the ratio of nickel, manganese and cobalt) to a higher percentage of nickel (NMC 811), although development is still at an intermediate stage (NMC 622 / NMC 532). NMC 111 is considered the simplest battery version based on an equal amount of the atoms of the three elements, NMC 532/622 have a higher energy density and a lower price than NMC 111 due to a lower cobalt content and NMC 811 is the latest and most advanced battery version with the highest theoretical lithium and cobalt performance. It was precisely because of this trend towards higher nickel content that Elon Musk called Nickel the „New Gold“ in mid-2020 and literally begged mining companies to develop new nickel mines.

# Decentralized storage will clearly dominate the market in the future

### Vanadium redox batteries are better suited for use in the field of renewable energies

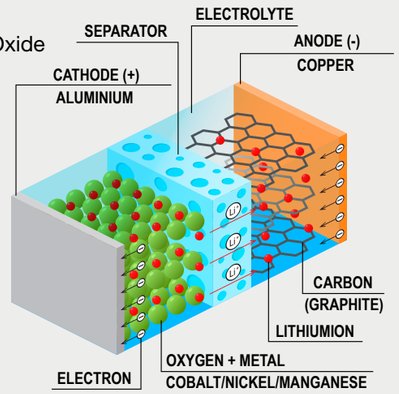
The use of lithium, cobalt and nickel in lithium-ion batteries and accumulators of the same name in automotive engineering is one side of the coin. Correspondingly larger energy storage units are increasingly being used to store electricity from alternative energy sources. The virtually explosive expansion of energy generation from wind

## Composition and operating principle of a lithium-ion accumulator

### Composition of a lithium-ion accumulator

Essentially a lithium-ion accumulator consists of the following components and materials:

- **Positive electrode (cathode):**
  Lithium-Cobalt(III)-oxide
  Lithium-Nickel-Manganese-Cobalt-Oxide
  Oxygen
  Aluminum as conductor material
- **Negative electrode (anode):**
  Graphite or related carbon materials
  Silicon
  Tin dioxide
  Copper as conductor material
- **Electrolyte (solution)**
- **Polymer membrane separator**




### Functionality of a lithium-ion battery

In simple terms a lithium-ion accumulator generates an electromotive force by the movement of lithium-ions. During charging the positive lithium-ions migrate through the electrolyte and the separator from the positive to the negative electrode. In the process the lithium-ions can move freely between the two electrodes through the electrolyte within the accumulator. Unlike the lithium-ions the transition metal and graphite structures of the electrodes are stationary and protected by a separator from a direct contact. The mobility of the lithium-ions is necessary for the compensation of the external current during recharging and discharging so that the electrodes stay largely electrically neutral. The negative electrode is a so-called graphite intercalation compound where lithium exists as cation. During discharge the intercalation compound emits electrons which flow back to the positive electrode viathe extern circuit. Simultaneously many Li+ ions migrate from the intercalation compound through the electrolyte also to the positive electrode. At the positive electrode the lithium-ions do not receive the electrons of the external circuit but the present structures of the transition metal compounds. Depending on the type of accumulator these are cobalt, nickel, manganese or iron ions that change their charge.

farms or by means of solar cells is a huge step forward in terms of environmental protection, but it is an enormous challenge for the power grids. This is because renewable energy sources often exhibit extreme fluctuations in power generation. When the wind blows or the sun shines, large quantities of Electricity is „pumped“ into the power grid. In the short term, this creates enormous overcapacities of electricity, some of which are not needed at all. According to calculations, up to 20 percent of the annual yield of a wind farm is already lost today because the turbines have to be shut down at short notice due to grid overload. This can be remedied by storage facilities that initially absorb the excess energy and later release it back into the grid when needed, i.e. when there is a threat of undersupply. The vanadium redox accumulator in particular plays a decisive role here.

### Vanadium redox battery - higher operational reliability than the lithium-ion battery, but not suitable for electric vehicles

The vanadium redox accumulator is a so-called flux accumulator, which uses vanadium compounds in aqueous solutions in both electrolytes. Vanadium redox flow cells offer a very high operational safety compared to other storage systems (especially the lithium-ion accumulators) because the electrolyte is neither flammable nor explosive due to its high water content. The currently available commercial batteries are used exclusively for stationary applications, such as in the field of regenerative energy sources for covering peak loads and as load balancing, as well as in the field of uninterruptible power supplies. By the end of 2019, more than 80 large vanadium redox flow batteries were in operation worldwide. The largest vanadium redox flow battery in Germany, with a capacity of 2 megawatts and 20 MWh energy storage capacity, was completed in Baden-Württemberg in September 2019. The largest battery in the world is also to become a vanadium redox flow battery. This is to have a capacity of 200 megawatts in northeast China and be able to store 800 MWh of energy.
For powerful electric cars, however, the vanadium redox accumulator is not an option, because the volumetric energy density of the battery is much too low, i.e. the battery needs too much space.

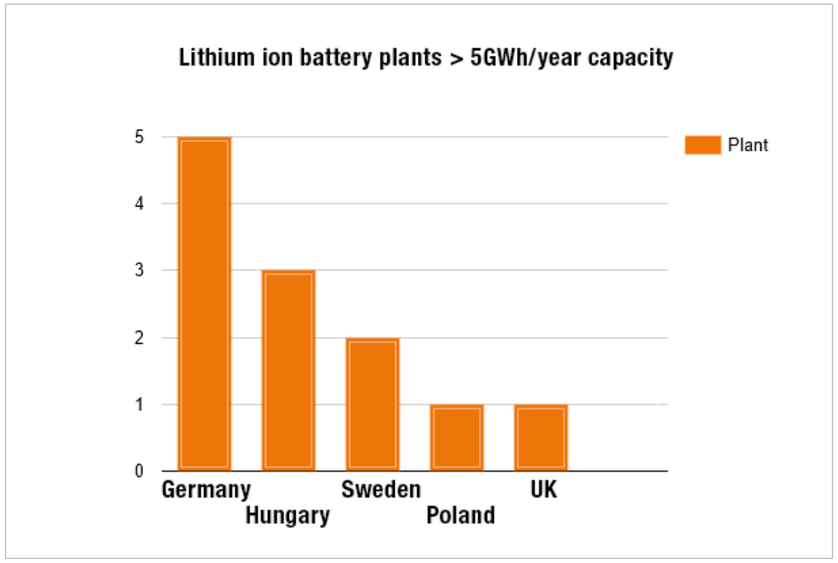
### The largest future application area for vanadium redox batteries: decentralized energy storage

So-called smart grid systems require a large number of short- and medium-term energy storage devices that can absorb too much generated energy and later, when there is no wind or sun, release it back into the grid. Vanadium redox batteries can clearly provide a remedy here by temporarily storing the over-generated energy and only releasing it back into the grid when needed. Many manufacturers are already trying out efficient vanadium redox batteries, which are to be used primarily on a decentralized basis, i.e. directly in the household of a family with a photovoltaic system on the roof or near wind farms.

## Asians dominate the battery sector

### North America is Tesla country ...

Outside Asia, North America in particular has taken the dominant position in lithium-ion battery production. Tesla Motors, in particular, has a big say in this. The company has been operating the so-called „Gigafactory 1“ in Nevada since 2016. Lithium-ion batteries, battery packs, electric motors and drive units for up to 500,000 electric vehicles per year are built there. The „Gigafactory 2“ is a photovoltaic factory located in Buffalo, New York. The „Gigafactory 3“ was completed in record time in China, near Shanghai, and will produce the same number of vehicles as the plant in Nevada.




*(Source: own presentation)*

### ... the EU is steadily catching up ...

In Germany, Tesla, is building another Gigafactory near Berlin. But CATL, Farasis, Northvolt and Volkswagen will also rely on battery production Made in Germany in the future. The furthest away is currently the Swedish company Northvolt, which is building a Gigafactory in Skellefteå in the north of Sweden, around 700 kilometers from the capital Stockholm. Initially, annual cell production of around eight gigawatt hours (GWh) is to be achieved, followed by 32 GWh from 2023. This would enable around 650,000 cars to be equipped with a 50-kilowatt hour battery. VW announced that it would enter the project with 20%. The car manufacturer is investing around 900 million euros in this project. Daimler is already one step ahead, already operates a plant in Saxony and wants to invest 20 billion euros in a battery cell production network by 2030. The partners are mainly from Asia. The EU has made a total of 3.2 billion euros available for the construction of two Gigafactories. Great Britain plans to provide 15 GWh within two years. In addition, corresponding production facilities are also planned or under construction in Hungary and Poland.

### ... but the music is made in Asia!

China alone already accounts for about one third of the total demand for lithium-ion batteries. According to expert estimates, this percentage will even increase as China continues to have by far the largest output of rechargeable batteries and accumulators. This stimulates the immense lithium and cobalt consumption of the country. It is still expected that China will continue to experience the strongest annual increase in lithium and cobalt demand of all major market players over the next 5 to 10 years, mainly due to


*China already has more than 40 major production facilities for lithium-ion batteries (Source: own presentation)*

an expected multiplication of the number of rechargeable batteries. Other major suppliers of lithium-ion batteries, including South Korea and Japan, are also expected to ensure robust growth in lithium and cobalt demand. Most notably, electronics giants Panasonic, Samsung, LG Chem, BYD, Boston Power, Lishen, CATL, Dynavolt and Great Wall.

### Further Gigafactories are already being created

Tesla is by far not the only lithium and cobalt consumer planning to increase production of lithium-ion batteries. LG Chem has already started production for Chevy in Michigan in October 2015. Foxconn, BYD (the world's largest producer of rechargeable batteries, primarily for cell phones), Lishen, CATL and Boston Power are also working on the construction of their own Gigafactories, including for so-called power banks, i.e. decentralized power storage facilities. Outside of Asia and North America there are currently only a few serious players. Worthy of mention are Northvolt from Sweden and Terra E Holding from Germany, each of which is aiming for a production capacity similar to Tesla. In China, 5 Gigafactories are currently being built in parallel. In addition, there are already about 40 larger companies producing lithium-ion batteries.

### Lithium-ion batteries are the current state of the art and market leader

In addition to the already mentioned raw materials lithium, cobalt, nickel and manganese, a lithium-ion battery essentially consists of aluminum, copper, graphite, zinc, tin, silver and steel. The majority of the (lithium-ion) batteries currently on the market are lithium-cobalt (dioxide) batteries, which is why this report focuses primarily on the battery metals lithium, nickel, vanadium and cobalt. We also want to take a look at the increasingly important copper for the first time.



# Lithium

### The element lithium

Lithium is a light metal from the group of alkali metals. It has the lowest density of all known solid elements. It is only about half as heavy as water, naturally silvery white and relatively soft. Lithium is highly reactive, which is why it is basically always found in nature as a lithium compound. When exposed to air, it tarnishes rapidly, which is due to the formation of lithium oxide and lithium nitride. In pure oxygen it burns with a bright red flame at 180°C to form lithium oxide. Lithium reacts very strongly with water to form lithium hydroxide.


### Lithium production is either lengthy or expensive

Worldwide lithium production is divided into several different branches, producing the following types of lithium compounds:

1. lithium carbonate,
2. lithium hydroxide,
3. lithium chloride,
4. butyllithium and
5. lithium metal.

Metallic lithium is usually produced from lithium carbonate in a multi-stage process and is usually traded with a purity of 99.5%. This metallic lithium is used as a catalyst in the chemical and pharmaceutical industry and for the production of aluminum-lithium alloys.

The industry essentially distinguishes three types or qualities of lithium compounds:

1. „Industrial Grade", with a purity of over 96%, mainly for glass, casting powder and lubricants,
2. „Technical Grade", with a purity of about 99.5%, mainly for ceramics, lubricants and batteries and
3. „Battery Grade", with a purity of over 99.5%, especially for high-end cathode materials in batteries and accumulators.

### There are two types of lithium deposits

Lithium is generally obtained from two different sources.

1. So-called „Brine" -, thus (salt) sheet or also brine occurrences: Mainly in salt lakes, lithium carbonate is obtained from lithium-containing salt solutions by evaporation of the water and addition of sodium carbonate. To obtain metallic lithium, the lithium carbonate is first reacted with hydrochloric acid. This produces carbon dioxide, which escapes as gas, and dissolved lithium chloride. This solution is concentrated in the vacuum evaporator until the chloride crystallizes.
2. So-called „hard rock spodumene", i.e. hard rock pegmatite deposits: Here, lithium compounds are not extracted from the salt of lakes, but from spodumene, a lithium-bearing aluminum silicate mineral. Produced using conventional mining technology, the resulting concentrate is often converted into lithium carbonate with a purity of more than 99.5%. The intensive thermal and hydrometallurgical process required for this is considered very costly. Such deposits are currently exploited almost exclusively in Australia, with most of the processing taking place in Chinese facilities.

## New processing methods and lithium sources could revolutionize production

Recently, more and more exploration and development companies have been focusing on novel technologies that will make it possible to extract lithium from brine deposits within days or even hours, instead of using natural evaporation. The processes developed by Tenova Bateman and IBC Advanced Technologies should be mentioned here.

