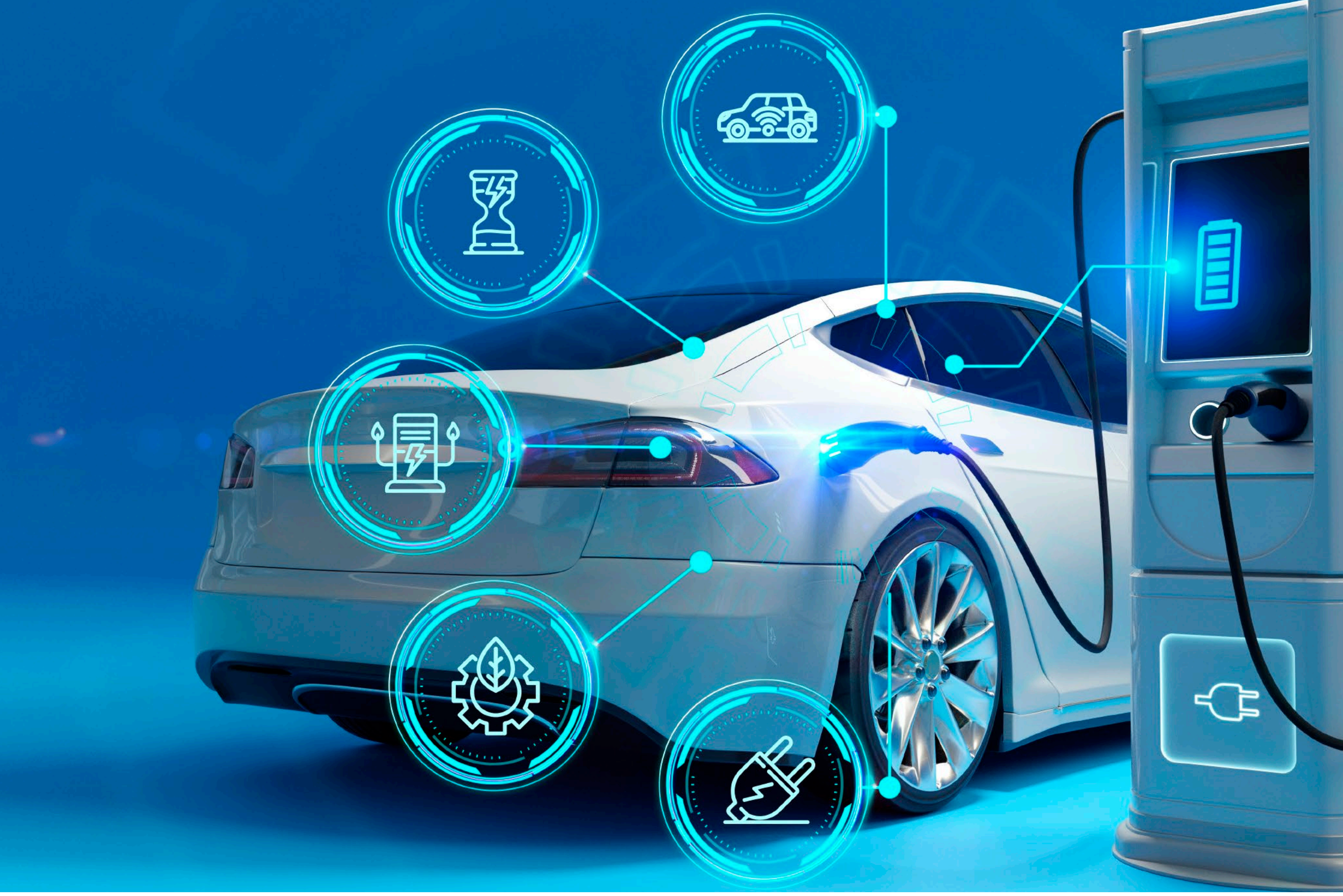

Battery Metals Report 2022

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

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Charts 02/28/2023
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Dear Readers,

We hereby present the latest edition of our Battery Metals Report.
Our special report series started in the fall of 2016 with lithium, as we see this metal, as well as cobalt, nickel, copper and tin, as one of the major energy metals of the future and as a great opportunity with a lot of potential. E-mobility continues to grow, batteries and accumulators are finding their way into more and more areas of life (e-bikes, cargo bikes, crafts). The lithium price, which unlike gold and silver is not quoted on any futures exchange and therefore cannot be manipulated, is a very good example, with a record price level of US$ 85,000 per ton in China at the peak. Lithium now has a huge supply deficit. Global lithium production must triple by 2030! Rio Tinto estimates that current supply and promised production expansions can meet only 15% of demand growth through 2050. 85% will have to be met from other sources, i.e., new mines. It also fits into the picture that two of our former report stocks (Millennial Lithium and NeoLithium) were recently taken over for a lot of money.
In the case of nickel, there was a short squeeze in March 2022 that was quite a surprise and shook the foundations of the LME. But this, too, is likely to be just the beginning of an unstoppable upward spiral in battery metal prices. According to one study, we need 26 new nickel mines and at least 30-40 new lithium mines by 2035 to match supply with demand. With construction and permitting times of 10 years or more, this will be very exciting.
Because the electric car is established in the market and will continue to sell well. Anyone who wants a world that is as CO_2-free as possible will no longer be able to avoid electric and hydrogen-powered mobility.
Lithium, nickel and cobalt are the main components of all batteries and accumulators available in large series and thus the main link of the electric vehicle dream. The movements in Germany are interesting, where not only Tesla has opened a factory (Gigafactory), but several well-known battery manufacturers are now building new battery factories and Volkswagen itself is now building batteries in Germany.
All these factories will be enormous drivers of demand for lithium, cobalt and nickel, but also for copper. Millions of tons of copper will be needed in the future not only for cars, but especially for the charging infrastructure. It is estimated that EUR 300 billion will have to be invested annually in the EU alone for low-CO_2 air in all sectors in order to achieve the Paris climate targets by 2050. In plain language, this means that we will need more raw materials than ever before. Let's see where they will all come from. The fact is that prices will continue to rise, and good companies can earn a lot from this. Because you will need profits, because inflation will increase much more. Whether we like it or not...

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We would like to give you the necessary insights and inform you comprehensively through our special reports. In addition, our two commodity IPTV channels www.Rohstoff-TV.net & www.Commodity-TV.net are available to you free of charge at any time. For on the go, we recommend our new Commodity TV App for iPhone and Android, which provides you with real-time charts, quotes and also the latest videos.

My team and I hope you enjoy reading the Battery Metals Special Report and we hope to provide you with lots 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.

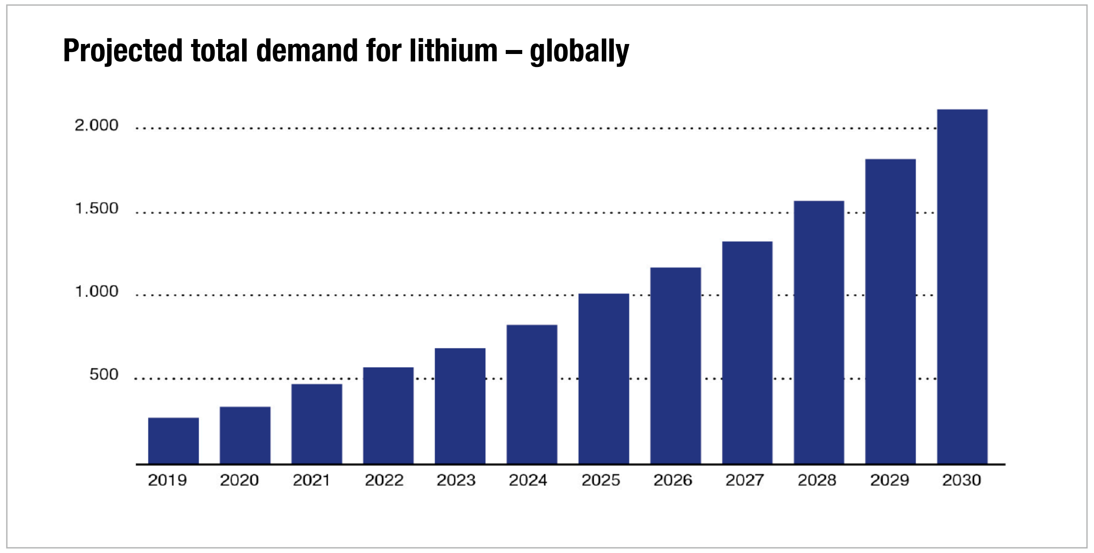
Tim Rödel is Manager Newsletter, Threads & Special Reports at SRC AG. He has been active in the commodities sector for more than 15 years and accompanied several chief-editor positions, e.g. at Rohstoff-Spiegel, Rohstoff-Woche, Rohstoff-raketen, the publications Wahrer Wohlstand and First Mover. He owns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

Battery metals are in demand as never before! –
The high demand can already no longer be satisfied!

