INTERGOVERNMENTAL FORUM on Mining, Minerals, Metals and Sustainable Development

BETTER POLICIES FOR BETTER LIVES

Determining the Price of Minerals

A transfer pricing framework for lithium

LITHIUM

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Introduction

About This Schedule

This mineral pricing schedule complements the practice note *Determining the Price of Minerals: A Transfer Pricing Framework* (Viola et al., 2023). The practice note provides a framework to identify the primary economic factors that can influence the pricing of minerals ("mineral pricing framework") using transfer pricing principles. This schedule shows how the framework can be applied to lithium brines and lithium minerals.

Importantly, this mineral pricing schedule does not replace, alter, or affect the Organisation for Economic Co-operation and Development [OECD] Transfer Pricing Guidelines (TPGs) (OECD, 2022) interpretation of Article 9 OECD Model Tax Convention (OECD, 2017) or the application of countries' domestic transfer pricing laws and the interpretation of those laws by the respective tax administration.

Framework: Using the comparable uncontrolled price method to determine the price of minerals sold

In applying the comparable uncontrolled price method to related-party mineral sales, the comparability factors or economically relevant characteristics outlined in Paragraph 1.36 of the 2022 OECD TPGs are to be considered. Paragraph 1.37 of the 2022 OECD TPGs further notes that the extent to which each factor is economically relevant in a particular transaction depends on the extent to which it would be taken into account by independent enterprises when evaluating the terms of the same transaction were it to occur between them. An accurate delineation of the arrangement should be undertaken in accordance with Chapter I of the 2022 OECD TPGs, considering all five comparability factors and the economically relevant characteristics of the transaction. Considering this, there are three primary comparability or economically relevant factors to consider that are particularly relevant when applying the comparable uncontrolled price method to scenarios involving related-party mineral sales.[1] These are as follows:

- the characteristics of the product, such as the physical features and quality of the commodity;
- the economic circumstances that existed at the time the sales agreement was entered into—that is, the period of the arrangement; and
- contractual terms, such as quantity transacted, transportation terms, payment terms, insurance, quotation periods, foreign exchange, and treatment and refining charges.

Importantly, this framework is premised on the following overarching conditions:

1. The associated mining enterprise (i.e., the seller) is treated as a mining enterprise that is part of a larger multinational mining group.

[1] Even though only three comparability factors are explored in detail, it does not diminish the importance of the other two comparability factors (business strategies and functional profile) when accurately delineating the transaction as outlined in the 2022 OECD TPGs.

2. Being part of the multinational group, the mining enterprise would have access to knowledge and intelligence of the commodity market conditions from its sister companies or its parent entity. This market knowledge and intelligence should include an awareness that the producing mine is one of a finite number of production entities in the world, and it produces a finite resource that is a primary source of value creation.
3. It is on this basis that the associated mining enterprise, operating wholly independently, would assess all of the options realistically available to it with the full benefit of market intelligence and knowledge that the wider multinational enterprise group has access to and sell at the highest possible price, taking into account its commercial objectives.

Application to Lithium

Lithium and Market Conditions

The lightest and most reactive of the alkali metals, lithium is a delicate silver-white metal. This element is found in trace amounts in almost all brines, minerals, clays, and seawater (International Lithium Association, 2023).

Lithium is used predominantly for producing lithium-ion batteries. Given its characteristics—high specific heat, high thermic capacity, low specific density, high voltage, and electric conductivity, which enable lithium to store and transmit energy. Lithium is well suited to power electric and hybrid vehicles, portable electronic devices, and renewable energy grid storage solutions. For electric vehicles, lithium is present in all cathode chemistries, representing between 75% and 85% of the cathode raw material cost to date.

Lithium has industrial applications, such as ceramics and glass, lubricants and grease, metallurgy, continuous casting mould flux powders, air treatment, and medical instruments. According to the latest United States Geological Survey (USGS), global end-use markets for lithium were estimated as follows: batteries, 80%; ceramics and glass, 7%; lubricating greases, 4%; continuous casting mould flux powders, 2%; air treatment, 1%; medical, 1%; and other uses, 5% (U.S. Geological Survey, 2023).

Lithium is traded either in chemical form or as a concentrate. The two dominant chemical forms of lithium on the global market are lithium carbonate and lithium hydroxide. Lithium-bearing minerals, such as spodumene, petalite and lepidolite, are mostly sold as concentrates and as direct shipping ore under certain market conditions.

Physical Characteristics of Lithium Deposits

Currently, lithium can be extracted commercially from two types of deposits: brines and minerals (hard rocks).[2] These types of deposits have different characteristics and geographical locations. As a result, the countries with the largest lithium resources are either countries with a majority of brine deposits, such as Bolivia, Argentina, the United States, and Chile, or those with a majority of mineral deposits, such as Australia, China, or the Democratic Republic of the Congo (DRC). The following table provides an overview of the countries that host the largest lithium resources worldwide. Because not all of the countries on the list have developed their resources through exploration and development, the global list of lithium reserves, the part of the resources that are commercially recoverable in Table 2, looks somewhat different from this table.

[2] Lithium production from clays will not be commercially significant until at least 2028.

TABLE 1. Lithium resources by country (tonnes of contained lithium)

Country	2023
Bolivia	23,000,000
Argentina	22,000,000
United States	14,000,000
Chile	11,000,000
Australia	8,700,000
China	6,800,000
Germany	3,800,000
DRC (Kinshasa)	3,000,000
Canada	3,000,000
Mexico	1,700,000
Czechia	1,300,000
Serbia	1,200,000
Russia	1,000,000
Peru	1,000,000
Mali	890,000
Brazil	800,000
Zimbabwe	90,000
Spain	320,000
Portugal	270,000
Namibia	230,000
Ghana	200,000
Finland	68,000
Austria	60,000
Kazakhstan	50,000
Total	**104,478,000**

Source: Authors, based on data from United States Geological Survey, 2023.

Although they contain lithium, some deposit types are not currently economically viable. Lithium, for instance, is present in some oilfield brines, as well as ocean brines in regions with geothermal activity, such as the western United States, Europe, New Zealand, and Iceland. Lithium is also present in certain sedimentary clays. Lithium production from oilfield brines, ocean brines, geothermal brines, and clays is still being investigated (International Lithium Association, 2023).

Lithium Brines

Brines in salar deposits in South America (Bolivia, Chile, Argentina), the United States (Nevada), and the Chinese regions of Qinghai and Tibet contain high quantities of lithium.