In addition, several lithium development companies have identified a third lithium source. This offers the possibility of extracting lithium from old, depleted oil reservoirs. The lithium is extracted from the wastewater remaining in the reservoirs. The fact that this process works has already been proven several times. Moreover, this seemingly unusual method of extracting lithium also appears to be economically feasible. This means that (former) oil fields containing brine are also becoming a focus of the lithium industry.

## Larger lithium deposits are concentrated in a few regions

Lithium has a share of about 0.006 % of the earth‘s crust and is thus somewhat less abundant than zinc, copper and tungsten and somewhat more abundant than cobalt, tin and lead. The U.S. Geological Survey estimates that about 40 million tons of lithium are recoverable as reserves worldwide. Approximately 67% of this in the South American countries Chile and Argentina alone. The largest lithium carbonate production currently takes place in the Salar de Atacama, a salt lake in the northern Chilean province of Antofagasta. However, around 61 percent of global lithium production comes from Australia, albeit at much higher costs than in South America. In addition, significant lithium deposits are found mainly in North America and China.

## Lithium production is currently concentrated mainly in four countries and few companies

Australia, Chile, China and Argentina currently also account for around 96 percent of the world‘s total lithium production, with only a few companies sharing this share. As a result, the entire lithium market is very non-transparent, which is why the large battery and accumulator manufacturers such as Panasonic have recently been relying primarily on long-term supply contracts with relatively small development companies, some of which will not be producing until 2023. As a result of this supply oligopoly, lithium is currently not traded on the stock exchange either, and the actual trading prices are kept strictly confidential treated. One reason for this, which is always gladly mentioned by the few providers, is that the available and required lithium qualities are too different for a standardized stock exchange.

## Main applications are alloys, lubricants and batteries

Its above-mentioned special and versatile properties make lithium a sought-after material in many different applications. So, it should not be surprising that the main field of application of lithium has been constantly changing in the past. Initially used mainly in medicine, the element began its triumphal march as a component of alloys in the 1950s. Its low weight, but also its positive properties in terms of tensile strength, hardness and elasticity, made it an established component, especially in aerospace technology. In the past 20 years, this picture has changed once again. In the course of the incipient electrical revolution, it was quickly recognized that it was almost perfectly suited as an anode in batteries due to its low normal potential. Lithium batteries are characterized by a very high energy density and can generate particularly high voltages. However, lithium batteries are not rechargeable. Lithium-ion batteries, on the other hand, have this property. Lithium metal oxides such as lithium cobalt oxide are connected as cathode. As a raw material for the production of rechargeable batteries and batteries, however, higher purity levels than 99.5% are required. Lithium hydroxide in „Industrial“ quality is used, among other things, as a raw material for lubricants and coolants, and with the higher „Technical“ quality grade it is also used in battery and accumulator production. Lithium carbonate - crystalline, granulated or in powder form - is used, for example, in the electrolytic production of aluminum, in the ceramic and pharmaceutical industries and in alloying technology. Special purity grades of lithium carbonate in the form of very fine powder (battery grade powder) are suitable as raw material for the production of lithium ion batteries. The extraction and processing of (especially high-grade) lithium is considered very costly.

## The production of lithium-ion batteries requires a large amount of lithium

A large amount of lithium is required for the production or operation of lithium-ion batteries. Each smartphone contains between 5 and 7 grams of LCE (lithium carbonate equivalent). In the case of a notebook or tablet, this is already 20 to 45 grams. Power tools such as cordless screwdrivers or electric saws need about 40 to 60 grams for their batteries. A 10 KWh storage unit for domestic use requires about 23 kilograms of LCE, while batteries for electric cars require between 40 and 80 kilograms. An energy storage unit with a capacity of 650 MWh needs about 1.5 tons of LCE.

## Lithium production will (and must) increase strongly

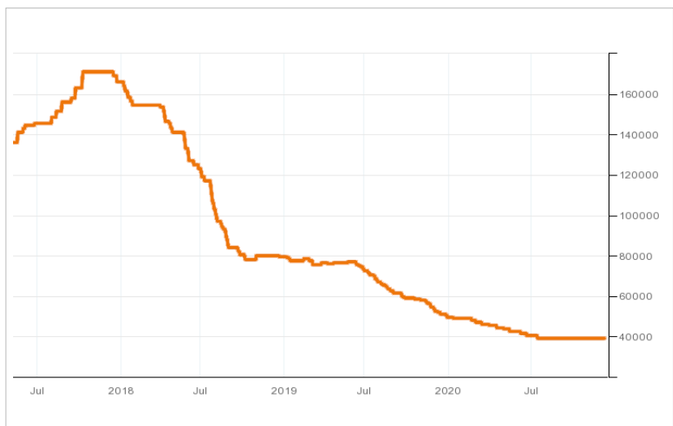
In 2018, worldwide lithium production amounted to around 175,000 tons of LCE. Projections assume that this figure could rise to a maximum of about 450,000 tons of LCE with today‘s mining activity, although very little effort has been made so far for concrete mine expansions or new mines, so that lithium is likely to run into a huge supply deficit. In addition to this, recent reports of several postponed mine starts have created additional uncertainty on the supply side.

## The decisive factor is always the price, but it is relatively insignificant for battery production!

Ultimately, it is the price alone that determines the economic recoverability of the existing lithium deposits. In mid-2015, the price of lithium carbonate was still around US$6,000 per metric ton, but since then it has soared to a peak of over US$20,500. It has currently settled at around US$ 6,500. Certainly, only a snapshot. In the medium to long term, it can be assumed that it will level off at between US$ 10,000 and US$ 12,000 per ton of lithium carbonate. Either way, this is a lucrative business for the producers, since the pure production costs for the current projects are only around US$ 1,800 (Chile) to US$ 6,700 (China) per ton. The situation is similar for lithium hydroxide. Since lithium

*Lithium carbonate price in yuan/tonne*

*(Source: own presentation)*



makes up a considerable part of a battery in terms of volume, but is only responsible for about 4-5% of the costs of a battery, the lithium price is ultimately relatively insignificant for the production of lithium-ion batteries and should therefore be kept at a level that is economically viable for lithium producers.

### Development companies work on new projects, ...

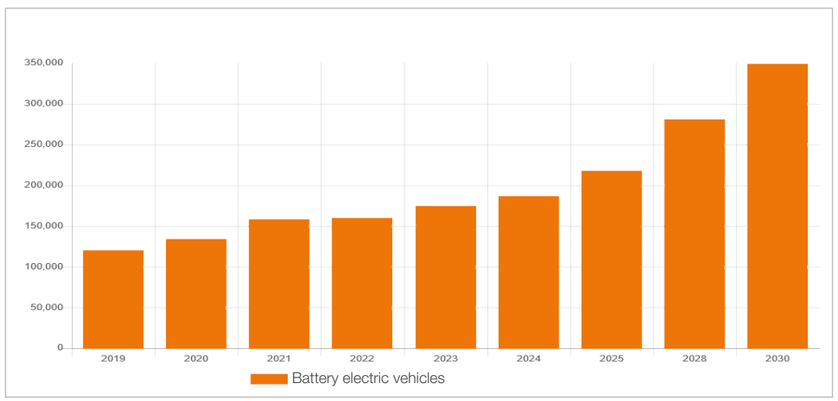
While the big names Albemarle, SQM, Livent (formerly FMC) and Tianqi have plans to expand their production, but at the same time are probably not very interested in falling lithium prices, numerous development companies are working on advancing new lithium projects and identifying specific deposits and resources.

### ... partly in new lithium hot spots

In addition to the classic lithium regions of South America and Australia, more and more North America and especially Canada, Mexico and (due to the proximity to the top consumer Tesla Motors) the USA are emerging as lithium hot spots. Another important lithium hot spot is located in northwest Argentina, where Orocobre operates the Olaroz lithium mine. There and in neighboring Chile are also several development companies that have already reported several high-caliber results, such as Millennial Lithium.

### The demand for lithium is growing rapidly!

The demand for lithium appears to be almost gigantic, not only because of the new boom sector of electromobility, but above all because of it! Whereas in the case of lithium in 2000, the demand for LCE was still around 65,000 tons, by 2017 it was already 220,000 tons of LCE per year. Experts expect the demand for LCE to rise to over 670,000 tons per year by 2025.
The main driving force will be the demand from the battery and accumulator sector and, in connection with this, the automotive industry. Industry experts expect demand for batteries and accumulators for electric vehicles alone to increase from 120,000 tons of LCE in 2019 to 350,000 tons of LCE in 2030. Assuming that currently a maximum of 450,000 tons of LCE per year can be extracted from existing mines, a supply deficit of well over 200,000 tons is indicated for 2025 alone! The outlook for 2030 is therefore even gloomier. There are signs of a bottleneck of undreamt-of dimensions.



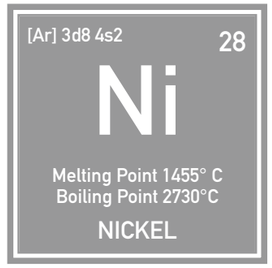

*Lithium demand due to Battery-powered vehicles in tons per year (Source: own presentation)*



## Nickel

### The element nickel

The same applies to another element that is becoming increasingly important for lithium-ion batteries: nickel! Nickel is a metallic, silvery shining transition metal. It is medium-hard, malleable and can be easily polished. Like cobalt, nickel is ferromagnetic and, in addition, very resistant to air, water, hydrochloric acid and alkalis at room temperature, which makes it ideal for use in lithium-ion batteries.




### Extraction

Most of the nickel is extracted from iron ores containing nickel and copper. By means of a multilayer process, copper-nickel fines are produced, which consist of about 80% copper and nickel and about 20% sulfur. To obtain the raw nickel, the nickel must be separated from the copper. To obtain pure nickel, the raw nickel is refined electrolytically. The purity of electrolytic nickel is around 99.9 %.

### Deposit and extraction

Nickel is found in the earth‘s crust with a content of about 0.008 %, i.e. with about twice the amount of cobalt and somewhat more frequently than lithium. Solid, i.e. nickel is rarely found in its elementary form. Until 2019, only about 50 sites for solid nickel were known worldwide. The most important deposits are in Canada, New Caledonia, Russia, Australia and Cuba.
The majority of nickel production comes from sulphide ores. In addition, lateritic nickel ores are also mined as raw materials for nickel production. Due to the exploitation of the classic sulphide deposits, the extraction is increasingly shifting to lateritic nickel ores, which, however, means more expensive extraction.

### Main application: steels and nickel alloys

Most of the annual nickel production (about 85%) is used for the production of stainless steels and nickel alloys. Nickel is one of the most important alloying metals, which is mainly used for steel refinement. It makes steel resistant to corrosion and increases its hardness, toughness and ductility. Steels high-alloyed with nickel are used in particularly corrosive environments. About 20% of the extracted nickel is used to produce nickel alloys such as constantan, nickel silver and monel.

### Other uses

Pure nickel metal is used in finely divided form as a catalyst in the hydrogenation of unsaturated fatty acids. Due to its chemical resistance, nickel is used for apparatus in chemical laboratories and the chemical industry, such as nickel crucibles for digestions. Nickel metal is used to produce nickel alloys, for example for coins. Nickel-base superalloys are alloys especially for use at high temperatures and under corrosive media. They are used, for example, in aircraft turbines and gas turbines of power plants.

### Nickel for accumulators and batteries

So-called class 1 nickel with a purity of at least 99.98% is required for batteries and accumulators. Only about 45% of the total nickel production of about 2 million per year is suitable for the production of class 1 nickel. More than half of this is needed for alloys and other applications. Less valuable Class 2 nickel is used exclusively in steel production.

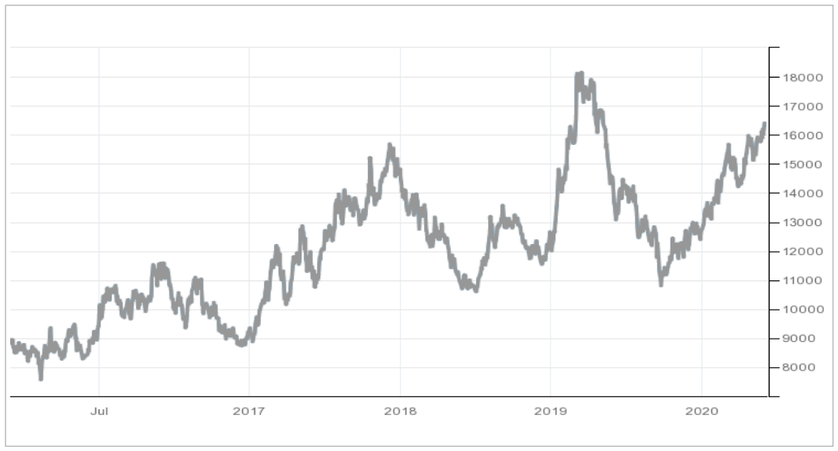
### Development from cobalt- to nickel-dominated batteries

Due to the fact that the development of lithium-ion batteries is moving more and more from cobalt- to nickel-dominated cathode materials, an already existing supply deficit is expected to widen in the coming years. For the nickel market as a whole, this has already been the case since 2016, and for Class 1 nickel, such a supply deficit is expected from 2023 at the latest, with a strong upward trend. For 2030 it is expected that 825,000 tons of nickel will be missing. In 2040 the supply deficit is expected to widen to 2 million tons per year - noting that new nickel projects are already included.