With the explosion in the number of e-cars, the demand for lithium & co. is also exploding

The e-car industry is now well established, as is impressively demonstrated by new production facilities opening almost daily, as well as supplier companies in the form of smaller plants through to the so-called „gigafactories“. The worldwide number of newly registered, electrically powered vehicles (cars) has developed at least as impressively, increasing almost a hundredfold from 2012 to 2022. While only around 125,000 pure electric vehicles and hybrids were registered worldwide in 2012, this figure had risen to almost 11 million units by 2022. By 2025, e-car registrations will double again to at least 23 million units per year, according to industry experts. At the same time, the capacities of the batteries required will continue to increase and at a faster rate, from around 46 KWh in 2022 to around 54 KWh in 2025.
The big question that arises is: Can the electric (car) revolution continue at this pace? Because there is already a supply shortfall for several metals needed for batteries. Such as lithium, where 436,000 metric tons were mined in 2021, but demand was 465,000 tons. The situation is similar for other important battery metals such as nickel and cobalt, as well as copper and tin, both of which are not used in batteries, or only to a limited extent, but are used to connect the battery to many individual electronic components in vehicles and other storage media.

The prices for these metals have therefore already skyrocketed. Lithium, in particular, has experienced an immense price surge in recent months. Lithium and nickel are therefore currently the two metals for which the mining industry is far from being able to meet the coming demand. This became all the more obvious when Tesla CEO Elon Musk literally begged mining companies to develop new nickel mines in 2020.
The International Energy Agency (IEA), even projected in one of its recent reports that the industry will need to bring 50 more lithium mines, 60 more nickel mines and 17 more cobalt mines online by 2030 to meet global net carbon emission targets.
For investors, therefore, there is an excellent entry opportunity into the world of battery metals right now, as we will explain in detail below.



The projected global demand for lithium will multiply in the coming years. (Source: own representation)

Basic information about the lithium-ion battery

The lithium-ion battery is the heart of nearly every electric vehicle

In addition to the engine, the heart of every electric vehicle is the energy storage unit, i.e., a rechargeable battery. In order to be operated economically in the long term, electric vehicles, but also increasingly emerging decentralized storage systems – such as for photovoltaic or wind power plants – require ever more powerful rechargeable batteries. The lithium-ion battery has emerged as the most efficient, mass-market type of energy storage currently available for vehicles. One of the reasons 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 power over the entire discharge period and do not exhibit any so-called memory effect, i.e., 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 (LFP) and – less commonly – the lithium-titanate battery and the tin-sulfur lithium-ion battery. The most common is currently the lithium-nickel-manganese-cobalt (abbreviated NMC) battery.

Cobalt will be displaced by nickel

Although the basic principle of the lithium-ion battery has not changed much over the past few years, development is continuing steadily. The main focus is on efficiency and charging capacity (in the case of electric vehicles, this is often referred to as range), but also on the use of metals and elements. In this respect, a transformation is currently taking place away from high proportions of cobalt (NMC 111, where the numbers indicate the ratio of nickel, manganese and cobalt) to a higher proportion of nickel (NMC 811), although development is currently still at the corresponding intermediate stages (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 newest and most advanced battery version with the highest theoretical lithium and cobalt performance.

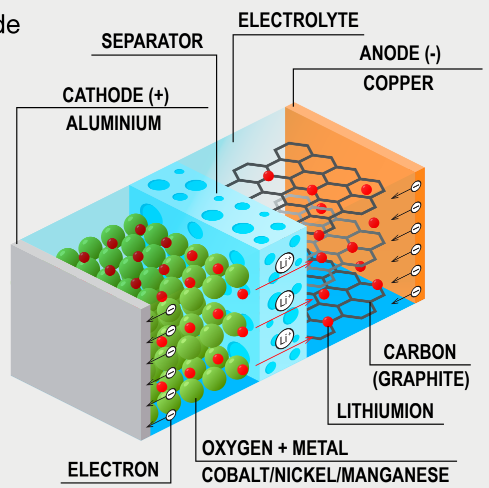
Source: shutterstock.com

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.

LFP batteries are on the rise, but have decisive disadvantages

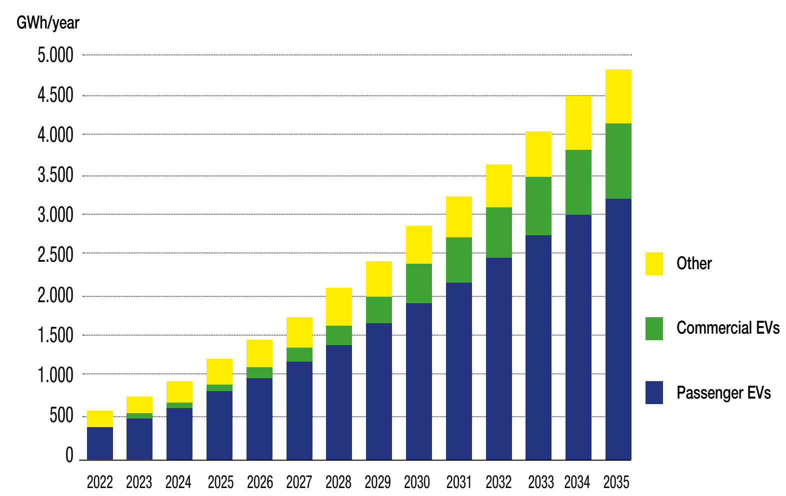
It currently appears that a serious competitor to lithium-ion batteries is gaining a foothold: The lithium iron phosphate battery, or LFP. This battery does not require nickel, cobalt or manganese, which makes it cheaper, and has an iron phosphate electrode instead of a cobalt oxide electrode. And indeed, Tesla and several Chinese carmakers in particular have recently made headlines by increasingly relying on the somewhat more environmentally friendly battery type. In addition to its slightly better environmental compatibility, the LFP battery has another advantage: the electrode is fireproof. But that‘s the end of the story, because the disadvantages compared to the lithium-ion battery (still) outweigh the advantages. The LFP currently has only about half the energy density of a lithium-ion battery. This means that the LFP currently requires about twice the size of a lithium-ion battery for the same power capacity. Another disadvantage is its aversion to cold. It is virtually impossible to charge it below 0° Celsius, which means it first has to be warmed up – by whatever means. The LFP battery is more or less unusable for colder regions. It therefore remains to be seen whether the LFP battery will really be able to gain more market share in the coming years or whether it will simply „only“ find its niche. Without a massive improvement in power density, it will probably not be able to establish itself in the long term, because cheap alone is not enough, which Tesla has recently clearly felt.

The global battery sector: facts & figures

Gigafactories still on the rise

Gigafactories are generally considered to be large manufacturing facilities that produce lithium-ion batteries for electric vehicles. As it stands, about 170 of the world‘s approximately 230 gigafactories in the pipeline are in China, while Europe has about 45 and North America only about 20 gigafactories in the pipeline. Worldwide, about 140 gigafactories are already in operation, of which only about 12 are currently producing in the EU. Global lithium-ion cell production capacity is expected to reach 1,250 GWh by the end of 2023 – a fourfold increase compared to 2018, with an additional expansion of production capacity to around 2,000 GWh in 2028 and 3,000 GWh in 2030. However, this would only cover the demand from the electric vehicle sector expected by then. Added to this is demand from the stationary storage sector and other industry (batteries for small appliances, etc.).

Lithium-ion battery demand outlook



(Source: own representation)

The Asians, and above all the Chinese, are clearly ahead of the pack

Asians, and China in particular, provide a large share of the overall demand for lithium-ion batteries. China is expected to continue to see the strongest annual increase in battery metal demand of all major market players over the next 5 to 10 years, largely due to an expected multiplication in the number of units of rechargeable batteries. Other major suppliers of lithium-ion batteries, such as South Korea and Japan, will also guarantee a robust increase in battery metal demand. Foremost among these are electronics giants Panasonic, Samsung, LG Chem, BYD, CATL, SK innovation and Great Wall, which accounted for 78% of global lithium cell production in 2020.

The EU makes gains thanks to funding programs

The EU, which seemed to sleep through the development of battery production for years, has been able to catch up powerfully with China thanks to many governmental and also private support programs and not least thanks to its strong industrial base.
Tesla's Gigafactory near Berlin and Northvolt's Gigafactory in Skellefteå in northern Sweden are just a drop in the bucket. By 2030 alone, more than 40 corresponding production sites for batteries and/or cathode materials are planned. At present, the planned battery capacity is at least 600 GWh by 2030. The established automakers in particular are driving European lithium-ion battery production forward.