One of the main sources of lithium compounds is salar brines. Large, dry lake beds known as salars are found high up in vast mountain ranges, where brines are found just beneath a layer of crusted salt deposits. In salars, which are closed or restricted drainage basins where the rate of evaporation exceeds the rate of precipitation, lithium brines are found.

There are at least six common characteristics that provide indicators of lithium brine deposit genesis: (a) arid climate; (b) closed basin containing a salar (salt crust), a salt lake, or both; (c) associated igneous and/or geothermal activity; (d) tectonically driven subsidence; (e) suitable lithium sources; and (f) sufficient time to concentrate brine (Munk et al., 2016).

Lithium brines are used to produce lithium carbonate out of concentrated lithium chloride. Some brines' carbonate production is then processed further to produce lithium hydroxide.

Chile, Argentina, and Bolivia hold the largest and richest deposits of lithium brines. The lithium brines deposit in the Salar de Atacama, Chile, stands out in terms of production.[3] Argentina, however, holds the vast majority of salar deposits of different sizes and grades. Lithium brine deposits in China and the United States have lower grades and a higher level of impurities, such as magnesium.

[3] Sociedad Quimica y Minera de Chile reports on production volume. See Solutions for Human Progress, n.d.

FIGURE 1. The world's largest producing lithium brine deposit, Salar de Atacama, Chile

Photo credit: Nicolas Maennling.

Lithium Minerals

Lithium in minerals is found in several mineralization forms, such as lithium oxide (Li_2O). The main lithium-bearing minerals found in pegmatites are spodumene, petalite, lepidolite, amblygonite/montebrasite, and eucryptite. While there are over 140 minerals containing lithium, only a few are commercial sources of lithium, including spodumene, petalite, and lepidolite.

TABLE 2. Sources and chemical composition of lithium minerals

Mineral	Chemical Composition	% Li_2O
Spodumene	$Li_2OAl_2O_3(SiO_2)_4$	8
Lepidolite	$K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$	7.7
Polylithionite (Sonora)	$KLi_2Al(Si_4O_{10})(F,OH)_2$	7
Petalite	$Li_2OAl_2O_3(SiO_2)_8$	4.7
Zinnwaldite (Cinovec)	$KLiFeAl(AlSi_3)O(F,OH)$	2.19-3.72
Hectorite (Thacker Pass)	$Na_{0.3}(Mg,Li)_3Si_4O_{10}(OH)_2$	1.17

Source: Authors, using data provided by iLiMarkets.

Lithium deposits from pegmatites contain a concentration range of lithium oxide from 1% to over 4% (International Lithium Association, 2023).

In terms of production, spodumene is the most significant mineral containing lithium. This is due to the large deposits, relatively high lithium content, and comparatively easy processing of the ores. Economically significant amounts of petalite and lepidolite are also recovered (International Lithium Association, 2023). The processing of their concentrates is different from that of spodumene concentrates. Many deposits contain both spodumene and petalite. In Africa, lithium minerals contain mostly petalite. Lepidolite is mostly produced in China. Spodumene is currently mostly produced in Australia.

Western Australia and China are the most important suppliers of these hard rock minerals. China also plays a dominant role in the processing of mineral concentrates. Almost all of Australian spodumene is currently processed into chemicals in China. Other countries may play a larger role as suppliers in the future, such as Zimbabwe and the DRC in Africa and Brazil in the Americas.

Until the middle of the 1990s, spodumene was the main source of lithium used to produce lithium carbonate. Nowadays, lithium carbonate and lithium hydroxide are made from roughly 60% and 40% of spodumene, respectively.

Lithium mineral concentrates are used to produce either lithium carbonate or lithium hydroxide.

FIGURE 2. The world's largest producing lithium minerals deposit, the Greenbushes Mine, Australia

Source: Talison Lithium, n.d.

Lithium Production Processes—Conventional routes

The process to extract lithium and produce its chemical forms differs between brine and mineral extraction. Both can be economically viable. Brines and mineral extraction projects are found at different points of the lithium carbonate and lithium hydroxide cost curves.

The economic value of a lithium deposit is dictated by its behaviour in the different production processes. In general terms, lithium production leaves behind calcium, sodium, magnesium, potassium, boron, and other impurities that negatively affect the cost of refining the commercially valuable lithium components.

Lithium Brine Production

Lithium production from brines begins with the production of lithium chloride (LiCl) concentrate, which is then converted into lithium carbonate (Li_2CO_3) through a carbonization process. At an incremental cost, lithium hydroxide (LiOH) can be produced from lithium carbonate.

Lithium Concentration

The first phase of the lithium chemical production process is the evaporation and concentration of lithium, carried out in the evaporation ponds. The resulting brine concentrate is then sent to a chemical plant.

Lithium concentration in the brine is key to a salar's economic viability (Gleeson, 2017). The lithium concentration defines the concentration factor and evaporation area.

The most attractive salars are those with high lithium concentration and evaporation rates and low sulphate, magnesium, and calcium quantities. Evaporation rates rely on elevation and local climate. Each salar has a unique brine composition, which requires a specific flowsheet to recover the lithium. In addition, there are different conditions that can affect the technical and financial feasibility of exploiting a salar, such as climate, reservoir hydrogeology, reserves, infrastructure (electricity and accessibility), and freshwater availability.

Lithium brine production is characterized by the construction of pumping wells capable of extracting brine from different aquifers of interest. The brine extracted from each of the wells is accumulated in different gathering ponds that allow it to be distributed to evaporation ponds and, eventually, to metallurgical plants.

There are few valuable by-products during this stage. As the brine moves through the ponds, different salts are precipitated. In the evaporation process, sulphate, potassium, calcium, and magnesium will concentrate together and must be removed before lithium chloride can be precipitated. Some of these elements can be sold commercially depending on individual market feasibility (for example, potassium chloride from the Salar de Atacama projects in Chile). At the time of writing, most brine projects treat them as a waste product.