Further developments also concern the lithium iron phosphate accumulator, in which the cobalt content is almost completely eliminated in favor of iron phosphate. In addition, Toyota plans to present the first solid-state battery ready for series production at the 2021 Summer Olympics in Tokyo, which uses porous carbon as the cathode. However, the latter application is still in its infancy.

### Supply shortfall inevitable, first signs already noticeable

A foretaste of what is yet to come was provided by LME inventories, which fell from around 400,000 to around 60,000 tons between the beginning of 2018 and the end of 2019. At the same time, the nickel price rose by about 60% to around US$18,000 per metric ton during this period but is still far from its peak of US$50,000. All in all, it looks as if nickel and its producers and developers will be the next big winners of the electro(mobility) boom! It is not without reason that Elon Musk called nickel the „new gold“ in mid-2020 and begged mining companies to develop new nickel mines.



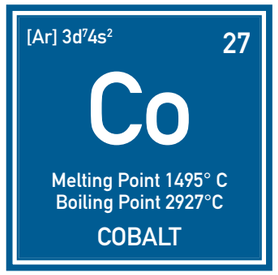

*Nickel price development over the last 5 years (Source: own presentation)*



## Cobalt

### The element cobalt

Cobalt is a steel-gray, very tough heavy metal (ferromagnetic transition metal) with a density of 8.89 g/cm3. As a typical metal, it conducts heat and electricity well; its electrical conductivity is 26 percent of that of copper. Its chemical behavior is similar to that of iron and nickel, and it is resistant to passivation in air; it is only dissolved by oxidizing acids.




### Cobalt extraction is relatively simple and inexpensive

Cobalt extraction is a well-known, relatively simple process. Cobalt is mainly extracted as a by-product from copper and nickel ores. In the first step, part of the iron sulfides present is converted into iron oxide by roasting and slagged with silicon dioxide as iron silicate. The result is the so-called rough stone, which in addition to cobalt also contains nickel, copper and other iron as sulfide or arsenide. Further roasting with sodium carbonate and sodium nitrate removes further sulfur. During this process, sulfates and arsenates are formed from part of the sulfur and arsenic, which are leached out with water. The corresponding metal oxides remain, which are treated with sulphuric or hydrochloric acid. Only copper does not dissolve, while nickel, cobalt and iron go into solution. With chlorinated lime, cobalt can then be selectively precipitated as cobalt hydroxide and thus separated. This is converted into Co3O4 by heating and then reduced to cobalt with coke or aluminum powder.

### Most of the cobalt deposits are under the seabed

Cobalt is a rare element with a frequency in the earth‘s crust of 0.004 percent. This puts it in thirtieth place in the list of elements ordered by frequency. Cobalt can be found in many minerals but is usually only found in small quantities. The element is always associated with nickel, often also with copper, silver, iron or uranium.
The world‘s known cobalt reserves are approximately 25 million tonnes, with the largest deposits being in the Democratic Republic of Congo, Zambia, Canada, Morocco, Cuba, Russia, Australia, Uganda and the United States. Over 100 million tons of cobalt are believed to be found in the earth‘s crust on the floors of the Atlantic, Pacific and Indian Oceans.

### So far, cobalt has been mined mainly in politically unstable regions

Most of the annual supply of cobalt comes from mines in the Democratic Republic of Congo. About 55% of the total production comes from the Central African civil war country. Followed by China with 6.3%. Another 5% was recently extracted from Russia, 3.7% from Zambia, 3.4% from Cuba and just under 3% each from the Philippines and Madagascar. These are all countries that are considered rather unstable or at least not necessarily inspiring confidence. The remai-

ning production is divided among Canada (just under 6%), Australia (4.15%), South Africa (2.45%) and several other countries with even lower production volumes.
Based on the current producers, future supply security appears to be extremely critical, which is why there have recently been increasing attempts to develop new mines and increase production accordingly, especially in Canada, Australia and the USA.

### Main applications are paints, alloys, medicine, magnets and batteries

Historically, cobalt has been used in the form of oxides, sulfates, hydroxides or carbonates for heat-resistant paints and pigments. Probably the best-known decorative application is blue cobalt glass. Today, cobalt is mainly used as an alloy component to increase the high-temperature strength of alloyed and high-alloy steels, especially high-speed steel and superalloys, as a binder phase in hard metals and diamond tools, as a component of magnetic alloys, as a drier for paints and varnishes, as a catalyst for desulfurization and hydrogenation, as hydroxide or lithium cobalt dioxide (LiCoO2) in batteries, in corrosion- or wear-resistant alloys and as a trace element for medicine and agriculture. Cobalt is also used in the production of magnetic data carriers such as audio and video cassettes, where it improves the magnetic properties by doping. Since the 1990s, cobalt has been used as anode material in the anode of lithium-ion batteries.

### Electric vehicles in particular require a lot of cobalt - but not only

Similar to lithium, cobalt also has a similar relationship to the quantities consumed in corresponding batteries. Thus, depending on the model, between 5 and 10 grams of cobalt flow into a single smartphone. In the case of a notebook or tablet, it is already 30 to 100 grams. Power tools need about 50 grams for their batteries. A 10 KWh storage unit for domestic use (such as Tesla‘s Powerwall) requires about 7 kilograms of cobalt, while batteries for hybrid vehicles require about 4 kilograms and those for purely electric cars 10 kilograms of cobalt. Tesla‘s Model S even comes to 22.5 kilograms. A passenger plane devours about 4,000 kilograms of cobalt.

### Cobalt supply must be increased

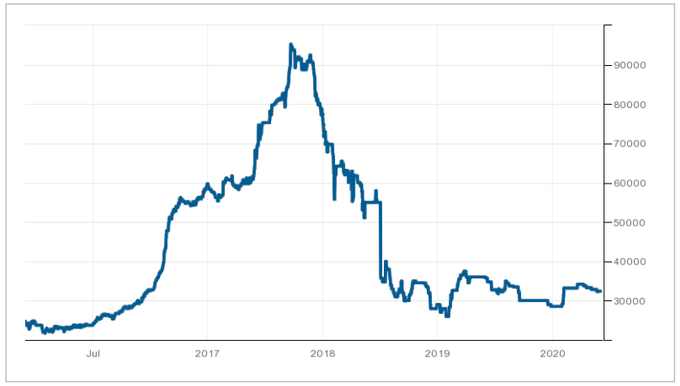
An increase in supply is urgently needed because the lithium-ion battery sector will demand ever larger quantities of cobalt in the coming years - even if the further development of batteries suggests that cobalt will be replaced more and more by nickel. While annual production in 2016 was still around 123,000 tons, leading experts believe that it will be difficult to expand this production at present. Nevertheless, it is a fact that the Congo will remain the absolute world market leader for the time being and will even increase its market share to 70% by 2021. The two world‘s largest mines, Kamoto and Kolwezi, will have a large share of this, which alone (will) produce about 50,000 tons of cobalt per year. Outside the Congo, several companies are working on expanding their existing mines (including Glencore, Norilsk, Umicore, Sumitomo and Vale), but these mine expansions are likely to be only a drop in the ocean due to the expected increase in demand.

### Cobalt Prize gives a foretaste of the years to come!

Many market participants have already recognized that cobalt production cannot be expanded so easily from now to the immediate future, which is why the price of cobalt has exploded from around US$5,000 to almost US$100,000 per metric ton since mid-2016 and is currently at around US$32,000 per ton. A similar increase can be expected when the leading car manufacturers drastically expand their model range, which is announced for 2021/2022.

### Cobalt will experience in the coming years an immense demand thrust and a supply deficit!

The demand for cobalt is expected to explode in the coming years! While in 2008 the demand was around 60,000 tons, by 2017 it was already 125,000 tons per year. By 2025, experts expect the demand for cobalt to increase to over 270,000 tons per year.
The main driving force will be demand from the battery and accumulator sector. Due to the current situation that demand is rising sharply, but at the same time only a few existing mines have the possibility to increase their production, there are signs of a supply deficit for cobalt in the coming years. This is likely to gradually increase and exceed 10,000 tons per year as early as 2021.




*Cobalt price development of the last 5 years (US$/tonne) (Source: own presentation)*

## Vanadium

### The element vanadium

Vanadium is a steel-gray, bluish shimmering transition metal which is very soft in its pure state. Although pure vanadium is relatively soft, it becomes harder when mixed with other elements and then has a high mechanical strength. Most of the vanadium is therefore used as so-called ferrovanadium in steel production. The addition of vanadium in chromium-vanadium steels leads to an increase in toughness and thus to increased resistance of the steel.

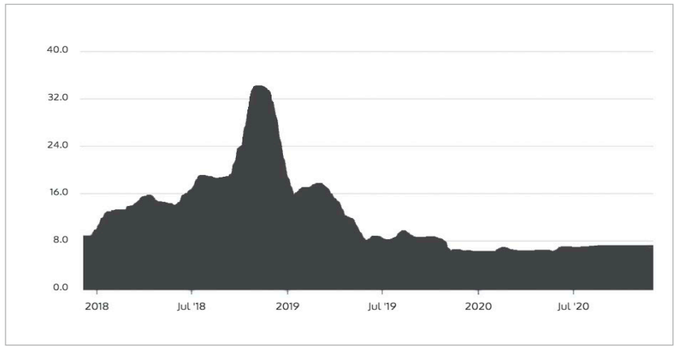

### The extraction is simple

Although the extraction of vanadium involves many intermediate steps, it has been tested over decades and is therefore now quite simple. In order to obtain pure vanadium, expensive calcium or aluminum is used as a reducing agent, since otherwise a high degree of purity cannot be achieved. While pure vanadium is obtained directly with calcium, with aluminum a vanadium-aluminum alloy is formed first, from which pure vanadium is obtained in a vacuum. However, most of the vanadium is not processed as pure metal, but in the form of the iron-vanadium alloy ferrovanadium, which contains at least 50% vanadium. In order to produce ferrova-

nadium, the slag containing vanadium and iron is reduced with ferrosilicon and lime to ferrovanadium. This alloy is sufficient for most technical applications.

## Deposit and extraction

Vanadium is a relatively common element, with a similar element frequency to chlorine and chromium. Its share in the continental crust is about 120 parts per million (ppm). The element is mainly found bound in various minerals. Despite the abundance of vanadium, deposits with high concentrations of the element are rare, many vanadium minerals are not abundant. Most of the vanadium is found in traces of other minerals, especially iron ores. The main producing countries are South Africa, China and Russia.




*Vanadium price development (US$/tonne) over the last 3 years (Source: own presentation)*

## Main field of application: (steel) alloys

91% of the vanadium mined in 2017 was used in a variety of alloys, mostly with the metals iron, titanium, nickel, chromium, aluminum or manganese. This means that vanadium has a particularly high use in buildings, bridges, tunnels and automotive parts, as well as in the aerospace industry. It is also frequently used to line pipelines and to reinforce power lines and high-voltage pylons. Vanadium is also used for many infrastructural applications, such as chemical plants, oil refineries, offshore platforms, railroad lines, railroad cars, freight containers, construction machinery and ships.

## Use in the field of renewable energies as load balancing for wind farms and photovoltaic systems

More recently, there has been a growing use in the field of renewable energies, for covering peak loads and as load balancing, often in close proximity to wind farms or photovoltaic plants. By the end of 2018, more than 60 large vanadium redox flow accumulators were in operation worldwide. The largest such battery is located in Japan and has a capacity of up to 15 MW. Some vanadium redox flow systems are also in use in Germany. The largest battery in the world is also to become a vanadium redox flow cell battery. It should be able to provide 200 MW and store 800 MWh energy. It will be installed in northeast China on the peninsula near Dalian and will consist of ten units of 20 MW and 80 MWh each.
In July 2018, the Irish company redT was awarded the contract for a similarly large project to be realized in Germany. The company signed an exclusivity agreement with Energy System Management GmbH (ESM), a German energy development company belonging to WWF solar, for the supply of two 40 MWh grid-connected energy storage projects in Germany, with a further 690 MWh of projects planned for the future.

## Vanadium price had increased sixfold in the meantime

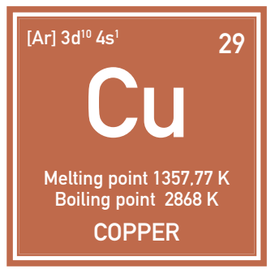
The number of plants commissioned and their size have multiplied in recent years, mainly due to the fact that ways must finally be found to make fluctuating power generators such as wind turbines or photovoltaic systems capable of providing halfway basic load capacity by means of battery storage technology. The price of vanadium has increased sixfold from the beginning of 2016 to the end of 2018 to over US$30 per pound and is currently around US$7.
Although experts predict that global steel production will grow by only 2% per year from 2017-2025, the increasing intensity of vanadium consumption combined with specific growth drivers for the end consumer will allow vanadium demand to continue to grow. Incidentally, the growth in global steel production rates has caused 87% of the increase in vanadium consumption from 2001 to 2018.