North America awakens from its slumber

In North America, Tesla held the dominant position in lithium-ion battery production for years. 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. Gigafactory 5 was opened in Austin/Texas in April 2022 and is by far the largest gigafactory in North America.
Tesla, however, is far from the only lithium and cobalt consumer planning major lithium-ion battery production. LG Chem already started production for Chevy in Michigan in October 2015 and is currently working with General Motors on a larger battery production. Foxconn, BYD (the world's largest producer of rechargeable batteries, especially 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 systems, which are likely to become increasingly important in the future.

Lithium-ion batteries are also needed in cell phones.
(Source: tyler-lastovich, unsplash.com)

The most important battery metals are lithium, nickel and cobalt – copper and tin provide the component linkage

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

Source: alexander-schimmeck@unsplash.com

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 basically always occurs as a lithium compound in the wild. It tarnishes rapidly in air, 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 extraction is either lengthy or expensive

Global lithium production is divided into several different variants, 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 industries as well as for the production of aluminum-lithium alloys.

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

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

There are two types of lithium deposits

Lithium is generally obtained from two different sources.

1. So-called „brine“, i.e. (salt) sheet or brine deposits: Mainly in salt lakes, lithium carbonate is extracted from lithium-containing salt solutions by evaporation of the water and addition of sodium carbonate. To extract metallic lithium, the lithium carbonate is first reacted with hydrochloric acid. This produces carbon dioxide, which escapes as a gas, and dissolved lithium chloride. This solution is concentrated in a vacuum evaporator until the chloride crystallizes out.
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. Mined by conventional mining technology, the concentrate obtained is often converted to lithium carbonate with a purity of more than 99.5%. The intensive thermal and hydrometallurgical process required for this is considered to be very costly. Such deposits are currently exploited almost exclusively in Australia, with most of the further processing taking place in Chinese facilities.

Three quarters of the world‘s lithium deposits are located in just three countries, and four countries are mainly responsible for production

Lithium accounts for about 0.006% of the Earth‘s crust, making it slightly less abundant than zinc, copper, and tungsten, and slightly more abundant than cobalt, tin, and lead. Estimates from the U.S. Geological Survey (USGS) in 2021 suggest that about 22 million metric tons of lithium are recoverable as reserves and 89 million tons are recoverable as resources worldwide. About 51.8% of the reserves are located in the South American countries of Chile and Argentina alone, and 25.9% in Australia. The largest lithium carbonate production currently takes place in the Salar de Atacama, a salt lake in the northern Chilean province of Antofagasta. In addition, significant lithium deposits are found mainly in North America and China.
Australia, Chile, China and Argentina recently accounted for around 95 percent of the world‘s total lithium production, which is shared among only a few companies. As a result of this supply oligopoly, lithium is currently not traded on the stock exchange, and the actual trading prices are kept strictly confidential. One reason for this, which is always mentioned by the few suppliers, is that the available and required lithium qualities are too different for a standardized exchange trading place.

Main applications have been alloys and lubricants and will be batteries in the future

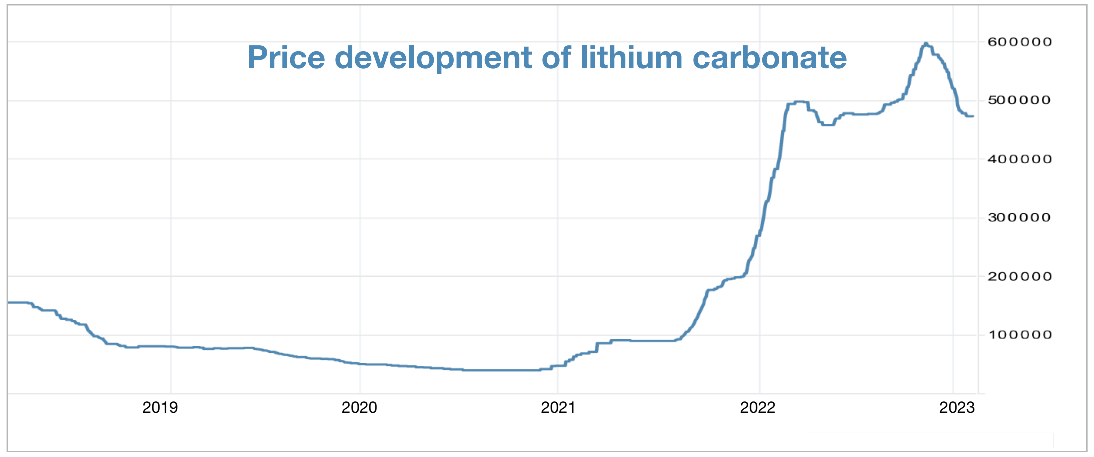
Its above-mentioned special and versatile properties make lithium a sought-after material in very many different areas of application. It should therefore come as no surprise that the main area of application for lithium has changed constantly in the past. Initially used mainly in medicine, the element began its triumphant advance in the 1950s as a component of alloys. Its low weight, but also its positive properties in terms of tensile strength, hardness and elasticity, made it an integral part of aerospace technology in particular. In the past 20 years, this picture has changed once again. As the electric revolution got underway, it was quickly recognized that its low normal potential made it almost perfect for use as an anode in batteries. 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, with lithium metal oxides such as lithium cobalt oxide connected as the cathode. However, as a raw material for the production of accumulators and batteries, purity levels higher than 99.5% are required. Lithium hydroxide in the „Industrial“ grade is used, among other things, as a raw material for lubricants and coolants; with the higher „Technical“ grade, it is also used in accumulator and battery production. Lithium carbonate – crystalline, granulated or in powder form – is used, for example, in the electrolytic production of aluminum, in the ceramics 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 a 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 and operation of lithium-ion batteries. Each smartphone contains between 5 and 7 grams of LCE (lithium carbonate equivalent; conversion factor LCE: pure lithium = 5.323:1). For a notebook or tablet, this is already 20 to 45 grams. Power tools such as cordless screwdrivers or electric saws require about 40 to 60 grams for their batteries. A 10 KWh storage unit for household use requires about 23 kilograms of LCE, while batteries for electric cars need between 40 and 80 kilograms. An energy storage system with 650 MWh capacity needs about 1.5 tons of LCE.

Lithium production will and must increase

In 2021, global lithium production was around 436,000 tons. Projections assume that this figure could be increased to a maximum of about 700,000 tons LCE with today‘s mining activity, whereby so far only limited efforts have been made for concrete



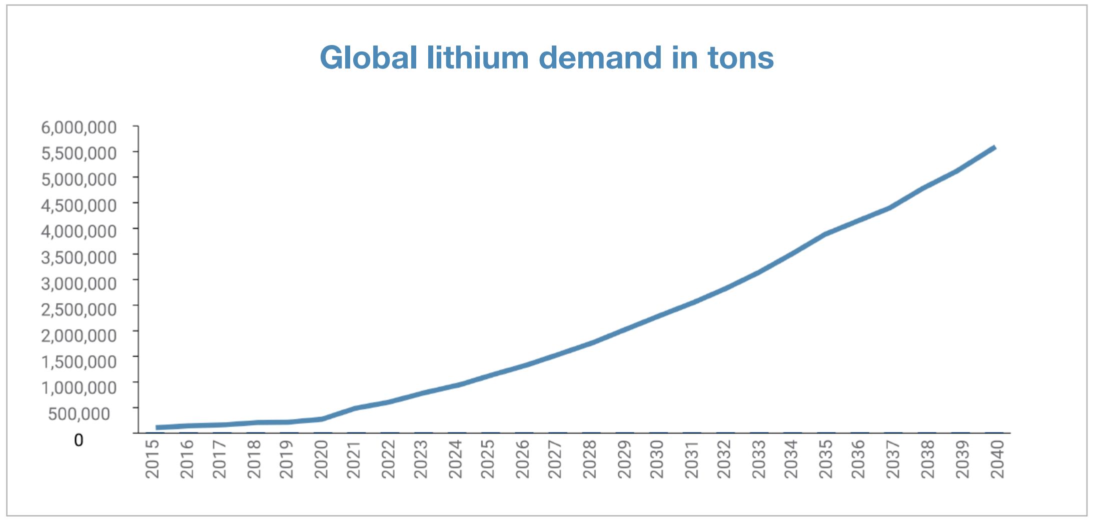
Lithium Carbonate Price in Yuan/Ton (Source: own representation) mine expansions or new mines, so that lithium is practically likely to run into a huge supply deficit. In addition, recent reports about several postponed mine starts caused additional uncertainty on the supply side.

The recent price explosion for lithium is making the producers‘ coffers ring

Ultimately, the price alone determines the economic extractability of the existing lithium deposits. While the price was still around US$6,000 per ton of lithium carbonate in mid-2015, it shot up to around 500,000 yuan at the beginning of 2022 and to just under 600,000 yuan by November 2022. Despite all the prophecies of doom, the lithium carbonate price continued to hold just below the 400,000-yuan (about US$58,000) mark until the end. This is a lucrative business for the producers, as the pure extraction costs for the current projects are only about US$ 2,500 (Chile) to US$ 8,000 (China) per ton. This is similarly the case for lithium hydroxide. **Since lithium makes up a significant part of a battery in terms of volume but is only responsible for less than 10% of the costs of a battery, the lithium price is ultimately relatively insignificant for the production of lithium-ion batteries and should therefore be able to be maintained at an economic level for the lithium producers.**

Demand for lithium is increasing rapidly – high supply deficit already exists since 2021!