Lithium Carbonate Production

The second phase of the chemical process is carried out in the carbonate plant. To get purified brine, chemical treatments are applied to eliminate the traces of impurities remaining from the evaporation process, mainly boron, magnesium, and calcium:

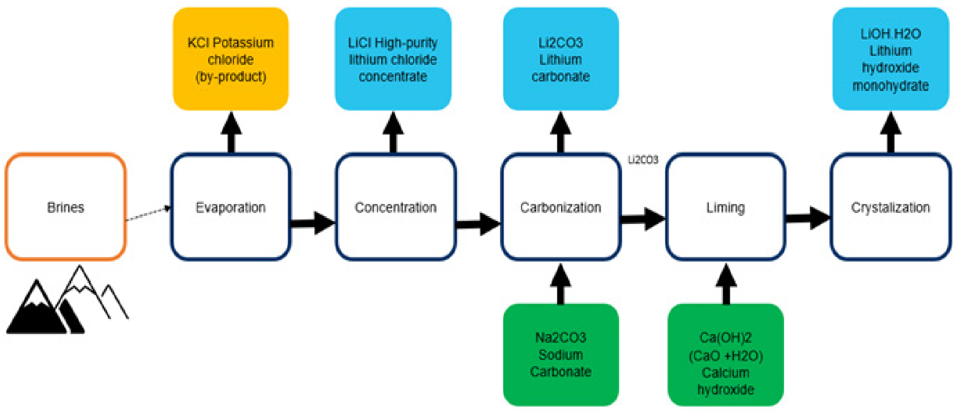
- boron: The brine is first pumped from the covered ponds to the solvent extraction plant in order to remove boron. The costs of reagents used in this stage, such as hydrochloric acid, sulphuric acid, and caustic soda, can be significant.
- magnesium: The end liquor and brine are combined after the boron is extracted in order to precipitate the majority of the magnesium as magnesium carbonate. After filtering, the brine is transferred to the second stage of magnesium extraction. Magnesium is then reacted with a lime solution to precipitate the magnesium as magnesium hydroxide. The ratio of Mg/Li indicates how much magnesium must be removed.
- calcium: To produce lithium carbonate, it is also necessary to precipitate calcium as calcium carbonate and/or calcium hydroxide.

Next, the purified brine is sent to the lithium carbonate plant.

The major cost item in the production of lithium carbonate is the consumption of soda ash. Soda ash consumption at the time of writing is around 1.9 tonnes per tonne of lithium carbonate. Lithium carbonate is precipitated by adding a soda ash solution to the purified lithium brine. After that, the lithium carbonate is dried after being filtered and cleaned on a belt filter (Ehren & de Castro Alem, 2013).

Lithium carbonate plant yield is expected to be in the 75%–80% range. A portion is expected to fail to meet the prescribed specifications or standards (10%–20%), which requires further processing, either lithium carbonate refining or conversion into lithium hydroxide.

FIGURE 3. Lithium production process from brines—process diagram



Source: Authors, using data provided by iLiMarkets.

Lithium Hydroxide Production From Lithium Carbonate

The main process of converting lithium carbonate to lithium hydroxide is called the liming route.

It starts by reacting lithium carbonate with calcium hydroxide, where lithium hydroxide is obtained in an aqueous state. Calcium carbonate is obtained, as well as waste. The yields of this process average 85% of lithium hydroxide in aqueous state. At high temperatures, this reaction yields a solution containing approximately 2.25%–2.75 % of lithium hydroxide monohydrate ($LiOH^{*}\ H_2O$). The insoluble residue (mainly calcium carbonate) is removed, and lithium hydroxide monohydrate is crystallized from the remaining solution by evaporation. After that, it is separated, and the water can be carefully dried out to yield anhydrous lithium hydroxide.

Lithium Minerals Production

Granitic pegmatites contain the most significant lithium-bearing minerals, spodumene being the most significant. The following processes refer to lithium production from spodumene but mostly apply to other minerals like petalite and lepidolite.

Lithium production from minerals can be divided into two segments: (i) mining and processing into concentrate forms and (ii) refining into chemical forms.

Mining and processing of lithium minerals include extraction, milling processes, and dense media separation. Every mine produces a different type of lithium mineral concentrate in terms of granulometry, grade, and contaminants. Refineries must be specifically fine-tuned to the concentrate they process.

Refining requires the calcination and acidification of the mineral to produce an acidic solution of lithium sulphate (Li_2SO_4), which can be reacted to produce lithium carbonate or lithium hydroxide at a similar cost. This is a major difference with brines. From the production of minerals, lithium carbonate is not necessary to produce lithium hydroxide.

Lithium Mining and Processing

Once the ore has been extracted by excavators and other mining vehicles, the concentration process starts by crushing the ore with high-pressure grinding rollers. Then, a dense media separator, deslime, and magnetic separation are used to remove impurities, including iron, mica, and dense grains. A flotation process can be added to produce a finer product. The process yields are on the order of 70% to 75%, with the aim of producing spodumene with 5.5% to 6% of lithium oxide concentration. The concentration plant is located at the mine sites, which can be in remote areas.

Transport costs can be a large cost component for lithium mineral concentrates. In Australia, some deposits are located as far as 500 km from the closest port, accessible by rail or truck. Assuming a transport cost of about USD 10/tonne per 100 km, this can add up to USD 40–50/tonne to the cost of spodumene exports.

Refining Lithium Carbonate From Spodumene

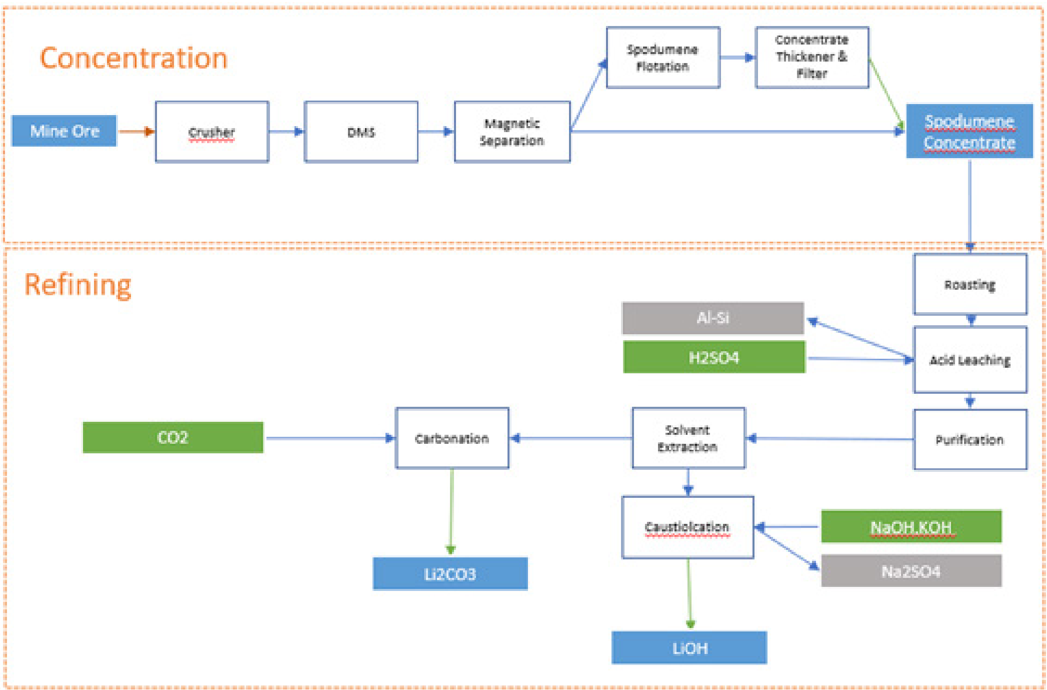
Spodumene concentrate is roasted at high temperatures to convert it to a more soluble form, specifically above 1,000°C to convert α-spodumene to β-spodumene.[4] The spodumene is then ground and mixed with sulphuric acid to extract the lithium. The lithium sulphate obtained is solubilized by leaching with water. The resulting solution can then be purified through a series of processes, including precipitation, filtration, and ion exchange to remove impurities such as iron, magnesium, and calcium. Lithium carbonate is then precipitated out of the purified solution using soda ash treatment. The amount of soda ash required for this process is similar to that required for refining lithium carbonate from lithium chloride in brines. The lithium carbonate is filtered, dried, and packaged for sale. The operating costs of the refining process are largely dependent on the prices of spodumene, sulphuric acid, soda ash, and energy (Azevedo et al., 2018).