## The price of vanadium will continue to rise, since the current production is needed for steel production alone

Vanadium therefore has one advantage: the current vanadium production is almost entirely used for the production of steel alloys.
An expected demand from the area of storage technologies cannot be met at the moment. The expected exponential development of demand from this new field of application will therefore lead to an immediate supply shortage of vanadium, which is already evident from the constantly rising vanadium price. On the other hand, only few or no new vanadium mines can be brought into operation. If so, vanadium can only be increasingly extracted from old overburden, for example from uranium mines, within the next 2 to 3 years. There will clearly be a need for new primary mined vanadium capacity in the future, which historically has always been a major challenge and cannot be achieved within 2 or 3 years. Thus vanadium will become a boom element that has been relatively unnoticed so far, because one thing is certain: the decentralized storage of excess energy will become THE decisive issue in the future in the question of where base loadable energy for „filling up“ millions of electric vehicles will come from.

# Copper

Although copper is not a classic battery metal, nothing works without the red metal in the implementation of the electrical revolution. Copper has the property of being the most conductive of all known metals after silver. And a world of electromobility and electrical storage cannot function without a reliable connection between the individual electrical components.




## The element copper

Copper is a chemical element with the element symbol Cu and the atomic number 29. Like silver and gold, it is one of the transition metals that occur in nature in a solid, elemental form. The name copper comes from the Latin cuprum, which is derived from Cyprus, where the most important copper mines were located in ancient times. It is the 26th most common element in the earth‘s crust (proportion of about 0.006 %) and has been mined for about 7,000 years. Copper has a reddish luster and, as a relatively soft metal, is easily malleable and tough. It has a very high thermal and electrical conductivity.

## Occurrence and extraction

There are several thousand sites around the globe. Significant copper production exists in only a few regions. Chile was by far the leader in copper production, with an annual production of 5.8 million tons. It was followed by Peru (2.4 million tonnes), China (1.6 million tonnes), the USA (1.2 million tonnes) and the DR Congo, also with 1.2 million tonnes. These five states together account for about 60% of the world production of about 20 million tons per year. The top 10 copper producing nations also include Australia, Zambia, Russia, Mexico and Indonesia. China is by far the leader in smelting.
Copper is obtained by smelting and refining. The corresponding processes have long been matured, and processing is correspondingly simple and relatively inexpensive.

## Most important properties: High thermal and electrical conductivity, soft, antibacterial, red

By far the most important ability of copper is its high current conductivity. Its conductivity is only slightly worse than silver and much better than gold, but copper is much cheaper than the other two metals. Since all impurities dissolved in copper, especially impurities such as phosphorus and iron, greatly reduce conductivity, the highest purity levels are often required for conductor materials. Its softness and red color also make it interesting for the jewelry and art industry, among others in the form of alloys (brass, bronze, nickel silver, red gold). In addition, it has an antibacterial, partly antiviral effect and can render bacteria, viruses and fungi harmless within a few hours.

## Main application areas: Electrical engineering, piping, art, construction

By far the largest area of application for copper is in electronics and electrical engineering as well as in piping, i.e. infrastructure. Among other things, it is used for electrical lines, switch wires, power cables, overhead lines, conductor tracks on printed circuit boards, wire windings in transformers, chokes/coils and in electric motors. Furthermore, as cable connection between electrical components such as batteries, motors and applications. Further applications are water piping, roofing, glass coating, tableware as well as in arts and crafts for the production of printing plates for copper engraving and etching and in the jewelry sector for alloys.

*Copper price development over the last 5 years (Source: own presentation)*

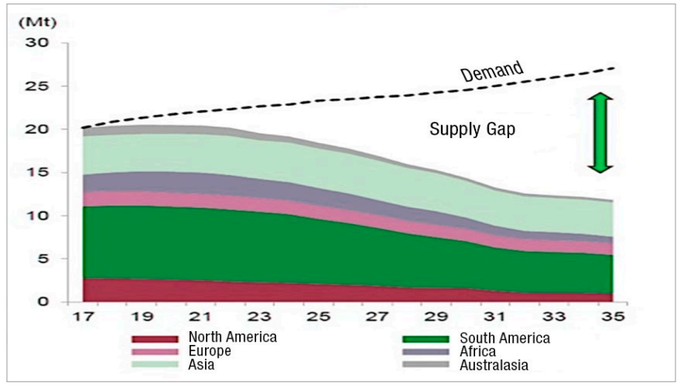



## Supply shortfall already exists de facto – expansion very likely

The International Copper Study Group calculated a supply shortfall of 340,000 tons for 2019. A similar development is estimated for 2020. The data from the first nine months of 2020, for example, suggest that there will be a supply shortfall of around 290,000 tons at the end of the year. Due to the fact that in the future more and more copper will be used in electromobility (an electric car needs about 90 to 100 kilograms of copper, while an internal combustion vehicle often manages with 20 kilograms), but also in the connection of regenerative power generators with the power grid (an onshore wind power plant needs about 5,4 tons of copper per megawatt, an offshore wind power plant even 15.3 tons of copper per megawatt), experts expect a gap of no less than 15 million tons per year, i.e. about 75% of current production, to open up by 2035. Furthermore, stimulus programs of many governments are likely to lead to a further boom in demand for copper.

## Mining activities no longer keep pace with higher demand

In addition to an expected increase in demand from currently about 20.5 million tons of copper per year to 25 million tons in 2030 and 28 million tons by 2035, copper production is expected to decline to about 13 million tons with the current mines. This is because the expansion of existing mines currently accounts for the majority of new copper production, which is to be commissioned by 2025. After that, new projects will be necessary to close the growing gap expected by analysts. However, this will require considerable investment amidst the strong performance of other commodities during the pandemic, especially gold. This is because many copper projects benefit from the production of valuable by-products such as gold, silver, cobalt and molybdenum, without which copper mining would often not be possible or profitable. Another aspect is the lack of exploration for large copper projects, which has been extremely sparse in the past ten years.

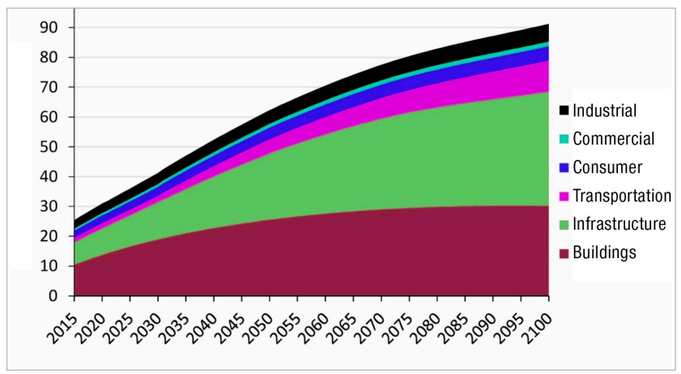



*(Source: own presentation)*

## There must be an upward adjustment of the copper price

As a result, there is currently a lack of high-quality development projects. Since the quality of many new copper projects is far inferior to that of current mines, an increase in production, i.e. the exploitation of mines of poorer quality, can only be achieved by adjusting prices. Copper speculators have recently recognized that this is the case and have caused the copper price to rise.

*Copper demand in the coming years (Source: own presentation)*



## Conclusio:
## The electrical revolution is just beginning to take off and will lead to a long-lasting boom in lithium, cobalt, nickel, copper and vanadium!

The demand for lithium, cobalt, nickel, vanadium and, to a lesser extent, copper will be determined by three different parties:

1. From the Asian electronics companies, which are mainly focused on the mass production of powerful lithium-ion batteries and accumulators for everyday use, in multimedia devices, etc.
2. By the automobile manufacturers and (initially) first and foremost by Tesla Motors, but also by almost all established automobile manufacturers worldwide.
3. From the manufacturers of decentralized energy storage systems, which are used wherever electricity is generated by photovoltaic or wind power plants and is to be used later by means of storage.

This constellation will cause the demand for lithium, cobalt, nickel and vanadium to increase in the coming years, in some cases many times over, and will also increase strongly for copper, whereby it is precisely the decentralized storage facilities that are likely to generate the greatest growth in demand and even overshadow the other two areas.

A summary of what is described above is therefore not too difficult, a look at the most important number estimates is basically sufficient. The number of electric vehicles will multiply in the coming years: From 1.2 million electric cars in 2017 to at least 20 million electric vehicles per year from 2025 onwards. 25 million electrically powered vehicles per year are expected from 2030 onwards, and from 2040 onwards as many as 60 million vehicles per year. In parallel, the demand for lithium-ion batteries will rise from 21 GWh in 2016 to 1,550 GWh in 2028! By 2021 alone, capacity demand will rise to an estimated 270 GWh, driven by the expansion plans of the upcoming storage production giants LG Chem, Samsung SDI, CATL, Lishen, Tesla and others.

### Procurement from dubious sources and China‘s market power in reprocessing

Lithium, cobalt and also graphite belong to the so-called „red group“ in the EU and thus also in Germany, i.e. materials with a very high supply risk. Most of them come from countries with dubious mining methods or high political risk. In addition to the actual procurement risk, issues such as lack of environmental compatibility or lack of social acceptance also play a role here. Another crucial point is that China currently controls a large part of the cobalt and lithium processing. A circumstance that will lead to either more projects outside China‘s sphere of influence or higher prices in the future. Recycling does not play any role at the moment and therefore cannot be seen as a source of needed materials.

### The upcoming supply shortfall will reward especially the advanced developers

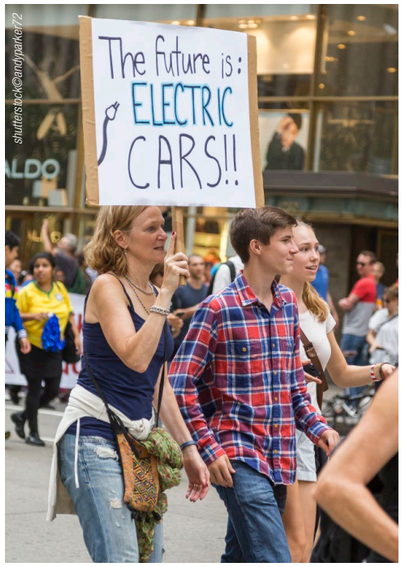
Overall, there are signs of a supply shortfall for the lithium, cobalt, nickel, copper and vanadium markets in the near future, as the increase in demand is likely to exceed the increase in supply (by far) in the future. However, due to the ongoing corona crisis and the associated expectation of additional purchase incentives for electric vehicles, it is now assumed that the supply shortage will be brought forward from around 2025/26 to 2023. Recent reports of projects that have come to a standstill, where production has been cut back and expansion plans have been delayed, strongly indicate this.



Since there is no end in sight to the increase in demand beyond 2025 and there are no major production projects in the pipeline worth mentioning, this situation is likely to continue for the foreseeable future.

The development companies in particular, which have already advanced their respective projects to a high degree, should offer the greatest opportunities for share price gains in the coming months, also with regard to possible consolidation, i.e. through takeover scenarios.

Some of these committed development companies, but also prospective producers, are introduced to you in the following.




*Demonstration for environmental awareness during the People's Climate March 2014, New York, USA*

## Interview with Tobias Tretter –
## Manager of the Structured Solutions Next Generation Resources Fund

***Mr. Tretter, the battery metal sector is slowly regaining momentum, after Tesla, among others, announced that in the future there could be a considerable supply shortage of nickel in particular, and that the search for lithium producers is being actively pursued. Even Trump stepped in and signed a decree that classified a total of 35 metals or elements as strategically important and scarce for the USA, including lithium and vanadium. Where are the battery metals heading?***

I believe we are at the threshold of Lithium 2.0 and the beginning of a new bull market. Electromobility is still in its infancy and only just beginning its breakthrough. Politicians worldwide have set themselves the goal of making electromobility competitive as quickly as possible and increasing the share of electric vehicles worldwide. In my opinion, the goals proclaimed by the automotive industry and also by politicians are very ambitious and probably not feasible in this form. Take Tesla as an example. At Battery Day, Elon Musk announced his intention to sell up to 20 million electric cars per year by 2030. If his ambitious plan works out, Tesla alone would need about 3 million tons of lithium per year. However, the current worldwide lithium production is only about 350,000 tons. Production would therefore have to increase more than eightfold in the coming years - just for Tesla alone. In addition to Tesla, however, there are other car manufacturers with ambitious plans, and it should not be forgotten that lithium is not only needed for electric cars, but also for cell phones, dis-

Tobias Tretter has been active in the mining sector since 2000. During his activity at Dr. Jens Ehrhard Wealth Management he supported the management of the DJE Gold & Resources Fund, which was awarded as the best performing commodity fund of 2003. From 2005 to 2008 he co-managed the Stabilitas Funds, which have been awarded as the "best performing Gold Fund" in 2006. Since 2009, Mr. Tretter acts as CEO and responsible person for the Index- and Portfolio-Managements of Commodity Capital AG. He is managing the Commodity Capital Global Mining Fund (ISIN: LU0459291166), the Structured Solutions Next Generation Resources Fund (ISIN: LU0470205575) and the Managed Accounts of Commodity Capital. Tobias Tretter holds a business diploma degree from the University of Bayreuth.

plays or even porcelain. You can certainly already imagine how realistic it is that lithium production can be expanded so exponentially. The example of lithium is representative for all battery metals, which are all facing an enormous double-digit increase in demand.