The demand for lithium appears to be almost gigantic, not only due to, but mainly because of the new boom sector of electromobility! While this was still at around 65,000 tons of LCE in 2000, in 2021 it was already 465,000 tons that were demanded per year. Experts expect lithium demand to rise to over 600,000 tons in 2023, to around 1 million tons by 2025 and to around 2.5 million tons per year by 2030.
The main driving factor will be demand from the battery sector and the associated automotive industry. Assuming that a maximum of 720,000 tons of LCE per year can be extracted from existing mines and that new mines cannot be commissioned in the short term, a supply deficit of around 300,000 tons is indicated for 2025 alone! This indicates a bottleneck of unimagined dimensions.



Global lithium demand in tons
(Source: own representation)

Nickel

The element nickel

Nickel is a metallic, silvery shiny transition metal. It is medium hard, malleable and easily polished. Like cobalt, nickel is ferromagnetic and also highly 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 nickel- and copper-bearing iron ores. A multi-layer process is used to produce copper-nickel fines, which consist of about 80% copper and nickel and about 20% sulfur. To obtain the crude nickel, the nickel must be separated from the copper. To obtain pure nickel, the crude nickel is electrolytically refined. The purity of electrolytic nickel is about 99.9%.

Occurrence and production

Nickel occurs 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 nickel, i.e., in elemental form, occurs only rarely. As of 2020, only about 50 occurrences of native nickel were known worldwide. The most important deposits are found in Canada, New Caledonia, Russia, Australia and Cuba.
The majority of nickel production comes from sulfide ores. In addition, lateritic nickel ores are also mined as raw materials for nickel production. Due to the exploitation of the classic sulfide deposits, mining is increasingly shifting to lateritic nickel ores, which, however, means more expensive extraction.
In 2021, around 2.7 million tons of nickel were mined worldwide. The largest producer was Indonesia with around 1,000,000 tons. Other major producers are the Philippines (370,000 tons), Russia (250,000 tons) and New Caledonia (190,000 tons). These countries are responsible for around 60% of total nickel production worldwide.

Main application: steels and nickel alloys

Most of the annual nickel production (around 85%) goes into the production of stainless steels and nickel alloys. Nickel is one of the most important alloying metals, used mainly for steel refining. It makes steel corrosion resistant and increases its hardness, toughness and ductility. Steels highly alloyed with nickel are used in particularly corrosive environments. Around 20% of the nickel mined 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 alloys, for example for coins, are produced from nickel metal. Nickel-based superalloys are alloys specially designed for use at high temperatures and under corrosive media. They are used, for example, in aircraft turbines and gas turbines in power plants.

(Source: own representation)

High-purity nickel is needed for rechargeable accumulators and batteries

So-called class 1 nickel with a purity of at least 99.98% is required for batteries and rechargeable accumulators. Only about 45% of the total nickel production of about 2.7 million tons per year is suitable for the production of class 1 nickel. Of this, more than half is required for alloys and other applications. Less valuable Class 2 nickel is used exclusively in steel production.

Supply deficit has existed for years

The nickel market has already been in a supply deficit since 2016. In 2021, the supply deficit amounted to 168,000 tons. For 2030, a shortfall of 900,000 tons of nickel is expected. In 2040, the supply deficit is expected to widen to 2 million tons per year – and that includes new nickel projects. Estimates suggest that demand for nickel from the automotive sector alone will increase more than tenfold from 130,000 tons in 2020 to 1.5 million tons in 2030.

Indonesia insists on export ban – Philippines to follow suit

Indonesia, the world's largest nickel producer, has insisted since 2020 that it will only export refined nickel abroad. The EU and the World Trade Organization have already tried to take action against this, but have not been successful. Now the Philippines, the world's second-largest nickel supplier, wants to follow Indonesia's lead and at least tax exports of the metal, further increasing supply uncertainties as the market braces for a new wave of demand from electric vehicles.

Nickel inventories at historically low level

Since mid-2021, LME inventories have only known one direction: down! Thus, since June 2021, LME inventories – after remaining at a level of around 250,000 tons for a good year and a half – have now fallen to less than 50,000 tons. In March 2022, one of the most spectacular short squeezes of all time took place. The nickel future, which had already risen by 66 percent the previous day, March 7, 2022, moved vertically early in the morning. In a few minutes, it went up by US$30,000 until the price broke through the US$100,000 per ton mark after a few minutes. Within less than 20 minutes, an entire commodity market was unhinged. The main player was the Chinese Tsingshan Group, which had built up a large short position of about 150,000 tons over months in order to hedge its own expected future production increase.

(Source: A.Ocram (CC BY-SA 3.0))

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, the electrical conductivity is 26 percent of that of copper. In chemical behavior it is similar to iron and nickel, resistant to air by passivation; it is dissolved only 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. First, some of the iron sulfides present are converted into iron oxide by roasting and slagged with silicon dioxide as iron silicate. The result is the so-called crude stone, which, in addition to cobalt, also contains nickel, copper and other iron as sulfide or arsenide. Further sulfur is removed by further roasting with sodium carbonate and sodium nitrate. In the process, sulfates and arsenates are formed from some of the sulfur and arsenic, which are leached out with water. The corresponding metal oxides remain, which are treated with sulfuric 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 to Co_3O_4 by heating and then reduced to cobalt with coke or aluminum powder.

The majority of global cobalt deposits lie beneath the seabed

Cobalt is a rare element with a frequency of 0.004 percent in the earth's crust. This puts it in thirtieth place in the list of elements ordered by frequency. Cobalt is found in many minerals, but usually occurs only in small amounts. The element is always associated with nickel, often also with copper, silver, iron or uranium.
The world's known cobalt resources are about 25 million tons, reserves 7.6 million

tons, with the largest deposits located in the Democratic Republic of Congo, Zambia, Canada, Morocco, Cuba, Russia, Australia, Uganda and the USA. Cobalt deposits of more than 120 million tons have been identified in polymetallic nodules and crusts on the floor of the Atlantic, Indian and Pacific Oceans.

The bulk of cobalt production comes from dubious sources

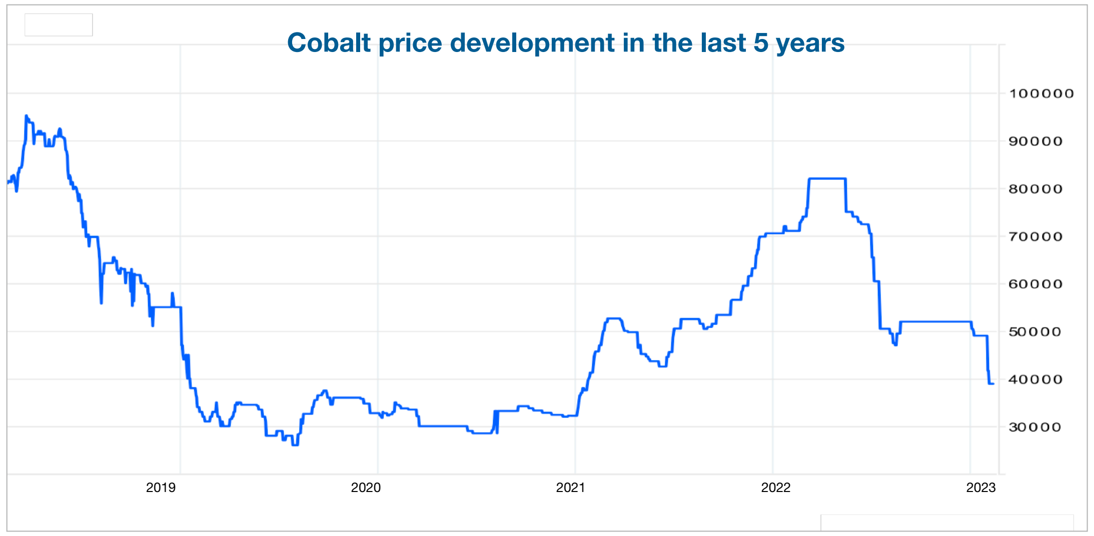
The majority of the annual cobalt production of 160,000 tons in 2021 came from mines in the Democratic Republic of Congo. Accordingly, around 70% of the total production volume in 2021 came from the central African country. Russia accounted for a further 4.5%, the Philippines for 2.6% and China for 1.3% at last count. All countries that are not necessarily considered to inspire confidence. The remaining production was split between Canada (2.5%), Australia (3.3%) and several other countries, some with even lower production volumes.
Future security of supply appears to be extremely critical based on current producers, which is why more and more attempts have been made recently to develop new mines and increase production accordingly, especially in Canada, Australia, the USA and Finland.