Refining Lithium Hydroxide From Spodumene

The refining process is the same as for lithium carbonate up to the ion exchange columns. Sodium hydroxide is then added to convert the lithium sulphate into lithium hydroxide and generate sodium sulphate, which is crystallized. The yield is in the order of 80%–85% Li.

An important operating cost component is the cost of handling/transporting the solid waste from the refinery: 10–12 tonnes of waste per tonne of lithium hydroxide. This requires either significant areas dedicated to waste dumping at the refining plant or additional logistical costs for the waste to be transported elsewhere.

FIGURE 4. Lithium production process from minerals—process diagram



Source: Authors, using data provided by iLiMarkets.

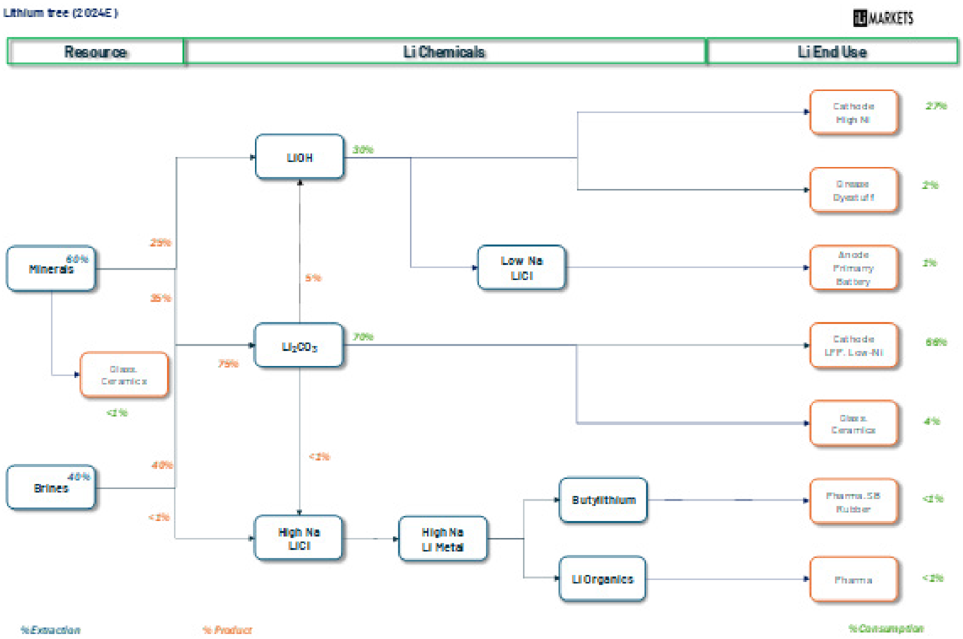
[4] Alpha spodumene is the natural crystalline form (monoclinal) where Li is more heavily bound with other elements, whereas the beta spodumene is tetragonal, making the Li extraction easier.

Lithium Production and Reserves

The following table provides an overview of the top lithium-producing countries and reserves.

Lithium production is still relatively small and concentrated but is expected to grow rapidly in the next decade. Six lithium mineral operations in Australia, one mineral tailings operation in Brazil, two lithium brine operations each in Argentina and Chile, and three mineral and two brine operations in China accounted for the majority of global lithium production in 2023 (United States Geological Survey, 2023). In recent years, lithium minerals have taken a growing share of the total lithium market. In 2022, lithium brines represented approximately 46% of the world's lithium production, and lithium minerals represented 54%.

FIGURE 5. "Lithium Tree": Sources and destination of lithium chemicals



Source: Authors, using data provided by iLiMarkets.

In 2023, production of lithium from brines was dominated by Chile (64%), China (22%), and Argentina (12%). Australia and China were the main producers of lithium from minerals.

TABLE 3. Lithium production and reserves (in tonnes of contained lithium)

Country	2020	2021	2022	2023	Reserves
Argentina	5,900	5,970	6,590	9,600	3,600,000
Australia	39,700	55,300	74,700	86,000	6,200,000
Brazil	1,420	1,700	2,630	4,900	390,000
Canada	N/A	-	520	3,400	930,000
Chile	21,500	28,300	38,000	44,000	9,300,000
China	13,300	14,000	22,600	33,000	3,000,000

Country	2020	2021	2022	2023	Reserves
Portugal	348	900	380	380	60,000
United States	-	-	-	-	1,100,000
Zimbabwe	417	710	1,030	3,400	310,000
	-	-	-	-	2,800,000
World total[5]	**82,500**	**107,000**	**146,000**	**180,000**	**28,000,000**

Source: Authors based on data from United States Geological Survey, 2023.

In 2023, six producers accounted for two thirds of global lithium carbonate equivalent (LCE) supply. Table 4 shows a 5-year outlook for LCE production.

TABLE 4. The eight biggest lithium producers at mine site level (in kilo metric tonne [kMT] LCE) in 2023[6]

Main lithium producers	LCE mined	Headquarters	Main origins of production
Sociedad Quimica y Minera de Chile	170	Chile	Chile, Australia
Albemarle	175	United States	Australia, Chile, United States
Tianqi	90	China	China, Australia
Pilbara	60	Australia	Australia
Mineral Resources	50	Australia	Australia
Allkem	35	Australia	Argentina, Canada, Australia
Ganfeng	30	China	China, Australia, Argentina
Livent	20	United States	Argentina

Source: Authors, based on data provided by iLiMarkets.