***Which battery metals will play the most important role in the future and why?***

The most important battery metal is and will continue to be lithium. Lithium is the main component, regardless of the composition and technological progress of batteries, and we do not see any efforts on the part of the industry to replace lithium. The situation is different for cobalt. Cobalt will play an increasingly insignificant role in future batteries and will have completely disappeared with the solid-state batteries at the latest. However, the situation is different for manganese and especially for nickel. Both will play a much more important role in the coming battery generations. However, it is also important to know that the majority of nickel and manganese production is consumed in the steel industry and that the nickel and manganese used here does not meet the requirements for the new batteries. For batteries, it is particularly important that there is no impurity in the nickel or manganese used. In addition to the raw materials needed for the battery itself, however, one should not neglect the demand for copper, which is needed to expand the network of charging points worldwide.

***What do you pay particular attention to in a battery metal mining company or a corresponding resource?***

The most important criterion for our investments is the management of the company. Apart from the fact that too little investment has been made in the battery metal sector in recent years, the main problem is not to find a good project, but an experienced management that can bring the project successfully into production. In addition, ESG criteria play a decisive role for us and are one of the reasons why we regularly visit our investments and seek contact with the local population. In the end, who can give you better information than the local population, who either work on the project every day or know someone who does? Besides management, we also try to minimize political risk and focus our investments on North America and Australia. Especially in the lithium sector, there is no way around investments in Argentina and Chile, but we try to keep the risks manageable here and carry out a particularly intensive due diligence.
In addition to the points mentioned above, we are also trying to invest in companies that can go into production under their own steam in the next 5 years and thus profit directly from the positive upturn in the coming years.

***Where do you see the main focus in battery production in the future? Are the Asians and Tesla really already ahead of the rest of the world or is there still hope, especially for Europe?***

Currently, the main focus of battery production is certainly in Asia, and they are certainly a step ahead of the rest of the world. However, this will have to change in the medium term. Especially in China, mainly electricity from coal is used for the production of lithium batteries and it leads the idea of electromobility ad absurdum if the batteries are produced energy-intensively with the „dirtiest“ way of energy production and then have to be transported to Europe or North America. It is certainly an interim solution, but in the medium-term batteries for European cars must be produced in Europe and American ones in America. I think we are also on the right track here and see massive investments in the expansion of battery capacity in Europe. Last but not least, battery production must also be decentralized and become independent of Asia, otherwise one of the most important industries in Europe will become dependent on Asia and especially on China. And to come back to the example of Tesla and the 3 million tons of lithium required. In the event that lithium becomes scarce, the question arises as to who will be supplied first from China? Europe or domestic Chinese production? So, Europe has no choice but to invest massively in new battery capacities itself and I see Europe on the right track here.

***It is often read that the purely electric car is only an intermediate technology towards fuel cell driven vehicles. Do you share this opinion?***

I am very often asked about hydrogen and fuel cells, but I do not see hydrogen as a replacement for the lithium battery for the electric car. First of all, it has to be said that fuel cells also have a battery, because the battery has to balance the power fluctuations. The fuel cell technology needs a constant energy consumption and especially in passenger cars this is not given by frequent breaking and acceleration. So, there is no getting around the lithium battery, it just turns out a little smaller. Hydrogen is used in fuel cells as an alternative source for the production of electricity and has considerable disadvantages, especially in terms of efficiency. Electricity is not stored directly in the battery but is used in the electrolysis process to produce hydrogen, which then has to be expensively stored to be converted back into electricity. In this respect we do not assume that the fuel cell will be able to establish itself for passenger cars. However, the situation is completely different, especially in the area of heavy transport, buses or ships, and we see very good chances for fuel cell technology to become established. In the case of electric cars, the trend is clearly in the direction of solid fuel batteries. The solid fuel battery is a quantum leap compared to the lithium batteries currently in use and will make the electric car more than just competitive with the combustion engine. However, the solid-state battery is still a few years away from series production and we are looking forward to the Olympic Games next year. There, Toyota wants to present the first car with a solid fuel battery.

***You are manager of the Structured Solutions Next Generation Resources fund. Which battery metals or equity securities does this fund cover?***

We established the fund in 2009 to give investors an opportunity to benefit from the switch to electromobility. Primarily, the portfolio contains over 60% lithium companies. In addition, we are currently also expanding the nickel and manganese companies. However, it is difficult to find companies that not only claim to be able to produce battery-grade nickel or manganese for themselves, but actually do so. 95% of the companies we investigate can unfortunately only produce battery-grade material on paper, but not under realistic conditions. We also have a few technology companies in the battery sector, two platinum and palladium exploration companies and a few companies in the gold and silver sector in our portfolio. Over 50% of our portfolio is invested in North America, 25% in South America, 15% in Australia and 10% in Asia and Europe respectively. We have positioned the fund to take advantage of the growing demand for electric vehicles in the best possible way and continue to focus not only on the development of battery metals but also on identifying the best companies within the sector.

# Canada Nickel

## One of the world‘s largest nickel deposits on the verge of an initial assessment of economic viability

*Mark Selby, CEO*

Canada Nickel is a Canadian mining development company specializing in the battery metal, nickel. The company was listed at the end of February 2020 after a successful private placement of CA$6.8 million. Canada Nickel owns 100% of the Crawford nickel-cobalt sulphide project, which hosts one of the world‘s largest nickel deposits in an established mining camp and is adjacent to existing infrastructure north of Timmins, Ontario, Canada.

### Flagship Crawford project – location and infrastructure

The Crawford nickel-cobalt project, which covers approximately 2,300 hectares, is located approximately 35 kilometers north of the mining town of Timmins, within the Timmins Mining Camp of the same name, which has a history of over one hundred years as a mining district. Highway 655 runs directly through the project site, as does a 550kV power line. The Lower Sturgeon Falls Hydroelectric Generating Station is only three kilometers away. Glencore‘s Kidd Creek Mine and Mill site including train connection is only about 10 kilometers away, the Hoyle Smelter/Refinery is about 40 kilometers by road and 25 kilometers by rail from Kidd Creek. Timmins itself has sufficient experienced mining personnel.

### Crawford Project – Limited Historic Exploration Activities

The Crawford project has only recently moved into the focus of modern exploration. In the 1960s, Inco drilled several holes, all of which indicated large nickel anomalies. Minimal exploration was conducted in the 1970s and 1980s. By 2011, the entire area was owned by forestry companies, so that no exploration took place for several decades and the project was almost forgotten. In addition, no nickel outcrops were found on the property. In 2011, Noble Mineral Exploration Inc.(“Noble”) finally acquired the project. The mineralization at Crawford is contained within a serpentinized ultramafic area that has a distinct geophysical signature. Crawford has several structures with approximately 7.9 kilometers of strike length.

### Crawford Project – Resource

In October 2020 Canada Nickel released a new resource estimate based on the Canadian NI43-101 resource calculation standard. This showed that Crawford hosts a resource with a higher grade core of approximately 283 million tonnes of Measured and Indicated resources of 0.31% nickel, 0.013% cobalt and 0.040 g/t palladium + platinum within a total Measured and Indicated resource of approximately 657 million tonnes of 0.26% nickel and 0.013% cobalt. In addition, a higher grade inferred resource of approximately 140.5 million tonnes containing 0.28% nickel and 0.013% cobalt within a total inferred resource of approximately 646 million tonnes containing 0.24% nickel and 0.013% cobalt. This places the Crawford resource among the 12 largest nickel deposits in the world!

### Crawford Project – Exploration Potential

Although the Crawford resource already appears huge, only about 4.2 kilometers of the total strike length of 7.9 kilometers have been drilled to date. This resource (Main Zone) alone is still open to the west. The higher-grade core area has been defined for 1.8 km long by a width of 150-220 meters and to a depth of approximately 650 meters. There is also enormous potential, especially at depth. For example, a borehole could be drilled to a vertical depth of 850 meters. The analyzed sample contained on average 0.31% nickel, 0.013% cobalt, 0.022g/t palladium and 0.008g/t platinum over 901 meters. Continuous drilling has been conducted throughout 2020 and has produced some spectacular results. For example, 27 metres of 0.40% nickel plus cobalt, palladium and platinum. In addition, a new zone called the East Zone was discovered in May 2020. There, 256 meters were recovered including 0.30% nickel and 0.05g/t palladium + platinum. In October 2020, Canada Nickel announced the discovery of a third zone called the West Zone. The Company initially drilled 4 holes and returned 30 metres of 0.29% nickel and 0.014% cobalt ending in mineralization.

### Crawford project – Platinum-Palladium discovery

In March 2020, Canada Nickel announced the discovery of a new palladium-platinum zone discovered through drilling. Several drill holes intersected this zone, starting at bedrock contact and extending to a depth of 500 metres over a strike length of 600 metres. The separate PGM zone returned grades of up to 2.6g/t palladium + platinum over 7.5 metres. With palladium prices in excess of CA$3,000 per ounce and few new palladium discoveries worldwide, the discovery of this new multi-gram near-surface palladium-platinum zone, which is parallel to Crawford‘s existing nickel-cobalt palladium resources, underscores Crawford‘s significant potential and provides additional options in the development of the project.

### Extension of the Crawford project

In March 2020, Canada Nickel announced that it had reached an agreement with Nobleto to expand the Crawford project. Under the terms of the agreement, the company will pay CA$500,000 in cash plus 500,000 treasury shares to acquire the Crawford Annex area. This covers 4,909 hectares. In addition, Canada Nickel may acquire up to 80% of the other 5 option areas, Crawford-Nesbitt-Aubin, Nesbitt North, Aubin-Mahaffy, Kingsmill-Aubin and MacDiarmid, ranging in size from 903 to 5,543 hectares, subject to various one-time payments and exploration expenses. In July 2020, Canada Nickel announced that it had identified a total of 7 nickel containing structures on the new concessions, each of which extends from 150 to 600 metres in length over a strike length of approximately 30 kilometers. Airborne geophysical surveys were conducted in October 2020.

### Profitability analysis

In June 2020, Canada Nickel commissioned an independent preliminary economic analysis (PEA) to be completed by the end of 2020. To this end, the company also appointed Christian Brousseau, an experienced engineer and project/study manager, as project director.

### Creation of NetZero Metals

In July 2020, a wholly owned subsidiary, NetZero Metals, was established to commence research and development of a processing plant in the Timmins region to utilize existing technology to produce carbon-free nickel, cobalt and iron products. The Company has applied for trademarks for the terms NetZero NickelTM, NetZero CobaltTM and NetZero IronTM in the United States, Canada and other jurisdictions related to the carbon-free production of nickel, cobalt and iron products. Canada Nickel will explore the potential for the production of nickel and cobalt products from existing pyrometallurgical processes such as roasting, sulfation and reduction using electric arc furnaces (which use natural gas as a reducing agent in place of coke or coal), with waste gases captured and diverted to capture the CO2 through the waste rock and tailings from the Crawford Nickel-Cobalt Sulfide Project.

### Successful and experienced management

Canada Nickel has a successful and experienced management team.

Chairman & CEO Mark Selby most recently served as President and CEO of RNC Minerals (Royal Nickel Corporation) where he led a team that successfully financed over $100 million and advanced the Dumont Nickel-Cobalt Project from initial resource to a fully approved project. Since 2001, Mr. Selby has been recognized as one of the leading authorities in the nickel market.
Director David Smith is Agnico Eagle‘s Senior Vice-President, Finance and Chief Financial Officer and has held this position since 2012 and has also held the position of Senior Vice President, Strategic Planning and Investor Relations. Prior to joining the Company‘s investor relations team in 2005, Smith, a professional engineer, was a mining analyst and held a number of mining engineering positions in Canada and abroad. He is a Chartered Director who holds a director position at Sprott Resource Holdings Inc. and was previously a director at eCobalt Solutions Inc.
Director Russell Starr has over nineteen years of experience in corporate finance, investment and business development, and has held senior management and advisory positions with financial institutions including RBC Capital Markets, Scotia Capital, Orion Securities and Blackmont. Following his departure from Bay Street, Starr held senior management positions at Cayden Resources (successfully acquired by Agnico Eagle Mines Limited in 2014) and Auryn Resources.

**Summary: PEA will provide important insights!**

Canada Nickel owns 100% of the Crawford nickel-cobalt sulfide project, a completely new nickel discovery with even greater potential in an established mining camp, one of the best infrastructures in Canada. Crawford is not only one of the top 10 nickel sulphide sources in the world, but also appears to have significant platinum and palladium potential, which will be further explored in the coming months and will provide a steady flow of news.
Initial mineralogical test results also show that 89% of the nickel in the higher-grade resource areas is contained in nickel sulphide and nickel-iron alloy minerals. Crawford continues to have significant potential for expansion as only a fraction of the existing anomalies has been tested to date, as recent discoveries have clearly demonstrated. The newly acquired regional exploration targets are also exciting as they have shown the same geophysical signatures that lead to the discovery of Crawford. Given Crawford‘s proven track record, this offers much larger areas to fully develop Crawford and additional exploration targets that may potentially host nickel-cobalt deposits similar to Crawford. Initial knowledge of potential economic production will be provided shortly by the PEA that is currently being developed. Canada Nickel is in a very strong financial position, having raised approximately CA$30 million since September 2019.