Main applications are paints, alloys, medicine, magnets and rechargeable 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 used primarily as an alloying 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 coatings, as a catalyst for desulfurization and hydrogenation, as a hydroxide or lithium cobalt dioxide ($LiCoO_2$) in batteries, in corrosion- or wear-resistant alloys, and as a trace element for medicine and agriculture. In addition, cobalt is used in the production of magnetic data carriers such as tape and video cassettes, where it improves magnetic properties through doping. Since the 1990s, cobalt has served as an anode material in the anode of lithium-ion batteries.

The e-car sector continues to require a lot of cobalt, which will not be changed much by the increasing substitution with nickel

As with lithium, the quantities of cobalt used in the corresponding batteries are similar. Depending on the model, between 5 and 10 grams of cobalt are used in a single smartphone. For a notebook or tablet, the figure is 30 to 100 grams. Power tools need about 50 grams for their batteries. A 10 KWh storage unit for home use (such as Tesla's Powerwall) requires about 7 kilograms of cobalt, while the batteries for hybrid vehicles need about 4 kilograms and for purely electric cars 10 kilograms of cobalt. Tesla's Model S even comes in at 22.5 kilograms. A passenger plane gobbles up about 4,000 kilograms of cobalt.
The automotive sector will demand ever greater quantities of lithium-ion batteries in the coming years – even if the further development of batteries suggests that cobalt will increasingly be replaced by nickel – and thus also ever greater quantities of cobalt. Leading experts believe that it will be difficult to expand production above 180,000 tons per year with the current mines. The fact is that despite this, Congo will remain the absolute world market leader for the time being and will even expand its market share to over 75%. The two largest cobalt mines in the world, Kamoto and Kolwezi, which alone can produce about 50,000 tons of cobalt per year, have a large share in this. Outside Congo, several companies are working to expand their existing mines (including Glencore, Norilsk, Umicore, Sumitomo and Vale).



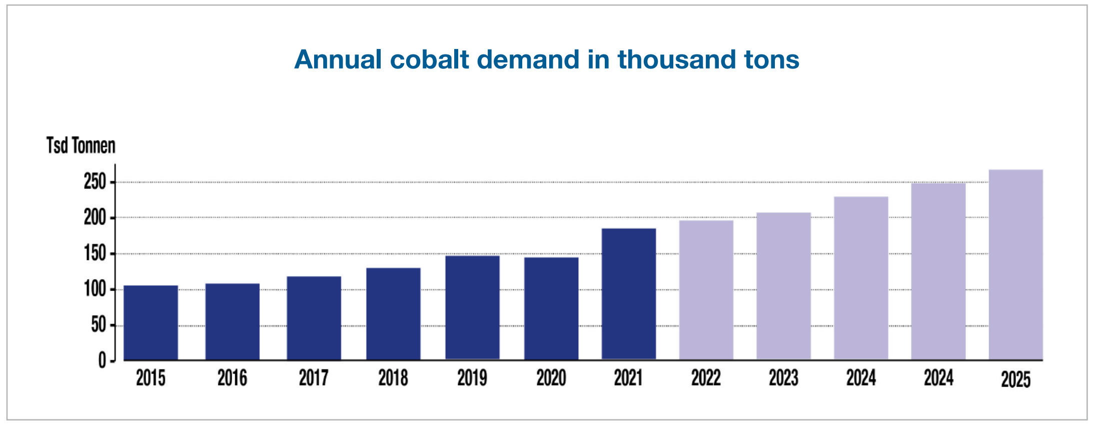
Cobalt price development (US$/ton) of the last 5 years (Graphic: own representation)

Cobalt price fluctuates strongly

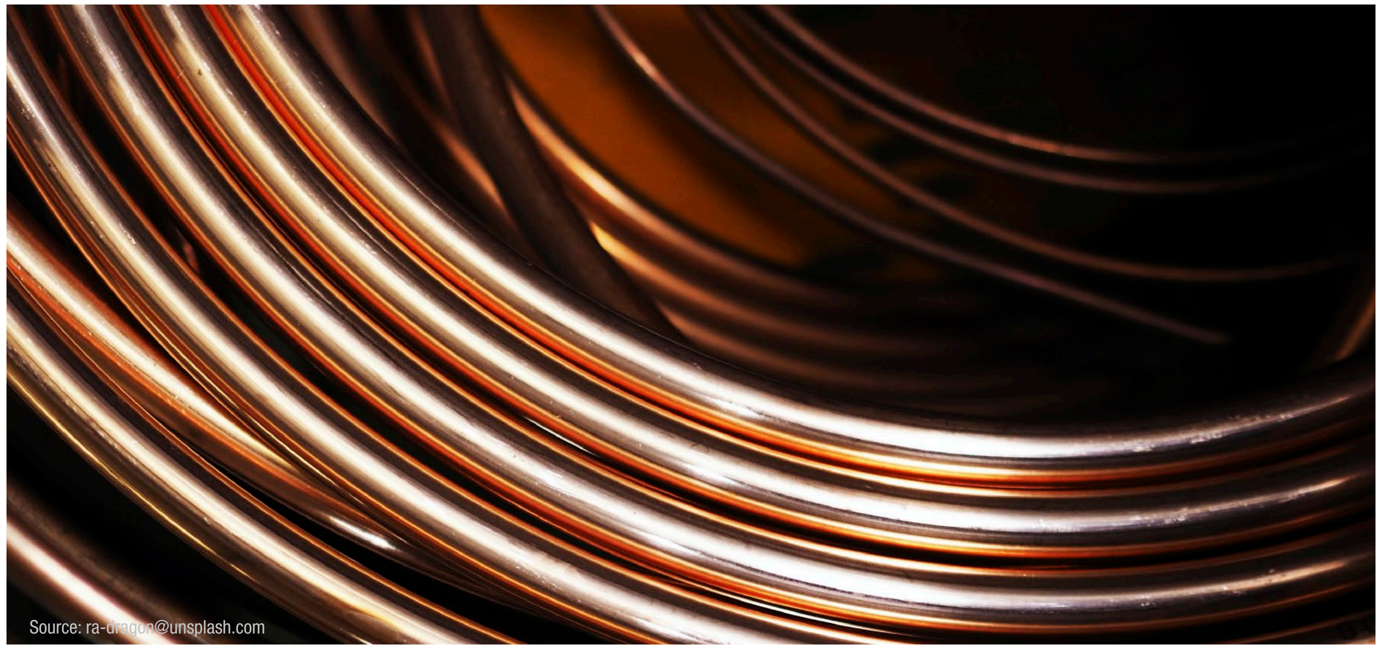
Many market participants have already recognized that cobalt production cannot be expanded quite so easily from one moment to the next. For example, the price of a metric ton of cobalt exploded from US$20,000 at the beginning of 2016 to US$95,000 in March 2018. After an interim low of around US$27,000 in July 2019, it fell back to around US$80,000 in March 2022. Currently, the price of cobalt has leveled off at just under US$40,000 per metric ton. A further increase can be expected as soon as the leading automakers drastically expand their model range.

Cobalt with supply deficit

The demand for cobalt will almost certainly continue to rise sharply in the coming years! While this was still around 60,000 tons in 2008, in 2017 it was already 125,000 tons that were demanded per year. In 2021, demand for cobalt was around 173,500 tons, of which around 34% came from the automotive sector. Experts expect cobalt demand to rise to over 270,000 tons per year by 2025.
The main driving factor will be demand from the battery sector. Cobalt has already been showing a supply deficit of around 13,000 tons per year since 2021. This is likely to multiply again in the coming years.

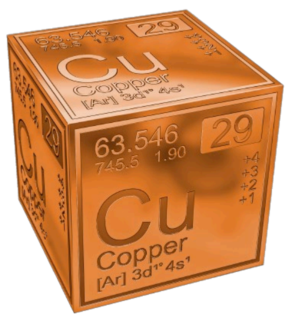


By 2025, experts expect cobalt demand to increase to over 270,000 tons per year (Graphic: own representation)



Copper

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



The element copper

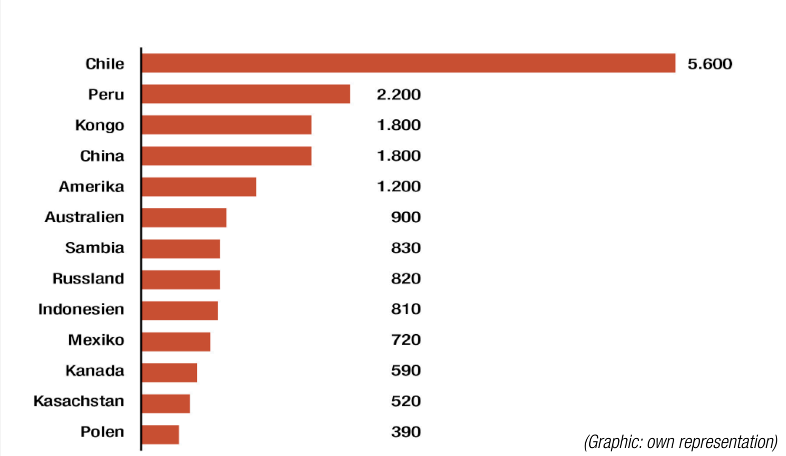
Copper is a chemical element with the element symbol Cu and the atomic number 29. Like silver and gold, it is one of the transition metals that occur naturally in pure form, i.e. in elemental form. The name copper comes from the Latin cuprum, which is derived from Cyprus, where the most important copper mines were located in ancient times. It is the 26th most common element in the earth's crust (share 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 ductile. It has a very high thermal and electrical conductivity.