Most companies involved in brine extraction are integrated into the sale of lithium chemicals (carbonate or hydroxide) to third parties. Most companies involved in lithium mineral extraction are integrated into the sale of mineral concentrate intermediates, such as spodumene. In China, there is a high level of concentration in the processing and refining of lithium chemicals.

[5] Rounded figures.

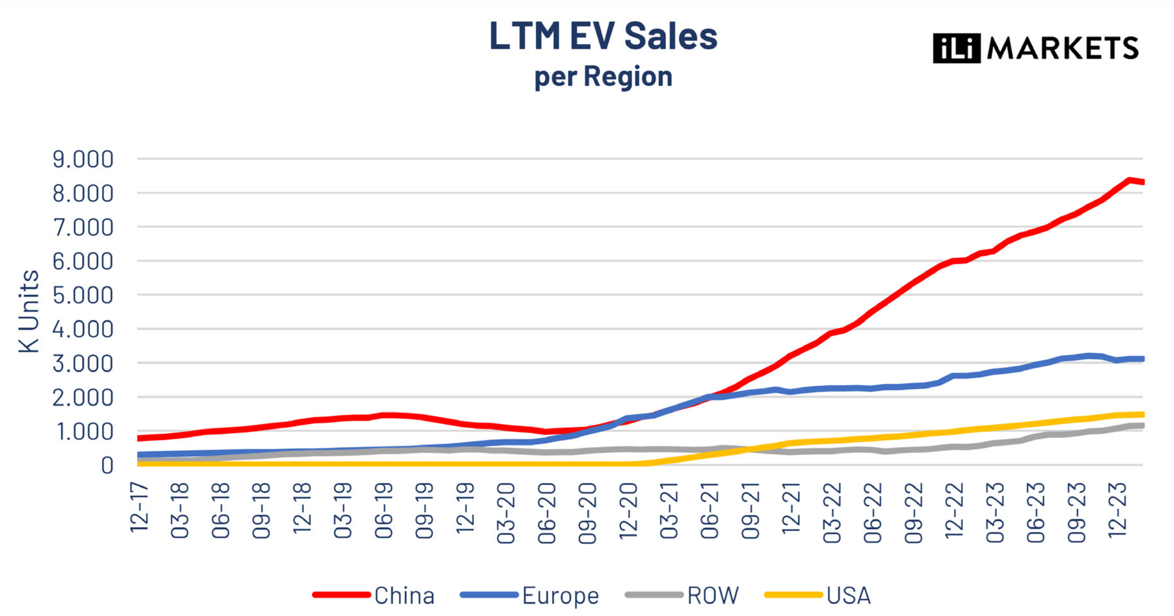
[6] Production estimate by iLiMarkets. One kMt is equal to 1,000 metric tonnes or 1 million kilograms (United States Environmental Protection Agency, n.d.).

Lithium Pricing Fundamentals

Lithium chemicals are valued for their lithium content and purity, with the vast majority of lithium chemicals used for battery production. This means that demand for lithium has a close linkage to electric vehicles and, subsequently, battery production. Outside of batteries, lithium is used in other industrial applications, such as glass and ceramics, lithium grease lubricants, and aircraft construction.

Growth in electric vehicles continues to drive lithium demand. Global electric vehicle sales grew from 6.4 million in 2021 to 10.1 million in 2022 (+60%) and reached 13.7 million in 2023. A million electric vehicles consume between 40 and 50 kMT LCE.[7] During 2023, LCE consumption in electric vehicles has grown by around 150 kMT LCE. In 2023, China accounted for 60% of global electric vehicle sales.

FIGURE 6. Electric vehicle sales per region (last 3 months [LTM]) from 2017 to 2023



Source: Authors, using data provided by iLiMarkets.

Governments are increasingly encouraging the transition to electric vehicles by combining incentives with regulatory targets. Europe and China reduced subsidies in 2023, while the United States has offered consumers the possibility to claim as much as USD 7,500 in federal tax credits "if they purchase a clean-energy vehicle that satisfies certain US rules regarding critical minerals and battery components" (Inflation Reduction Act of 2022); its effects on demand are not yet clear.

In 2022, lithium represented between 75% to 85% of the cathode raw material costs, and it is present in all cathode chemistries (lithium nickel, cobalt, manganese oxide [NCM] 111, NCM 523, NCM 622, NCM 811, lithium nickel-cobalt-aluminum oxide, lithium nickel dioxide, lithium iron phosphate, lithium manganese oxide, and lithium manganese nickel oxide (LMNO) (Jiménez & Sáez, 2022). Lithium carbonate is used to produce low-nickel cathodes, a type of

[7] Lithium carbonate equivalent.

lithium-ion batteries commonly used for electric vehicles (i.e., NCM). Lithium hydroxide is used to produce high-nickel cathodes. The respective demand for low-nickel cathodes and high-nickel cathodes is constantly changing. At the time of writing, low-nickel cathodes are being adopted more widely (e.g., by leading electric vehicle producers, such as Tesla), leading experts to expect higher demand for lithium carbonate than lithium hydroxide in the future.

An important concept is the "lithium grade." The grade refers to the quality of the lithium carbonate or lithium hydroxide and is dependent on the lithium purity, or concentration, and the level of impurities, also called the contaminant profile. Battery-grade lithium has a higher purity of lithium than technical-grade lithium, i.e., 99.5% vs 99%. Battery-grade lithium also generally has a lower level of impurities (i.e., sodium, calcium, sulphate, potassium, magnesium and chloride) and lower levels of magnetic particles (i.e., Fe, Cr, Ni, Zn). In terms of particle size, micronized battery-grade lithium is common, as opposed to technical-grade lithium, more often found in the form of crystals or powder.

A cathode producer might require technical-grade (industrial-grade) or battery-grade lithium carbonate and hydroxide. The qualification processes differ: battery grades require longer qualification processes (i.e., Initiative for Responsible Mining Assurance, International Organization for Standardization, and other certifications required by original equipment manufacturers). Refining lithium carbonate or hydroxide from technical grade to battery grade costs USD 1.5–2.5/kg on average, plus a yield loss of 3%–5%. This does not always lead to an equivalent gap in spot prices. There is typically a spot-price gap between battery grade and technical grade of USD 1–2/kg, which can increase when the market is oversupplied and decrease when the market is undersupplied.