# Exclusive interview with Mark Selby, CEO of Canada Nickel

***What have you and your company achieved in the past 12 months?***

We are very proud of the achievements made in our inaugural year – from private company with target with just four drill holes previously completed to one of ten largest nickel sulphide resource globally with district scale potential in one of best jurisdictions globally just outside Timmins.  Completion of latest $13 million raise allows company to deliver PEA in 2020 and complete a Feasibility Study by year-end 2021.
In October 2020, we announced an updated Crawford resource, with total M&I resources totalling 657 Mt grading 0.26% nickel for 1.7 Mt of contained nickel, a 9% increase from the maiden resource released in February 2020. Furthermore, inferred resources increased by 121% to 646 Mt.
Overall, the main zone’s higher grade portion in the measured category increased substantially by 162% to 153 Mt averaging 0.32% nickel for 485,000 tonnes of nickel, and the initial inferred resource for the East zone totals 213 Mt at 0.24% nickel for 505,000 tonnes of nickel.
Our most recent third discovery (which was on an anomaly even larger than Crawford) announced in October underscore our vision that this could be a very large nickel sulphide district scale play that could be an important source of nickel for both the high growth electric vehicle and stainless steel markets.
As reflected in the number of discoveries made this year, Canada Nickel has been aggressive with exploration efforts to answer Elon Musk’s request to find more nickel. Our footprint increased in the region with the overall land package now including seven additional different structures in addition to Crawford. Each structure has yielded historical drill intersections indicating that the geophysical targets identified are nickel bearing and we made a number of discoveries which will be followed up next year.

***What are the most important company catalysts for the next 6 to 12 months?***

Completion of the PEA by year-end 2020. Completion of the Feasibility Study by year-end 2021. Continuing exploration drilling to define district-wide set of targets. Commencing our aboriginal and community stakeholder consultations and environmental studies for the formal permitting process.
Given we have already defined and upgraded a substantial resource, with additional drilling in 2021 we anticipate making more discoveries, underpinning our strong belief that we are just scratching the surface of the nickel-cobalt sulphide potential of this property.

***How do you see the current situation on the market for battery metals?***

Very positive.  We believe that 2020, despite the global pandemic, has been a positive year for Nickel and that 2021 will continue to see that trend reinforced by market recognition that the long-term market requirements for nickel far exceeds the nickel supply in the project development pipeline.

**ISIN:** CA13515Q1037
**WKN:** A2P0XC
FR**A:** 4E0
**TSX-V:** CNC

Shares outstanding: 79.8 million
Options/RSUs: 6.6 million
Warrants: 3.0 million
Fully diluted: 89.1 million

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## Canada Nickel Company

# ION Energy

## First mover advantage and largest battery market in the world right at its doorstep

*Ali Haji, CEO*

ION Energy is a brand-new Mongolian mining development company focused on the aggressive development of lithium-brine projects and was first listed on the TSX Venture Exchange and in Frankfurt in August 2020. Management has a strong track record of resource projects in Mongolia, which is why ION Energy‘s flagship project is also located in Mongolia. The company benefits from a first mover advantage and also has the largest battery market(s) at its doorstep as potential buyers.

### Baavhai-Uul Lithium Brine Project: Location

ION Energy‘s flagship project Baavhai Uul is located in southeastern Mongolia, only about 24 kilometers by road from the Chinese border and thus from the world‘s largest battery producer. The project site covers 80,000 hectares and represents one of the largest approved exploration licenses and the first lithium brine license in Mongolia‘s history. The project is located in one of the largest and least explored salars in Mongolia.

### Baavhai-Uul Lithium Brine Project: first exploration successes

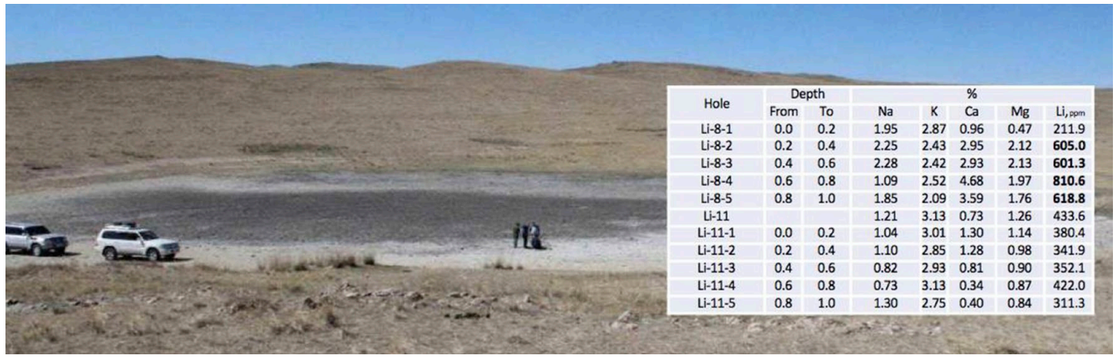
Baavhai-Uul has a high potential for a high-grade lithium brine resource, as drilling has already confirmed. Directly at surface, average lithium grades of 426ppm (parts per million) have been reported. The highest lithium concentration was 810.6ppm. All holes drilled contained lithium and also had low potassium and magnesium ratios, which favors the formation of large crystals at this elevation and at the low temperatures encountered. The project area is characterized by extremely high evaporation and low precipitation. It is a so-called endorheic basin, which has no outflow into external water bodies or the sea. Furthermore, it is home to shallow aquifers. Such volcanic and sedimentary rocks from the Cretaceous period are the most suitable aquifers for the enrichment of lithium. Another advantage of lithium-brine deposits is that they can be mined more cheaply than hard rock projects.

### Baavhai-Uul Lithium Brine Project: Upcoming Exploration Work

The Company has recently commenced a geophysics program (CSAMT), which will be followed by a seismic program. It has also purchased a truck-mounted drilling rig that can drill down to 20 meters and is already onsite, ready to be mobilized in Q1 2021. The company is pursuing a strategic and efficient drilling approach and plans to drill aggressively in the first quarter of 2021. The first two targets are targets L8 and L11, where crossed sections of 8 and 12 kilometers respectively are to be drilled at 50-meter intervals.

### Mining-friendly Mongolia with unexplored raw material potential and great locational advantages

Mongolia is generally considered a very mining-friendly country. Overall, Mongolia‘s mining industry accounts for 20% of Mongolia‘s GDP and 80-90% of the country‘s exports. The big advantage is that it is the neighbor of two huge markets: China & Russia. The low transport costs to the Chinese raw material markets are a great location advantage for raw material companies. Moreover, for decades there was no historical exploration of battery metals. The current government attaches great importance to an investment-friendly environment: The Mongolian People‘s Party (MPP) won another resounding victory in 2020, with a majority mandate for four years. Low corporate income tax and state license fees are the result. The government‘s anti-investment regulations were lifted in 2014. The country has an untapped and unlimited potential for lithium:



| Hole | Depth | | % | | | | |
|---|---|---|---|---|---|---|---|
| | From | To | Na | K | Ca | Mg | Li, ppm |
| Li-8-1 | 0.0 | 0.2 | 1.95 | 2.87 | 0.96 | 0.47 | 211.9 |
| Li-8-2 | 0.2 | 0.4 | 2.25 | 2.43 | 2.95 | 2.12 | **605.0** |
| Li-8-3 | 0.4 | 0.6 | 2.28 | 2.42 | 2.93 | 2.13 | **601.3** |
| Li-8-4 | 0.6 | 0.8 | 1.09 | 2.52 | 4.68 | 1.97 | **810.6** |
| Li-8-5 | 0.8 | 1.0 | 1.85 | 2.09 | 3.59 | 1.76 | **618.8** |
| Li-11 | | | 1.21 | 3.13 | 0.73 | 1.26 | 433.6 |
| Li-11-1 | 0.0 | 0.2 | 1.04 | 3.01 | 1.30 | 1.14 | 380.4 |
| Li-11-2 | 0.2 | 0.4 | 1.10 | 2.85 | 1.28 | 0.98 | 341.9 |
| Li-11-3 | 0.4 | 0.6 | 0.82 | 2.93 | 0.81 | 0.90 | 352.1 |
| Li-11-4 | 0.6 | 0.8 | 0.73 | 3.13 | 0.34 | 0.87 | 422.0 |
| Li-11-5 | 0.8 | 1.0 | 1.30 | 2.75 | 0.40 | 0.84 | 311.3 |

*First promising drilling results from the surface (Source: Ion Energy)*

no historical exploration in and new, little explored projects for battery minerals, but at the same time a geologically well-equipped and high-quality destination or jurisdiction.

### Strong management team

ION Energy has a very strong management team that has been operating successfully in Mongolia for over a decade and has over 100 years of combined mining and exploration experience.

Chairman Matthew Wood is currently also Chairman of Steppe Gold. He was also the founding Chairman of Avanco Resources (sold in March 2018 for AU$440 million) and HunnuCoal (sold in 2012 for US$500 million).

CEO Ali Haji is the current director of Antler Hill Mining Ltd and Spirit Banner II Capital Corp. He has over 13 years of international experience in asset management, risk analysis and program governance. He is also a consultant to ATMA Capital Markets Ltd and Steppe Gold and holds a BSc from the University of Western Ontario.

Director Bataa Tumur-Ochir is a Mongolian citizen who serves as CEO and Director of Steppe Gold. He is an advisor to the Ministry of Mining and Heavy Industry, holds a bachelor‘s degree in business administration and a diploma in international business administration and marketing from Australia and Singapore.

Director Enkhtuvshin Khishigsuren has more than 30 years of experience in resource projects for multinational companies. He has discovered several prospective gold, molybdenum and copper deposits, including the multi-million-ounce Olon Ovoot gold deposit.

Consultant Paul Fornazzari has been involved in the lithium industry since 2008 when he initially founded Lithium Americas Corp. as its Chairman (which is currently mining lithium with its partner Ganfeng Lithium) and secured the initial strategic investments from Mitsubishi and Magna International that helped launch this world-class lithium brine facility. Subsequently, he was a director of Neo Lithium Corp. (currently in the feasibility study phase). He has been involved in the extractive industry for many years and has gained insight and experience in the start-up process through various board memberships and as legal counsel.

Consultant Don Hains is President of Hains Engineering Company Limited and Managing Director of Hains Technology Associates. He is an industrial mineral exploration and economic geologist with over 30 years experience in the exploration, development, exploitation and analysis of industrial mineral properties and materials. He has a particular focus on critical and energy-related minerals such as lithium and has worked on projects around the world, including lithium and other industrial mineral projects in China


*The Baavhai Uul Projekt is located in southeastern Mongolia, only about 24 kilometers by road from the Chinese border.*
*(Source: Ion Energy)*

and Mongolia. His lithium experience covers all types of deposits, processing routes and stages of project development from exploration to plant construction. He has written numerous NI 43-101 technical and due diligence reports on lithium projects in Canada, the United States, South America, Africa, Europe, the Middle East and Asia.

### Summary: Early stage story with almost unlimited upside potential

ION Energy was one of the first to recognize Mongolia‘s great locational advantages. Its proximity to China, the largest battery market, is almost unbeatable. Furthermore, Mongolia only opened up to financially strong foreign companies a few years ago. The country‘s rich mineral resources had remained almost untouched until then. Accordingly, the country is almost unexplored in terms of exploration and has already been able to produce some top-class raw material deposits. ION Energy‘s management team is considered the pioneer of the mining industry in Mongolia and has been active in the country for more than 10 years. During this time, they identified potential high-grade lithium deposits and ultimately secured the current flagship Baavhai-Uul project. This project is so huge that it could potentially host several high-grade lithium brine deposits. If the proof of this is successful in 2021, an extremely cost-effective lithium production could be established, also due to the special climatic conditions (high evaporation, hardly any precipitation). The Company is adequately funded for the first drilling (all near surface) and should have a continuous news flow from the first quarter of 2021.
With one of the largest exploration licenses in Mongolia, ION Energy is on track to become a major player in the booming lithium market in Asia.

## Exclusive interview with Ali Haji, CEO of ION Energy

***What have you and your company achieved in the past 12 months?***

Thank you for the opportunity for ION Energy to share its story. Though we were founded in 2017, and the Mongolian government awarded our licence in 2019, the last 12 months have been very busy and exciting for our team. In 2020, ION completed its qualifying transaction, listed on the TSX in August 2020 and is now fully funded for exploration on the Baavhai Uul license in Mongolia. In September, we started publicly trading on the Börse Frankfurt and Couloir Capital announced research.