The deposits are concentrated in a few areas worldwide; extraction is simple

There are several thousand sites around the globe. Significant copper production, however, exists in only a few regions. By far the most recent leader in copper production was Chile, with an annual production of 5.6 million tons in 2021. It was followed by Peru (2.2 million tons), China (1.8 million tons), the Democratic Republic of the Congo (also 1.8 million tons) and the USA (1.2 million tons). Together, these five countries account for around 60% of world production of around 21 million tons per year. In smelting, China (10 million tons) is by far the leader. In addition, there is recycled copper of about 900,000 tons per year.
Copper is extracted by smelting and refining. The corresponding processes have long been perfected, and processing is correspondingly simple and relatively inexpensive. The USGS estimates that around 5.6 billion tons of copper are available worldwide as resources and 880 million tons of copper are mineable as reserves.

Main features: High thermal and electrical conductivity, soft, antibacterial, red

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



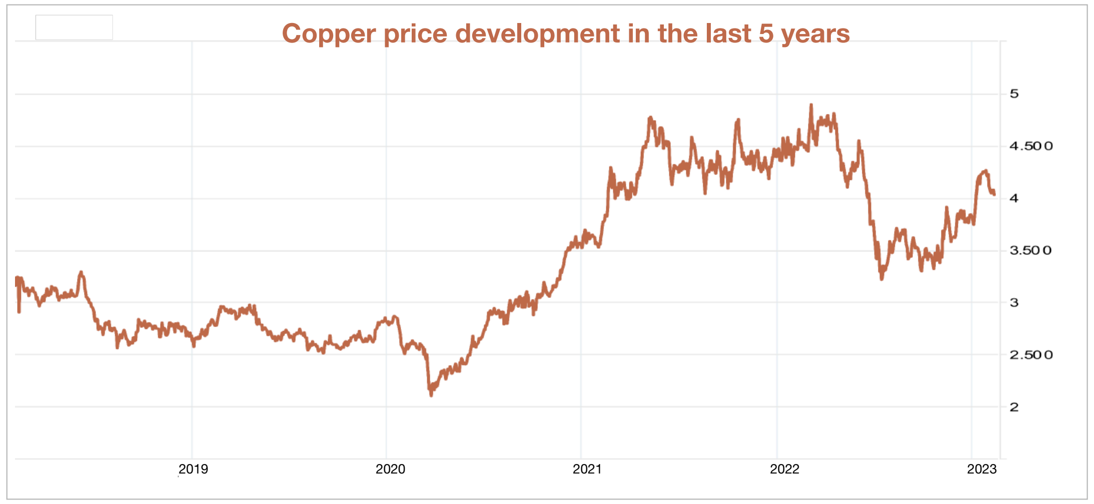
(Graphic: own representation)

Main fields of application: Electrical engineering, piping, art, construction

By far the largest area of application for copper is electronics and electrical engineering as well as piping, i.e. infrastructure. It is used, among other things, for electrical lines, switching wires, power cables, overhead lines, conductors on printed circuit boards, wire windings in transformers, chokes/coils and in electric motors. Furthermore as cable connection between electrical components like accumulators, motors and applications. Other applications include water piping, roofing, glass coatings, tableware, as well as in the arts and crafts sector for the production of printing plates for copper engravings and etchings and in the jewelry sector for alloys.

Less copper present than needed

The International Copper Study Group has already calculated a supply deficit of around 300,000 tons for 2020. Glencore CEO Gary Nagle recently predicted a supply deficit that could reach a cumulative 50 million

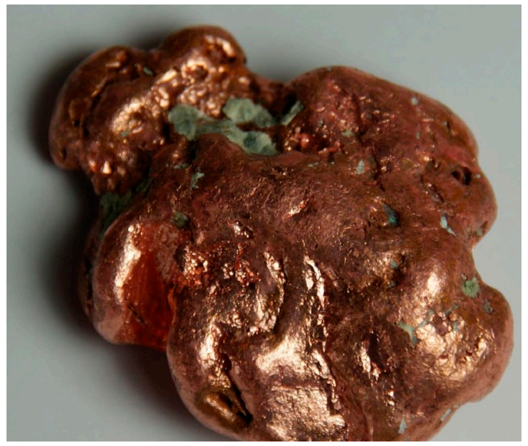


(Graphic: own representation)

tons from 2022 to 2030, which is why several U.S. senators are now calling for copper to be added to the list of critical metals. Due to the fact that in the future more and more copper will be used in electromobility (an electric car requires about 90 to 100 kilograms of copper, while a combustion vehicle often gets by with 20 kilograms), but also in the connection of regenerative power generators to the power grid (an onshore wind power plant requires about 5,4 tons of copper per megawatt, an offshore wind power plant even 15.3 tons of copper per megawatt), experts reckon that by 2035 there will be a gap of no less than 15 million tons per year, i.e. about 75% of current production. Furthermore, infrastructure and electric vehicle support programs of many governments are likely to lead to a further boom in demand for copper. Experts predict that copper demand from the automotive sector alone will increase to over 4 million tons per year by 2030.

Major producing nations have massive production problems

In addition to an expected increase in demand from the current level of around 21 million tons of copper per year to 25 million tons in 2030 and 28 million tons by 2035, copper production with the current mines is expected to fall to less than 15 million tons at the same time. This is because at present it is mainly the expansion of existing mines that accounts for the bulk of new copper production, which is expected to come on stream by 2025. After that, new projects will be needed to close the growing gap expected by analysts. However, this will require significant investment. Goldman Sachs estimates that over US$150 billion will have to be invested in mining projects worldwide by 2030 alone in order to be able to handle the expected increase in demand. 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 even be possible, i.e., profitable. Another aspect is the lack of exploration for large copper projects, which has been extremely sparse over the past ten years. In addition, massive production problems have recently occurred in Chile and Peru, the two largest copper producing countries in the world. While several mines in Chile had to accept production and refining losses due to technical reasons, in Peru production losses were primarily politically motivated. In this respect, the Democratic Republic of Congo made a significant contribution to global growth, as production at the new Kamoa mine and other mines increased by 28%.



Copper nugget (Source: Jurii, Copper, CC BY 3.0)

Many copper mines operate at a loss

The fact is that there is currently a shortage of high-quality development projects. As the quality of many new copper projects is far inferior to that of current mines, an increase in production, i.e. exploitation of poorer quality mines, can only be achieved by adjusting prices. At the current copper price level of around US$4.00 per pound, a large proportion of the world‘s copper mines cannot be operated economically. According to Goldman Sachs, the current incentive price to build a new copper mine is around US$5 per pound. If the expected wave of demand from the automotive industry, renewable energies and the power infrastructure comes soon, the copper price could make unprecedented price jumps.

(Source: Orjen, CC BY-SA 4.0)

Tin

Although, like copper, not a classic battery metal, tin is irreplaceable for the connection of important electronic components. As an electrical solder in semiconductors or in the form of solder ribbons in photovoltaic panels, the critical metal is of vital importance.

The element tin

Tin is a chemical element with the element symbol Sn and the atomic number 50 and belongs to the heavy metals that occur naturally as doped elements. The name tin comes from the Latin stannum. It is the 30th most abundant element in the earth‘s crust (proportion of about 35ppm) and has been mined since about 5,000 BC. Tin is silvery-white shiny and very soft, so that it can be scratched with a fingernail. Its most important property is that it has a very low melting point for metals.

Largest deposits in Asia and South America, extraction and processing simple

Although tin is found in its raw form all over the world, the largest or most deposits are located in Asia and South America. China, Indonesia and Myanmar stand out in terms of both reserves and production capacity. All three countries together hold about 53% of the globally known reserves and produce about 63% of the total annual mine supply. Because the most economically important tin mineral, cassiterite SnO2, also known as tinstone, is a very stable heavy mineral, much of the tin production also comes from secondary placer deposits. Within primary tin deposits, the element often occurs associated with arsenic, tungsten, bismuth, silver, zinc, copper and lithium. The extraction of tin is quite simple. First, the ore is crushed and then enriched by various processes (slurry, electrical/magnetic separation). After reduction with carbon, the tin is heated just above its melting temperature so that it can flow off without higher melting impurities. Today, much of it is recovered by recycling and by electrolysis.
The USGS estimates that there are about 4.8 million tons of tin in reserves worldwide.