Beyond the grade, there is no unique specification. Each cathode producer has specific requirements and a different contaminant profile, which are typically considered commercial secrets. Cathode producers will try to buy the products whose contaminant profiles are acceptable for their production process and are consistent over time. The level of impurities will impact end users to varying degrees. For example, the iron content matters more for nickel-manganese-cobalt batteries than for lithium iron phosphate batteries.

Refiners that produce lithium chemicals from minerals produce both carbonate and hydroxide. They are currently the marginal producers in the lithium production cost curve. The marginal costs of producing lithium carbonate and lithium hydroxide from spodumene are similar. Therefore, these marginal producers will produce whichever product sells at the highest price. Seeking to maximize prices, they balance the market to match the demand for each product. In other words, the current structure of the market leads to similar prices for lithium carbonate and hydroxide in the main market of Asia.

Typically, a lithium brine producer will generate a higher profit margin if it produces lithium carbonate rather than lithium hydroxide. From an economic efficiency perspective, brine producers using conventional processes should only produce lithium carbonate. However, this is not always the case. Producers might want to diversify their customers, and vice versa, and some countries may make commercial choices to secure their place in the electric battery value chain.

Although the demand for lithium seems sustainable, there are some risks from non-lithium-ion batteries. For instance, in February 2023, Hina Battery and Sehol unveiled the first test vehicle with sodium-ion batteries (Kang, 2023). Hydrogen and flow vanadium are other, albeit less likely, alternatives.

High lithium prices represent an increased recycling incentive. Recycling is expected to be a relevant source of supply from 2027 onward once used lithium-ion batteries start to become available. Beyond 2030, recycling should account for an ever-increasing percentage of the total supply of lithium. The growth of the supply of primary lithium is therefore likely to decrease in the 2030s.

Components for an Agreement for the Sale of Lithium

Lithium can be sold either in chemical form directly to cathode producers or in mineral or concentrate form to be refined into a chemical form. A very small percentage of lithium from brines is sold as lithium chloride concentrate to producers of specialty products like butyllithium. Such products are typically sold under a fixed price on long-term contracts and are outside the scope of this report.

Lithium is mostly consumed in the form of either lithium carbonate or lithium hydroxide. There is currently a large and growing market for these products, which are gradually being standardized. Although product customization for each customer is still the norm, especially for trace impurities, there has been a convergence in the limits of "typical" impurities in lithium carbonate and lithium hydroxide. The main lithium chemical producers are now able to produce a quality acceptable to most users. Therefore, buyers can source their lithium chemicals from an increasing number of sources, and sellers can sell their lithium chemicals to different customers.

Lithium is increasingly being sold as spodumene concentrate. The number of mineral refiners in China has increased, leading to a growing market for mineral concentrate imported from Australia, Africa, and Brazil for its conversion into lithium chemicals.

As with any mineral product, the terms and conditions that impact the price of a sales and purchase agreement are specific to that commodity. Lithium prices have historically been a one-on-one negotiation between the buyer (a plant that uses lithium products) and the seller (a production entity), with limited space for independent traders. This could change in the future as the market develops, but it will depend on the respective market structure of the producers and buyers of lithium chemicals and mineral concentrates.

There are many forms of contracts for the sale and purchase of lithium. This section attempts to describe the main elements of these contracts between independent parties to assist tax administrations in applying the arm's-length principle. As outlined earlier in this toolkit, this mineral pricing schedule does not replace, supersede, alter, or affect the 2022 OECD TPGs and should be read in conjunction with the main mineral pricing toolkit (Viola et al., 2023).

Sale and purchase contracts or agreements for lithium chemicals have the same structure but will contain different terms and conditions than those for lithium mineral concentrates because the product is different, as are the parties involved. They are, therefore, reviewed separately below.

Regardless of the type of lithium product, buyers request representative samples and check metallurgical and mineralogical characteristics before importing lithium chemicals, concentrates, or minerals. These characteristics are the basis of the contract and price negotiations.

Lithium Chemicals

Lithium carbonate and lithium hydroxide (monohydrate) are both used as inputs into cathodes for batteries, with similar lithium content (19% and 16.5%, respectively) and similar pricing mechanisms. Although the analysis in the following section tends to focus on lithium carbonate, most of it equally applies to lithium hydroxide.

The key components of a lithium chemical sales and purchase agreement are as follows:

- product description:
    - whether it is lithium carbonate or lithium hydroxide: a cathode producer uses one or the other, depending on its specification. They are not interchangeable.
    - battery grade or technical grade.
    - impurities that are required to be specified include:
        - sodium, calcium, potassium, iron, chrome, nickel, zinc, copper, sulphate, and chloride.
    - impurities specified upon request, normally not disclosed in the specifications, but discussed individually with customers, such as silica, alumina, lead, barium.
    - other physical properties included in specifications: particle size distribution; metallic magnetic particles; humidity (not applicable to $LiOH.H_2O$).
    - there are no price adjustments for products that do not meet the contract specifications. The off-specification products could be rejected by the buyer, as they are restricted by the processes of the cathode producer.
- quantity involved: The quantity to be transferred from the seller to the buyer. Buyers and sellers typically engage in repeated sales and may increase the volume transacted over time. In principle, the volume transacted should impact price: a large buyer should be able to negotiate additional discounts. However, this has not always been the case in practice, as the price is usually determined by supply and demand factors. For example, in an undersupplied market, sellers have more options, and large buyers may be desperate to satisfy their cathode production needs and therefore would be willing to pay a premium to secure additional volume.
- duration: determines whether it is a one-off, immediate (spot) sale, has a different delivery date (+30 days, +90 days, etc.), or is a contract for several batches at specific intervals over time (e.g., 1 year, 5 years). Many thousands of tonnes of lithium carbonate may be delivered on a multi-year contract, typically a 3–7-year contract. Typically, multi-year contract prices are negotiated periodically or linked to price indices.
- delivery terms: Depending on the arrangements negotiated between the buyer and seller, lithium carbonate can be sold at the delivery port, dispatch port, or an intermediate location. Typically, cost, insurance, and freight (CIF), or free carrier (FCA) incoterms are used when shipments go to Asia. Ex Works (EXW) can also be used for shipments within China. The FCA and delivery duty paid (DDP) incoterms are used when shipments go to Europe or North America. When contracts include variable prices with caps and floors, they typically use CIF multiple locations as a delivery condition.