***What are the most important company catalysts for the next 6 to 12 months?***

ION Energy is currently kicking off its exploration efforts on what is one of the largest land exploration and first lithium brine exploration licence ever granted in Mongolia. Our Geophysics (CSAMT) program has just commenced, and it will be followed with a Seismic program at our site in the southern Gobi region of Mongolia. This ensures we’re taking a targeted and strategic approach to our auger led exploration efforts that will follow. The company acquired a truck mounted Auger Rig capable of drilling down to 20m, which we expect to mobilize before the end of 2020. The ION team is embarking on an aggressive growth strategy from now into 2021.

***How do you see the current situation on the market for battery metals?***

Battery metals are without doubt gaining momentum in the global markets, as we all prepare for the third wave and the clean energy revolution. Governments, one-by-one, have been announcing economic plans that focus on a green recovery in a post-covid world. Canada and UK most recently made such announcements. The EU and US also added lithium to their critical materials list. Bloomberg has estimated that global demand for lithium will increase eight-fold to 2030, as electric vehicle adoption increases, and the battery sector expands. The world is going electric, ultimately spurring demand for lithium - and ION Energy is ready for this!
ION’s Baavhai Uul site is located just 24 kilometres from the Chinese border, and we know that our neighbours have the largest consumer demand for electric vehicles. China is also the highest global manufacturer of batteries. With the first lithium brine exploration licence in Mongolia’s history, and so close to the Chinese border, ION Energy has ‘first-mover advantage‘ to meet this increased lithium demand – locally, and globally.

## ION Energy Ltd.

**ISIN:** CA4620481099
**WKN:** A2QCU0
**FRA:** 5YB
**TSXV:** ION

Shares outstanding: 48.8 million
Options/warrants: 13.0 million
Fully diluted: 61.8 million

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# Neo Lithium

## First battery-grade lithium carbonate received from the pilot plant! - Battery giant CATL on board!

*Waldo Perez, CEO*

Neo Lithium is a Canadian mining development company that has secured one of the world's largest lithium deposits within the „Lithium Triangle" in Argentina. The special thing about it: The lithium resource there is growing - day by day! The project is home to an extremely high-grade resource that is only just below the surface. A pre-feasibility study impressively demonstrated the world-class status of the flagship project Tres Quebradas. In addition, the first battery-compatible lithium carbonate was recently obtained from the company's own pilot plant. With the Chinese battery giant CATL, one of the very big players in the industry was won as a strategic partner. A feasibility study is currently being conducted.

### 3Q Project – Location and Infrastructure

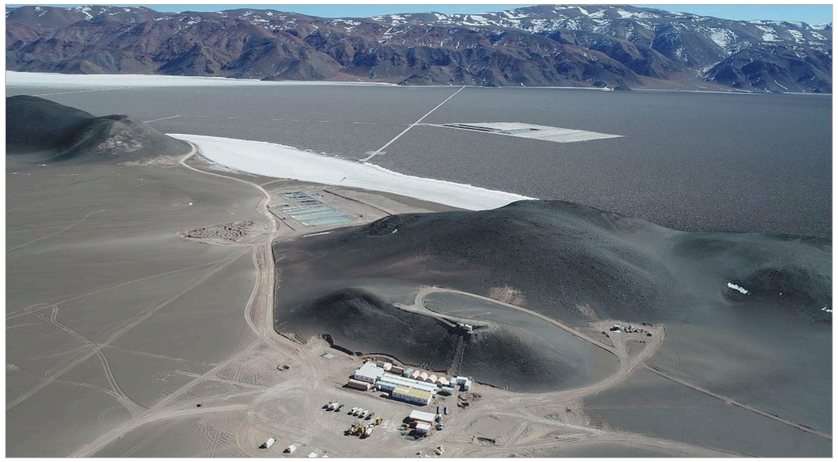
Neo Lithium's flagship project Tres Quebradas (3Q) is located in the Argentine province of Catamarca, about 30 kilometers from the Chilean border. The nearest town is located about 100 kilometers to the east. The closest highway to the project is the Ruta Nacional 60, which connects the capital Catamarca (San Fernando del Valle de Catamarca) with Copiapó and the port of Caldera via the Paso de San Francisco. The project can be reached from the highway over a 60 kilometer stretch of road in all weathers. Over US$25 million has been invested in the 3Q project. Among other things, it has a 100-person camp, a weather station, a geochemical analysis laboratory, solar and diesel power plants and a wastewater-free sewerage system.

### 3Q Project – Geothermal sources allow the deposit to grow steadily

The 3Q Project covers approximately 350 square kilometers, with Neo Lithium holding a 100% interest. The project is located at approximately 4,000 meters above sea level and consists of a complex of three brine reservoirs and three salars. This is a brine lake, of which only one more is known in China and already houses a lithium mine. What is special about the 3Q Project is that geothermal energy sources feed the northern part of the project. These contain high-quality lithium and feed the lakes and salars with about 3,000 tons of lithium carbonate equivalent per year. Isotope and mass balance studies show that the lithium mineral deposit is still in the process of formation due to evaporation from the lakes.

### 3Q Project – Big Resource, High Grades

Through more than 10,000 meters of drilling and other geophysical surveys, the company has already been able to create a hydrostratigraphic model of the salar. In addition, a resource estimate was released in 2018, underscoring the world-class nature of the 3Q Project. The salar contains a total of at least 4 million tonnes of lithium carbonate equivalent, with high average grades of 614mg/L in the measured and indicated category. The ratio of magnesium to lithium is very good at a low 3.3, with an additional 3,000,000 tons of lithium carbonate equivalent in the inferred category. The average grade is 584mg/L, the ratio of magnesium to lithium is 4.5 and the cut-off grade is 400mg/L. An even higher-grade resource has also been identified in the northern part of the salar. This contains at least 746,000 tonnes of lithium carbonate equivalent at an average of 1,007mg/L in the Measured and Indicated categories and 186,000 tonnes of lithium carbonate equivalent at 1,240mg/L in the Inferred category. The magnesium to lithium ratio is only about 1.7, with a cut-off grade of 800mg/L. Reserves were reported at 1,300,000 tonnes of lithium carbonate equivalent in mid-2019, averaging 794mg/L. The interesting thing about this is that while the southern area was drilled to a depth of 600 metres, the northern, higher grade area was only advanced to depths of



*The company is currently focusing on expanding the high-grade resources in the northern part of the lake (Source Neo Lithium)*

100 metres. This means that there is still a high blue-sky potential below.
In April 2019, Neo Lithium was able to investigate the high-grade resource below a depth of 100 meters for the first time. An average of 1,128mg/L lithium was discovered in a 137.6-meter-long section. The drill hole advanced to a depth of 160 meters. In addition, stable lithium production between 773 and 787mg/L was demonstrated during a 20-day pump test.
In June 2019, Neo Lithium intersected an average of 1,117 mg/L lithium and 11,319 mg/L potash in another well over 178 metres. The sensation is that the hole is located on the eastern edge of Lake 3Q, an area where the reserve estimate assumed that brine was only present to a depth of 10 metres, but the hole encountered brine to a depth of 265 metres.
To summarize, the 3Q project has the highest grade in Argentina, top 3 worldwide the lowest critical impurity content of any known salar worldwide and a very large resource with significant blue-sky potential!

### 3Q Project – Prefeasibility Study + Feasibility Study

In March 2019, the Company announced a pre-feasibility study (PFS). The PFS determined an after-tax net present value (NPV, discounted at 8%) of US$1.14 billion. The after-tax return on investment (IRR) is an excellent 49.9%. The capital expenditure was estimated at US$318.9 million and the operating cash cost at US$2,914 per ton of lithium carbonate equivalent. This would put 3Q in the range of the most cost-effective lithium mines in the world. Over a period of 35 years, 20,000 tons of lithium carbonate could be produced annually. According to this estimate, the payback period would be 1 year and 8 months. Compared to the scoping study, the main benefits were a reduction in capital costs and an increase in profitability from 27.9% to 49.9%. The company is currently working on the preparation of a definitive feasibility study.

### 3Q Project – Pilot Production, Pilot Plant

A complete pilot plant on a scale of 1:600 has been in operation for about two years. Neo Lithium was able to achieve a pond concentration of 3.8% lithium in the brine without the addition of additives. This makes 3Q the only project in the world that can achieve a lithium concentration of 3.8% without the addition of additives and only by natural evaporation. In 2018, a pilot plant for the annual production of 50 tons of lithium carbonate was built and installed on the project site in February 2019. This was previously successfully tested with

synthetic brine in Chile and is now being fed with brine from the 3Q project, which concentrates approximately 4% lithium from the 3Q project's evaporation ponds to start pilot-scale production of lithium carbonate at the plant. Currently, the planned annual capacity of the pilot ponds is over 500 tons of approximately 4% lithium brine per year.
In March 2019, Neo Lithium announced that it was possible to obtain battery-grade lithium carbonate with a purity of 99.535% (process compliant with the pre-feasibility study). Using an improved extraction process, a purity of 99.599% was even achieved. This new process is also to be included in the final feasibility study; whereby further cost savings are hoped for.

## Entry of the battery giant CATL

In September 2020, Neo Lithium announced the entry of Contemporary Amperex Technology Co. Limited (CATL), China's largest manufacturer of lithium-ion batteries and the world's leading EV battery manufacturer. CATL sold about 40 GWh of storage in 2019 for electric, hybrid electric and plug-in hybrid vehicles - and plans to increase this to 100 GWh in 2020. The company manufactures such storage systems mainly in China but is currently also building a production facility in Erfurt, Germany, for 1.8 billion euros. It is scheduled to start operations there in 2022 and supply BMW, Daimler, Groupe PSA, Volvo and Jaguar Land Rover, among others. CATL purchased a total of approximately 8% of the shares in Neo Lithium for approximately CA$ 8.58 million. In addition, a joint Technical Committee was formed to oversee the feasibility study and jointly determine the overall financing requirements for the 3Q Project. CATL will also receive a seat on the board of directors and has a pre-emptive right for future equity financings.

## Top management team

Neo Lithium has a top management team, of which President & CEO Waldo Perez again stands out.

Dr. Perez has 28 years of academic and industrial experience in mineral exploration in South America. He was the founder and technical director of the Cauchari Project acquired from Lithium Americas Corp. and served as its President and CEO from inception to the final feasibility study. Previously, he was CEO of Latin American Minerals Inc, Senior Geologist for Barrick Gold, IAMGOLD, Apex Geoscience and Opawica Exploration.

## Stable shareholder structure, sufficient cash

Neo Lithium has a stable shareholder structure. Over 40% of all outstanding shares are held by institutional investors such as BlackRock, Sprott, Mackenzie and CATL. About 11% of the shares are held by insiders. Neo Lithium had approximately CA$ 37 million in cash, also thanks to the CATL deal, at the end of September 2020, which is more than sufficient to complete the feasibility study and have significant cash position post feasibility study.

## Summary: Top project with world-class partner + feasibility study ahead

The 3Q Project is an active lithium deposit that is still in the process of formation, and the grade and size of the deposit continues to increase daily - almost unparalleled in the world. The pre-feasibility study clearly confirmed that the 3Q Project is one of the best, highest grade, and most cost-effective lithium brine projects in the world. Neo Lithium is working feverishly on a definitive feasibility study and will then take care of the financing of the project. The new mega-partner CATL could prove to be very helpful. The management has already proven in the past that it can bring lithium-brine projects into production within the self-imposed time schedule.



# Exclusive interview with Waldo Perez, CEO of NEO Lithium

***What have you and your company achieved in the past 12 months?***

Neolithium signed a strategic agreement with catl, a 60 billion dollars chinese company that is the largest battery manufacturer of the world. They invested 8.5 Million dollars acquiring 8% of the shares of neolithium at 0.84$ wich is the equivalent to 30% premium over 30 days volume-weighted average price. The use of proceedings is to finance the definitive feasibility study completly. They obtain a sit in the board and we will assemble a joint team to carry on the definitive feasibility study. The company will have after closing approximatly 38$ million in the treasure, one of the best financed juniors companies in the lithium space.

***What are the most important company catalysts for the next 6 to 12 months?***

We will complete the definitive feasibility study with our strategic partner catl and we expect to complete project financing and start mine construction.

***How do you see the current situation on the market for battery metals?***

Prices are improving and the tesla announcments on their demand clearly show that more projects have to come online quickly to keep up with global need for lithium. We expect prices to increase during 2021. Also, the pandemic has caused a shift of many countries towards stricter enviromental regulation on $CO_2$ emmision. Also, many automakers announced new full electric models. The penetration of electric cars is faster than every analyst expected. The battery metals industry will thrive and will be the engine of the economic recovery after the pandemic.

**ISIN:** CA64047A1084
**WKN:** A2AP37
**FRA:** NE2
**TSXV:** NLC

Shares outstanding: 128.1 million
Options/warrants: 8.5 million
Fully diluted: 136.6 million

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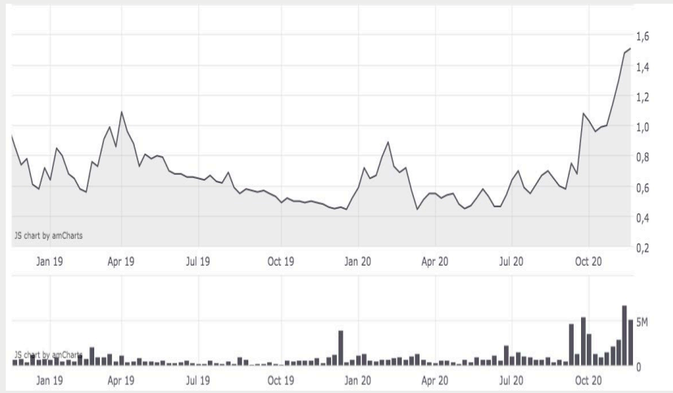
## Neo Lithium Corp.