Main properties: Very soft, low melting point

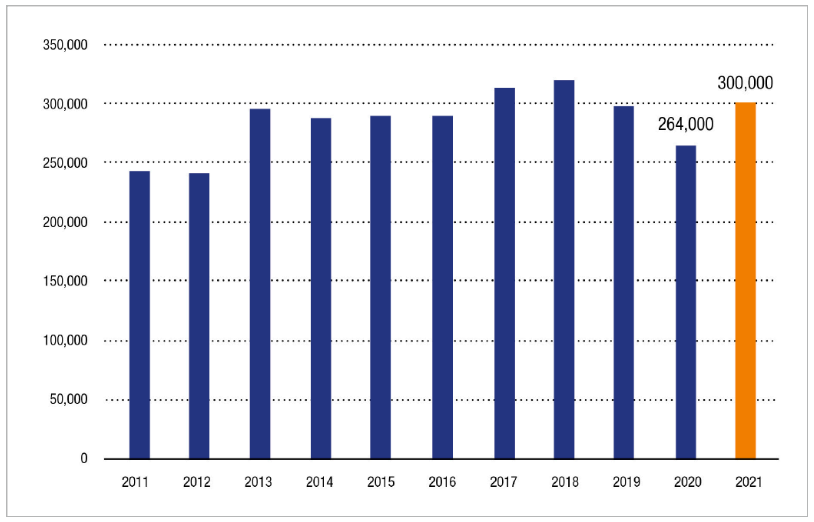
By far the most important properties of tin are its softness and the very low melting point of just 231.93° Celsius. This makes for easy, low-energy processing and forming, which is why tin is used wherever soldered joints are required.

(Graphic: own representation)

Main fields of application: Semiconductor, electronics, medicine, chemistry, art

The main use of tin in the past was in the manufacture of tableware, utensils and ornaments, organ building and, of course, bronze. In organ building, tin is an indispensable component in the manufacture of metal pipes. Modern use is in the field of electric soldering as well as in the tinning of food-safe canned goods or even in medicine. Historically, man first used tin as an admixture to copper as an alloying agent for the production of bronze. Nowadays tin is mainly used in semiconductors. Over 50% of the world's tin production is used as electronic solder to connect circuit boards. Furthermore, tin plays an increasingly important role in the field of photovoltaics, as solder ribbons are used to connect solar cells. Tin is additionally used as a chemical in the manufacture of flat glass panels, stabilizes PVC and plastics, coats steel cans, and is present in both lead-acid and lithium-ion batteries. Tin is essentially a turbocharger for lithium. The current best technologies for lithium-ion batteries use tin anodes, which provide much faster recharging than any other technology.

Worldwide tin production in tons per year
(Graphic: own representation)



Rapid rise in tin demand – supply can no longer keep pace

Worldwide, about 300,000 tons of tin were mined and refined in 2021 and just over 315,000 tons were in demand. However, leading experts expect tin demand to rise to as much as 430,000 tons per year in the years up to 2030.
Demand for semiconductors has already been growing rapidly recently, and the global semiconductor market is forecast to double in the next five years (from around US$400 billion in 2021 to around US$800 billion in 2028). Strong growth will be driven by demand for emerging technologies such as electric and autonomous vehicles (sales in this segment alone are growing at a five-year CAGR of 21%), artificial intelligence, 5G, Internet of Things, and consumer electronics. Similarly, the market for photovoltaics will double by 2030 as the use of renewable solar energy increases. The world desperately needs new tin deposits, but there are few projects in operation and even fewer sustainable projects. As demand for tin is fueled by the increasing use of electronics, the rise of the Internet of Things, and the green energy revolution, the tin deficit has caused the tin supply chain to be more depleted than at any time in history and to reach critical levels. Increasing demand combined with shortages are expected to result in tin experiencing sustained deficit markets for the foreseeable future.

Conclusion: In fact, all of the metals mentioned are already in a supply deficit, with the electrorevolution only just gaining momentum

Demand for lithium, cobalt and nickel as well as copper and tin will be determined by three sectors in the future:

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

This constellation will cause demand for lithium, cobalt and nickel to increase many times over in the coming years in some cases, and for copper and tin it will also increase sharply, with decentralized storage in particular generating the greatest growth in demand and likely to dwarf even the other two areas.

Most of the production comes from dubious sources, refining is controlled by China

In the EU and thus also in Germany, lithium, cobalt and graphite belong to the so-called „red group", i.e. materials with a very high supply risk. In the USA, lithium is also considered a „critical mineral". Currently and in the future, however, many of these metals (in the case of copper, around 50% of the most advanced projects) will come from countries with dubious mining methods or high political risk, such as the Democratic Republic of the Congo, Russia or Papua New Guinea. Moreover, 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 lithium, but also of the tin refining. A circumstance that will and must lead to either more projects outside China's sphere of influence or to higher prices in the future. Recycling currently plays no role at all for lithium and cobalt and therefore cannot be seen as a source of needed materials.

Supply deficits for all battery metals will be re-evaluated by producers and advanced developers in particular

Overall, there is already a supply deficit for the lithium, cobalt, nickel, copper and tin markets, as the increase in demand exceeds the expansion in supply. In this context, the gap between supply and demand will initially widen further. This is strongly indicated by recent reports of projects stalling, with production curtailed and expansion plans delayed.

As demand growth will continue to increase strongly beyond 2025 and, in addition, there are still no significant large production projects in the pipeline, this situation is likely to continue for the foreseeable future.

Especially producers and development companies, which have already advanced their respective projects, should offer the greatest share price opportunities in the coming months and years, also with regard to a possible consolidation, i.e., through takeover scenarios.

Some of these dedicated development companies, as well as prospective producers, are presented below.

Golden Arrow Resources

Successful IOCG development company working on next bull's eye

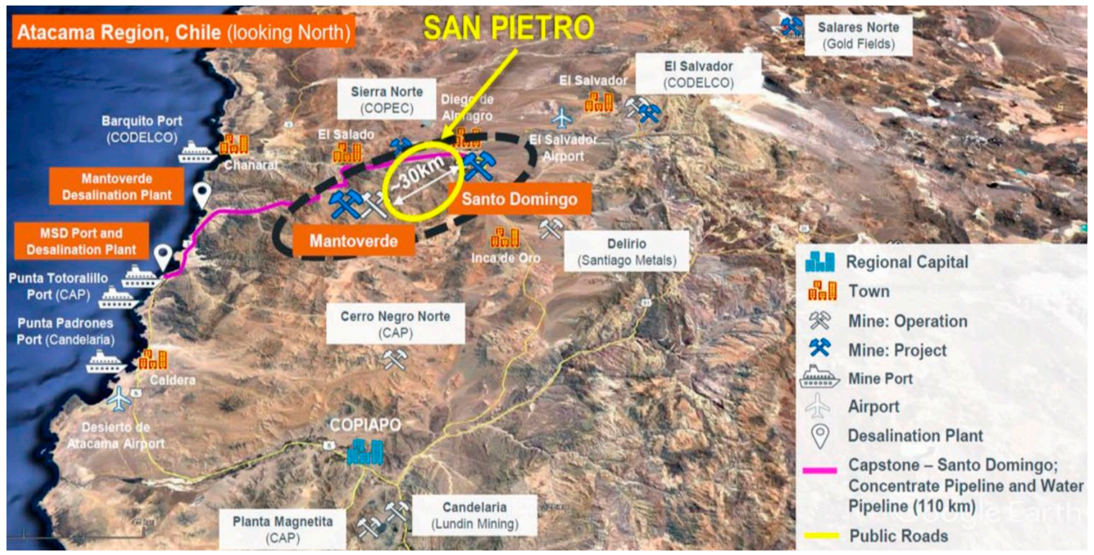
Golden Arrow Resources is a Canadian mining development company specializing in the discovery and development of high-caliber base metal and precious metal projects in Argentina and Chile. The, Vancouver, Canada-based company has a successful history of identifying, acquiring and advancing precious and base metal discoveries. For example, Golden Arrow advanced its Chinchillas silver project in Argentina's Jujuy province from discovery to development in just five years and then successfully monetized the project by selling it to SSR Mining. Golden Arrow now benefits from a significant equity stake in SSR Mining, which offers upside potential and leverage to gold and silver. The company is actively exploring in Chile and Argentina. With a pipeline of more than 180,000 hectares of high-grade mineral projects at all stages of development, the company is well positioned to define and develop exceptional new deposits.