TABLE 5. Incoterms in lithium contracts

CIF	The cost of insurance and freight, duty-free, to the specified port of destination is covered by the seller. As soon as the goods are placed inside the ship, risk is transferred.
FCA	The buyer supplies the carrier, and the seller is in charge of delivering the item into their custody. As soon as loading occurs, risk is transferred.
EXW	The seller is only responsible for making the goods available at the seller's premises. From that point on to the destination, the buyer assumes all risk.
DDP	It is the seller's responsibility to transport the goods to the destination port, pay any applicable duties, and give the buyer access to them. As soon as the buyer has access to the goods and they are prepared for unloading at the designated location, risk is transferred.

Source: Authors based on data from Trans Ocean Pacific, n.d.

- price: In contracts, sellers and buyers can agree to a price that is fixed, variable, or variable with caps and floors.
    - fixed prices: Standard contracts used fixed prices until around 2016, while the market was relatively stable. Prices were fixed from 1 to 3 years. With high price volatility, these contracts became a bet on future prices, with one party winning and the other losing as a result. Only a minority of contracts still used fixed contracts at the time of writing.
    - variable prices: Sellers and buyers agree on a base price adjusted by an index, where the index is derived from assessments by leading price-reporting agencies (one or multiple, such as Benchmark Mineral Intelligence, Fastmarkets, or S&P Global Commodity Insights) or trade statistics, plus/minus discount/ premium from that index of -15% to +5%. The contract can specify a yearly, biannual, quarterly, or even monthly price update. Prices are usually linked to indices reported for previous period(s). Recent contracts use an average of the prices from the 21st of the previous month to the 20th of the month of sale.
    - variable prices with caps and floors: Where variable prices with caps and floors exist in contracts, the average duration is from 3 to 7 years. The base price is also adjusted by an index derived from assessments of price-reporting agencies or trade statistics minus a discount or plus a premium (typically -15% to +5%). The cap becomes active if the variable price exceeds the cap price, and the floor becomes active if the variable price is lower than the floor price. There are price reviews if the cap or floor prices go out of a certain previously agreed range.

In general, in long-term contracts, there are clauses to review the price every 3 months or monthly.

- quotational period: When referring to a price index or assessment, the quotational period is subject to negotiation between the parties. Buyers and sellers may attempt to game the quotational period: for example, if the contract price is the lagged spot price from the previous quarter, the buyer may try to delay its purchase if the spot price is going down. Newer contracts use different quotational periods to address this problem, such as monthly updates or quarterly averages.

- premiums or discounts: When referring to a price index or assessment, prices may include premiums or discounts above/below a price index or assessment. The quantum of any premium and discount is usually set by negotiations and the market dynamics of when the contract is entered into. Another factor is the contaminant profile of lithium carbonate or hydroxide, which is specific to a producer and should not vary over time, therefore the premium or discount is negotiated upfront in the contract between the buyer and the seller. If a product has a high level of contaminants, the producer will get a lower price for the lithium concentrate. A producer with a better-quality product has more options and can obtain a premium.
- payment conditions: These generally depend on the agreed delivery term. For instance, if the contract uses CIF, payment should be made within 30 days of the shipping date; if the contract uses DDP, payments could be extended, such as 90 days of the delivery/invoicing date. Payments could be made against a letter of credit. Take or pay clauses and deliver or pay clauses are common contractual terms in lithium chemical sales and purchase agreements.

Lithium Mineral Concentrates

Lithium minerals, such as spodumene, are sold by miners in the form of concentrate. They are an intermediate product. Buyers purchase the concentrate for its lithium content, and it is used in refineries to produce either lithium carbonate or lithium hydroxide. Therefore, the payable mineral is the lithium oxide contained in the concentrate.

- type of mineral or concentrate. At the time of writing, most mineral concentrates sold are spodumene. In future, it is expected that more contracts will be entered into for petalite and lepidolite concentrates when refineries adjust their processes to be able to utilize these minerals, and miners develop these deposits.
- lithium oxide content is specified in contracts. It is the most important determinant of spodumene prices. The price can be adjusted upwards or downwards if the product differs from the specification on a linear basis, as long as it meets a minimum threshold agreed between the parties, e.g., 5% of lithium oxide from spodumene or 2.5% of lithium oxide from lepidolites.
- specifications. There is no premium or penalties in the sale of lithium concentrate, like there is for copper or gold concentrates, impurities, or valuable by-products. The price is based only on the lithium oxide content and is priced on a dry basis. The contaminants are important to determine if the specifications are met or not: if they are not, the product is rejected by the buyer. However, the buyer can negotiate the lithium concentrate price based on a contaminant profile. In a lower price environment, buyers may also consider other factors than the contaminant profile, such as moisture and particle size, which may diverge from their target specifications.

Other factors that influence the price of the lithium mineral concentrates could include incoterms, volume, quotational period, and duration, which do not differ substantially from lithium chemicals, besides the packing of the lithium mineral concentrates, which can be delivered in bulk.

Determining the Price of Lithium

In the early 2000s, determining a price for lithium was inherently difficult due to the lack of global trade in lithium. In recent years, due to the growth of lithium chemical and concentrate trade, several pricing data agencies have started collecting price intelligence and publishing lithium chemical and concentrate prices. Driven largely by Asian imports, the availability of pricing data has increased, thereby facilitating the price-discovery process and allowing the development of lithium price indices. Lithium pricing data is published by price-reporting agencies such as Argus Media, Asian Metals, Benchmark Mineral Intelligence, Fastmarkets, S&P Global Commodity Insights, and Shanghai Metal Market and can be accessible through a subscription.

Price-reporting agencies have their own published methodology to develop spot and/or contract prices. The methodology is based on a range of factors, such as actual third-party transactions, bids and offers, and market intelligence—i.e., calls and other communication methods, such as emails to buyers and sellers. Neither indicator is a perfect reflection of market prices, although this is expected to change as the market grows rapidly in coming years and the price indices become more reliable.

Spot prices have long been based on a small volume of transactions. As of 2023, spot sales had been increasing, mostly within China, and into China, Japan, and Korea. In coming years, spot sales could increase significantly in various markets as additional supply and buyers come online, which will make reported spot prices by price-reporting agencies more accurate reflections of market prices.

The reported contract price may reflect actual prices in sales contracts, but these are composed of old and new contracts, some of which are based on a fixed price, which might differ significantly depending on when they were negotiated, the volume involved, and the quality of the lithium sold. As such, reported contract prices tend to be significantly different than spot prices. This highlights that a relevant consideration when reviewing the pricing term is the period when the sale and purchase agreement was entered into.

The availability of pricing indices themselves does not represent a substitute for an arm's-length price that would be agreed between independent parties. It does, however, present a reliable starting point for price-discovery purposes.