# Sierra Metals

## Future base metal supplier for lithium-ion batteries with its three profitable mines fully on course for growth

*Luis Marchese, CEO*

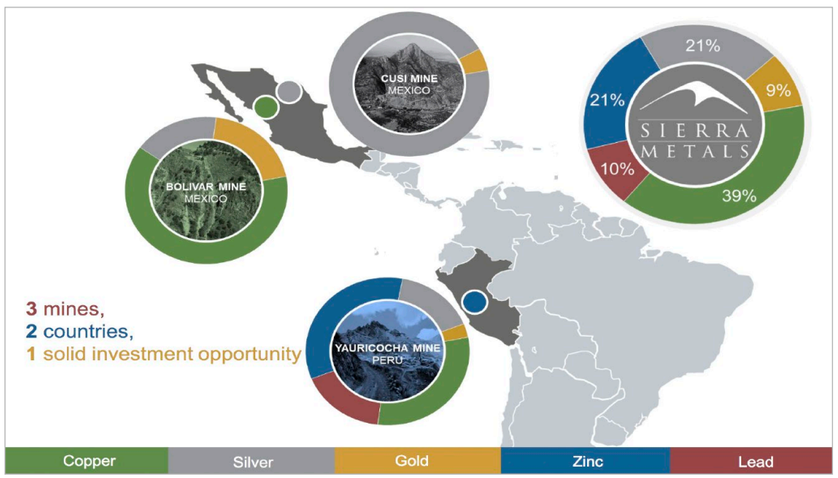
Sierra Metals is a Canadian resource producer that operates three mines in Mexico and Peru. All three mines are highly profitable and have a balanced production ratio of silver, zinc, copper and lead/gold. This alone makes Sierra Metals an absolute low-cost junior. The company plans further production increases and sees itself primarily as a future supplier for the lithium-ion industry. Its greatest strength is its exploration potential, which appears almost gigantic. Recently, excellent production and financial figures have been published. For example, Sierra Metals reported record adjusted EBITDA of US$37.2 million in Q3 2020, a 73% increase over Q3 2019.

### Yauricocha Mine – Location and production

The Yauricocha Mine is located in Peru, covers approximately 18,000 hectares and is 82% owned by Sierra Metals and has been in continuous operation since 1948! The mine has a daily processing capacity of 3,150 tons and mines silver, gold, lead, zinc and copper from underground. In the first 9 months of 2020, Sierra Metals has recovered a total of 1.373 million ounces of silver, 3,180 ounces of gold, 14.967 million pounds of copper, 24.564 million pounds of lead and 60.256 million pounds of zinc from the Yauricocha Mine. In October 2019 Sierra Metals released a new reserve and resource estimate. Yauricocha had reserves of 13.0 million ounces of silver, 210.0 million pounds of copper, 572.0 million pounds of zinc, 144.0 million pounds of lead and 136,000 ounces of gold. In addition, Yauricocha had resources (including reserves) of 29.1 million ounces of silver, 573.2 million pounds of copper, 1.075 billion pounds of zinc, 328.5 million pounds of lead and 349,700 ounces of gold.

### Yauricocha Mine – Exploration Potential

The exploration potential is much higher as only a fraction of the total project area has been drilled to date. Particular attention is being paid to the La Fortuna, Ipillo and Kilkasca zones. In the area of current mining activity, the main focus in the coming months will be on closing the gap between the Cachi-Cachi Mine and the Esperanza Zone. In addition, both the Cachi-Cachi Mine, Esperanza, and Central Mine areas are still open at depth, and therefore have the potential for additional resources.




*Sierra Metals' mines with corresponding production distribution of the individual metals (Source: Sierra Metals)*

### Yauricocha Mine – Expansion Plans

Due to the numerous new discoveries, the management decided to gradually expand the production capacity from 3,150tpd to 5,500tpd. A Preliminary Economic Assessment (PEA) published in June 2018 confirmed a return on investment (IRR) of 486% for the company in the event of a corresponding expansion. Sierra Metals plans to implement this gradually through 2024.

### Bolivar Mine – Location and production

The Bolivar Mine is located in the Mexican state of Chihuahua, covers approximately 15,217 hectares and is 100% owned by Sierra Metals. It has a daily processing capacity of 5,000 tons and produces silver, gold and copper from underground. In the first 9 months of 2020 Sierra Metals has recovered a total of 623,000 ounces of silver, 6,843 ounces of gold and 18.669 million pounds of copper from the Bolivar Mine. Bolivar had reserves of 3.2 million ounces of silver, 114.5 million pounds of copper and 53,500 ounces of gold at the end of March 2020. Indicated and inferred resources were 19.3 million ounces of silver, 703.6 million pounds of copper and 274,300 ounces of gold.

### Bolivar Mine – Exploration Potential

Starting from the current El Gallo mining area, two vents are running towards each other at depth. The Company suspects the source of the copper mineralization to be at the exact point where they meet. There, a high-grade copper porphyry may be encountered. In addition, the concession area has another 10 areas that host or may host significant resources. These include the Bolivar West Zone, where Sierra Metals has already identified high grade copper areas. A 20,000-metre drill program at La Sidra included 3.5 metres at 9.22% copper equivalent and 9.7 metres at 10.63% copper equivalent. The Bolivar West Zone included 9.2 metres at 4.05% copper equivalent and 10.5 metres at 4.26% copper equivalent.
In September 2017, Sierra Metals announced assay results from the completed definition drilling program in the West Bolivar Zone. This zone is adjacent to the current workings at the Bolivar mine. The drill program returned excellent copper, zinc and silver grades. The average grade was 2.55% copper equivalent with an average true thickness of 9.1 metres.

### Bolivar Mine – positive PEA for expansion plans

Between 2017 and 2020, the capacity of the Bolivar Mine has already doubled from 2,500tpd to 5,000tpd. In October 2020, the Company announced a PEA for an expansion to 10,000tpd. Based on a copper price of US$3.05/lb, this resulted in a net present value (NPV) of US$283 million after tax (discounted at 8%). The pure advantage over the current production of 5,000tpd is an NPV of US$57.4 million and an internal rate of return (IRR) of 27.9% after tax. The total capital costs for the 14-year mine life are therefore US$317 million. The planned expansion should be implemented by 2024.

### Bolivar Mine – Letter of Intent with Mega Partner

In September 2017, Sierra Metals entered into a letter of intent with Jinchuan Group Co Ltd to develop their Bahuerachi Copper Project. This project is immediately adjacent to Sierra Metals' Bolivar concessions. The Jinchuan Group is one of the world's largest base metal producers and North China's largest copper producer. Both companies expect the collaboration to generate synergies for both projects.

## Cusi Mine – Location and production

The Cusi Mine is also located in the Mexican state of Chihuahua, covers approximately 11,671 hectares and is 100% owned by Sierra Metals. It has a daily processing capacity of 1,200 tons and mines silver, gold and lead from underground. Since 2017 the production has been successively expanded from 650 to 1,200 tpd and in a second step to 2,400 tpd by 2024.
In 2019, Sierra Metals recovered a total of 547,000 ounces of silver, 385 ounces of gold and 776,000 pounds of lead from the Cusi Mine. In February 2018 Sierra Metals was able to release a new resource estimate for Cusi. According to this, the mine had 50 million ounces of silver equivalent at that time.


*The Santa Rosa de Lima complex is located within a regional structure that extends for approximately 64 kilometers. (Source: Sierra Metals)*

## Cusi Mine – Exploration Potential

Sierra Metals announced in February 2017 the discovery of a new high-grade silver intercept in the Santa Rosa de Lima complex within the current production area at the Cusi Mine. The discovery included 1.5 metres at 1,243g/t silver equivalent and 3.1 metres at 1,126g/t silver equivalent. The Santa Rosa de Lima complex is located within a regional structure that extends for approximately 64 kilometers. The portion of the complex occurring on the Cusi property is expected to be 12 kilometers long. Mineralization in the Santa Rosa de Lima structure is only 100 metres below the surface and can occasionally be seen at the surface even at intersections of veins such as „Promontorio“ and „Santa Edwiges“.
In June 2017, the Company announced further results from a new high-grade zone. This zone is at least 1,700 meters by 400 meters in size. The average grades were 372g/t silver equivalent and the average thickness of the mineralization drilled was 3.8 meters.
In June 2020 another spectacular find was reported. A new high-grade network of silver veins was discovered, including 17.45 metres of 428g/t silver.

## Summary: Production increase and world-class exploration potential

Sierra Metals has reported record production results month after month from 2016 on the flagship Yauricocha project. The discovery of several new zones in the area of all three mines not only proves that Sierra Metals has tremendous exploration potential, but also provides improved production results. With increased production that has been, or is being, implemented at all three mines, rising silver and base metal prices and falling production costs, Sierra Metals should see profits bubble up soon. This is especially in view of the fact that Sierra Metals wants to establish itself as a supplier for the booming lithium-ion industry. Sierra Metals‘ big plus is certainly the exploration potential in all three project areas, which should ensure a steady, positive news flow. The new CEO, Luis Marchese, who previously worked for Anglo American as Country Manager Peru for 22 years and therefore has a lot of experience in the development and operation of mines, especially in Peru, brought a special momentum. Sierra Metals had approximately US$63.8 million in cash or cash equivalents as of September 30, 2020.



# Exclusive interview with Luis Marchese, CEO of Sierra Metals

***What have you and your company achieved in the past 12 months?***

- Record quarterly production for Q3 2020
- New high-grade silver zone discovered at Cusi
- Updated Mineral Resource estimate and technical report filed at Bolivar Mine
- Updated Reserve & Resource estimate and technical report filed at Yauricocha Mine
- Updated PEA for the Bolivar Mine

***What are the most important company catalysts for the next 6 to 12 months?***

- Yauricocha - Continuing toward the completion of the permitting process to operate the Mine at 3,600 tonnes per day.
- Bolivar - Continued development and infrastructure improvements as well as high value target drilling.
- Cusi – completion of an updated 43 101 technical report with a goal of further increasing resources.
  - Mine development will continue to provide access to the higher-grade economic ore and feed ore to the mill at the targeted rate of 1,200 tpd.
  - Additional drilling is also planned to better understand the extension of the NSEV zone at depth and to the Northeast.
  - Commence work on a new tailings dam near the Mal Paso mill, providing for deposition capacity for the foreseeable future.
- Overall – Completing PEAs and Feasibility studies to examine potential for further expansion at all three mines beyond the current capacity ramp up levels.

***How do you see the current situation on the market for battery metals?***

While the current state of the world economy has slowed down demand for some battery metals, we believe there is still growth to be achieved albeit with slower pace. We remain bullish on the longer-term outlook for battery metals as E-vehicles and other green power generation methods continue to grow.

**ISIN:** CA82639W1068
**WKN:** A1J9PT
**FRA:** DFXN
**TSX:** SMT
**NYSE:** SMTS

Shares outstanding: 162.8 million
Options: -
RSUs: 1.4 million
Fully diluted: 164.2 million

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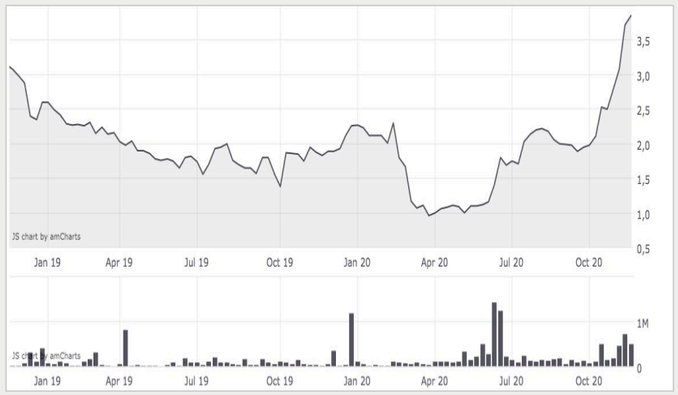
## Sierra Metals Inc.



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**You Tube Channel** – more than **1.1 Mio views** p.a. •

**Partnership with Dukascopy-TV** – worldwide **7 Mio views** p.a. •

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## Swiss Resource Capital AG & Commodity-TV Fairs and Events

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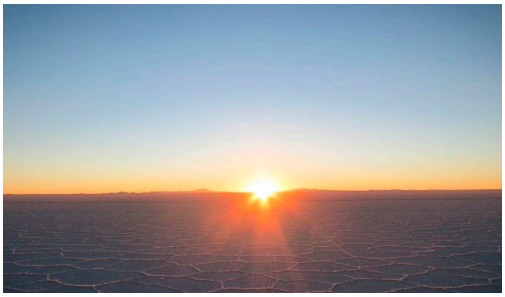


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