Flagship project San Pietro – Location and infrastructure

Golden Arrow's current 100% owned flagship project is called San Pietro, covers 18,448 hectares of exploration and mining concessions and is located in the Atacama region of Chile, approximately 100 kilometers north of Copiapo in an active mining district where all of Chile's major copper-gold-iron-cobalt (IOCG) deposits are located. The project site has excellent mining infrastructure, being located only 8 kilometers from the mining town of Diego de Almagro. The entire site is accessible year-round by well-traveled roads, with a highway and two power lines running through the project. San Pietro is located immediately west of Capstone Copper's Santo Domingo mine development project and 10 kilometers northeast of its Mantoverde mine.

Flagship Project San Pietro – Geology

Mineralization at San Pietro is typical of an IOCG system with copper-gold-iron-cobalt minerals in breccias, veins and mantos within a zone of K-feldspar-chlorite alteration. The San Pietro project has an extensive historical database that includes results from over 34,270 meters of drilling, as well as over 1,000 surface samples and several geophysical surveys compiled to identify four main target areas. Golden Arrow's due diligence confirmed the significant potential of the known targets and identified areas where new interpretation and additional work should improve prospects.



San Pietro is located in the middle of an emerging IOCG mining district. (Source: Golden Arrow Resources)

San Pietro Flagship Project – Historical Drilling and Targets

The Rincones target area has been the focus of most historical work and drilling and is therefore the primary target for near-term resource delineation. Highlights of drill hole results (47 holes) included 1.14% copper, 0.12 g/t gold and 335 ppm cobalt over 28 meters, 1.20% copper, 0.21 g/t gold and 579 ppm cobalt over 34 meters, 1.25% copper, 0.32 g/t gold and 70 ppm cobalt over 36 meters, and 0.76% copper, 0.13 g/t gold and 146 ppm cobalt over 20 meters.

Several other target areas have also shown significant cobalt grades in the past. For example, within the Colla target area, which is located 2.3 kilometers southwest of Rincones. Just four holes have been drilled in the past over a strike length of 2.2 kilometers, all of which have shown significant cobalt grades. These include 626 ppm cobalt over 10 meters, 414 ppm cobalt over 32 meters, 310 ppm cobalt over 17 meters and 364 ppm cobalt over 12 meters. Colla spans 2.2 kilometers of the northwest trending structure, potentially opening a link to the Rodeo target.

Rodeo is located 7.5 kilometers northwest of Rincones and produced 334 ppm cobalt and 1.03% copper over 34 meters, among other grades. Rodeo lies along the same structure as the Paraiso & Rodeo small private company mining operations. The structure at Rodeo could continue to the Colla target, which is located approximately 5 kilometers to the southeast.

Further, the Radiss Norte target, located 2.7 kilometers north of Rincones, had 276 ppm cobalt over 58 meters, 269 ppm cobalt over 27 meters, and 306 ppm cobalt over 29 meters, among others. Radiss Norte is where most of the surface sampling was done, with geophysical surveys indicating that Radiss Norte has deeper targets. Previous drilling has taken place in various directions to intersect the numerous structures.

San Pietro flagship project – Own exploration activities

Golden Arrow Resources is currently working to fill existing gaps in sampling. This will include a further close examination of drill core. In addition, geological and geophysical interpretations are being reviewed and updated. Following this, an initial drilling campaign of approximately 2,500 drill meters is expected to commence shortly. After more precise target identification, the company plans to drill up to 20,000 meters.

More projects

In addition to the fairly advanced San Pietro project, Golden Arrow owns both several other earlier-stage core portfolio projects with high discovery potential and joint venture projects that may experience value growth as the Company advances its flagship and core projects.

Caballos

One of these projects is Caballos, which is currently optioned to Hanaq Argentina S.A.. The Caballos property covers more than 12,000 hectares and is located in the province of La Rioja in the Andes Cordillera at an altitude of 4,000 to 4,500 meters above sea level. A paved highway and good gravel roads provide easy access to the eastern part of the property. In 2012, Golden Arrow discovered a large copper-gold porphyry target at Caballos through the completion of a surface exploration program including an IP/resistivity geophysical survey, a detailed ground magnetic survey, geological mapping and additional geochemical sampling of surface rocks and debris. The core magnetic zone of the interpreted porphyry system measures 300 by 800 meters. Sampling at the edge of the magnetic core survey returned 12 meters averaging 2.4% copper within an 18-meter continuous chip sample. A nearby hand trench returned a composite chip sample averaging 0.60% copper and 0.35 g/t gold over 5 meters.

Rock sample from Caballos (Source: Golden Arrow Resources)

Don Bosco

The Don Bosco copper-gold project comprises a total of approximately 4,300 hectares of exploration licenses covering five distinct target areas in the western province of La Rioja, Argentina. The property is located at an elevation of 2,500 to 3,500 meters above sea level. Work can be carried out throughout the year and an asphalt highway provides easy access to the southern portion of the property. The Don Bosco project includes historic copper and gold occurrences as well as high-grade mineralized zones identified by the Company's reconnaissance teams. Golden Arrow conducted several prospecting and sampling campaigns on the project. A total of 187 reconnaissance rock chip samples were collected from three different target areas: El Pircarda copper-gold skarn, Llantenes copper zone and Las Minitas silver zone. In doing so, the Company received some encouraging results, such as a composite chip sample from the San Alberto Scarn zone of 11 meters averaging 0.53 g/t gold, 46 g/t silver and 1.77% copper, a composite chip sample from the El Pircarda Scarn zone of 2,4 metres averaging 2.04 g/t gold, 114 ppm silver and 10.0% copper, and chip samples from the Llantenes Sedex zone of 1 metre grading 25% copper and 8.6 g/t silver, 2 metres grading 3.3% copper and 33 metres grading 0.49% copper.

Grosso Group as the perfect back-up

Golden Arrow Resources is part of the Grosso Group of companies. The Grosso Group is a management company that has been in business since 1993, specializing in South America, particularly Argentina, and has made 3 multi-million-ounce precious metal discoveries in Argentina alone. In addition, partnerships with commodity giants such as Barrick, Areva, Rio Tinto, Teck and Yamana have been established. Company CEO Joe Grosso was named Argentina's Mining Man of the Year in 2005. The Grosso Group has an extensive network of industry and political contacts in Argentina. Grosso is executive chairman and CEO of Golden Arrow Resources.

Summary: Increased newsflow ahead due to drilling results!

Golden Arrow Resources has something decisive ahead of many mining development companies: They have already landed a real bull's eye once and were able to sell the corresponding project lucratively. Accordingly, they are now working on a second „chinchilla", focusing less on silver and more on IOCG resources. With the flagship project San Pietro, the company seems to have found a project that hosts several worthwhile targets and is also framed by large deposits to the west and east. In the current year 2023, the first own drillings are now scheduled, after a detailed due diligence has been carried out. Accordingly, the coming months will also be characterized by many drilling results. This first phase of drilling work is fully financed and should lift the company to a completely new valuation level.

Exclusive interview with Brian McEwen, VP Exploration & Development of Golden Arrow Resources

Brian McEwen, VP Exploration & Development

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

Golden Arrow added the San Pietro Copper-Cobalt-Gold (IOCG) Project to our portfolio in 2022. It is an 18,448-hectare project in the Atacama region of Chile situated between, and adjacent to, Capstone Copper's Santo Domingo IOCG mine development project and Mantoverde IOCG mine property. Capstone's integration plan for their two projects would create a world-class mining district and San Pietro exhibits many geologic similarities to those projects, with the potential to host significant resources of the critical metals copper and cobalt. Needless to say, San Pietro has quickly become the flagship project for us and we hope to define the next significant deposit in the district.
We have established a large team in Chile and over the course of the year they compiled and reviewed the existing database, completed detailed mapping and surface sampling at several of the main targets, and started relogging the more than 34,000 metres of drill core. The purpose of all of that work was to refine targets for a large drill campaign this year.
At the same time, we have advanced our project pipeline in Argentina, evaluating and advancing several properties as well entering into our third joint venture by optioning out one of our non-core projects.

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

Our plan this year is to drill up to 20,000 metres at San Pietro. We will test existing and new target areas to expand the known mineralization and work towards resource delineation. Our first program of 2,500 metres will be executed in the first quarter of the year and will help us hone the remaining programs. Its a huge project so the work of refining and generating targets is on-going. In Argentina, we will continue working to make new discoveries at several precious metals projects and we look forward to exciting results from our joint-ventured properties.

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

Copper and cobalt both saw strong price moves in 2022 and we look forward to that continuing. Cobalt in particular is interesting, as so much of the current production is controlled exclusively by the DRC and China. As an alternative to those locations, Capstone's district integration plan in Chile could help turn the area around our San Pietro project into one of the world's largest and lowest-cost sustainable cobalt producers. We look forward to being part of the continued growth in this important sector.

Golden Arrow Resources Corp.

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WKN: A2DSQD
FRA: G6A
TSX-V: GRG

Fully diluted: 141.4 million

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