To determine whether it is appropriate to use such indices, it must be first established whether independent parties in negotiations use these indices and, if so, to what extent. From interviews with price-reporting agencies and market experts, it can be concluded that many buyers and sellers of lithium chemicals and concentrates do use price indices in their negotiations. Depending on market conditions, a discount or a premium to the price index or assessment can be negotiated. For instance, discounts are often negotiated when the market conditions favour the buyer and premiums when market conditions favour the seller. Tax administrations should account for market conditions prevailing at the time of a transaction when using price indices as a basis for an arm's-length price.

Lithium Price Indices

Price-reporting agencies report lithium chemicals and concentrate prices. These are Argus Media, Asian Metals, Benchmark Mineral Intelligence, Fastmarkets, S&P Global Commodity Insights, and Shanghai Metal Market.

Almost all agencies publish spot-price assessments in importing countries, particularly China, Japan, and Korea. In China, they are able to distinguish between domestic sales, typically priced on a DDP incoterm basis, and imports, priced on a CIF basis. Agencies with access to knowledge of commercial contracts also report contract prices. Asian Metals and Benchmark Mineral Intelligence also publish free on board (FOB) price assessments for some of the major exporting regions: North and South America, and, along with S&P Global Commodity Insights, Australia for spodumene exports.

Because the lithium market is still relatively opaque and open trades are limited, some price-reporting agencies report assessments of price ranges or the middle of a price range rather than a single market price. Other price-reporting agencies report an assessment daily for certain price assessments, as they are confident there is enough liquidity in the market. These are price assessments, not price indices, strictly speaking. They are not observed in a fully transparent market where most bids, offers, and transactions are public, like a metal exchange. The price-reporting agencies publish price assessments based on a range of factors, such as individual contacts or transactions, bids and offers, and communications with producers, buyers, sellers, and other market agents. Through their networks, they have access to valuable information and produce price assessments following rigorous methodologies, most of them compliant with the International Organization of Securities Commission (IOSCO, n.d.). Full details of the price methodologies followed by price-reporting agencies are published on their websites and/or available upon request.

At the time of writing, the only markets large enough to produce reliable market assessments for lithium chemicals in price-reporting agencies' publications are in Asia: China, Japan, and Korea, representing together over 90% of traded volumes of lithium. Given the size of Australia as a producer of lithium mineral concentrate and the diversity of buyers, an FOB Australia price for spodumene concentrate may also represent a relatively liquid market.

The lithium market is growing and evolving quickly. It is expected that price-reporting agencies will keep adjusting their price methodologies as the market evolves. For example, growing producing regions may see dedicated FOB price indices, and growing buying regions may see new CIF, DDP, EXW, or other relevant price indices. Price assessments for deliveries in Europe and North America that have been recently created may become more representative of market prices when these regions become more important buyers of lithium chemicals. Tax administrations should keep abreast of these developments. This means, for example, adjusting their transfer pricing analyses to market conditions applicable during an audit period or taking a forward-looking or flexible approach in negotiating advanced pricing arrangements or safe harbours.

Argus Media

Argus is an important price-reporting agency recognized by a large number of commodity producers (Argus Media, n.d.-a). It is a more recent publisher of lithium price assessments. In 2018, Argus introduced two fresh evaluations of lithium: lithium hydroxide, 56.5% (battery grade, FOB China) and lithium carbonate, 99.5% (battery grade, CIF China). It now reports other lithium chemicals and spodumene prices. Argus reports a distinct seaborne China price for lithium, having established that China is the biggest, if only, liquid spot market. All prices are reported on a spot basis only.

Argus lithium price assessments are tailored for specific market conditions through direct industry consultation. A methodological note for all battery materials is available on their website (Argus Media, n.d.-c). The process is similar to other price-reporting agencies. Argus collects information on transactions, bids and offers, and other market information to include spread values between grades, locations, timings, etc. The data is verified by price reporters and assessed and reviewed before publication.

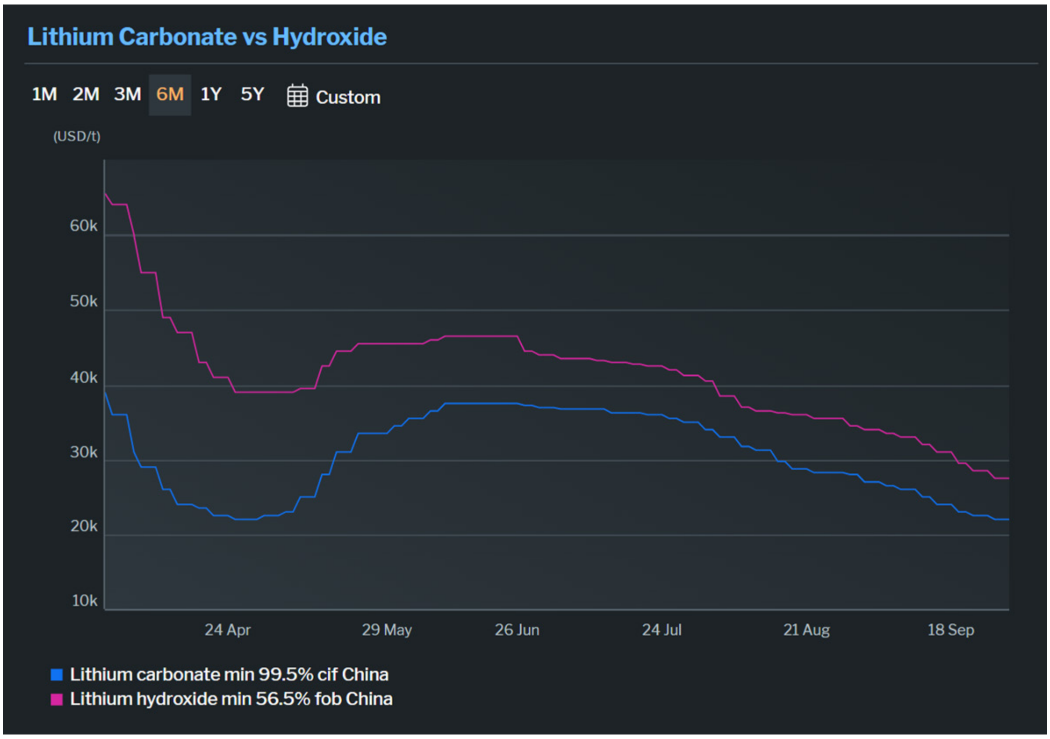
The main consumers of Argus lithium pricing assessments are producers and purchasers of raw lithium, as well as large-scale industrial buyers, especially automakers. Globally, businesses and governments use their data as benchmarks in the financial markets and to index physical trade.

TABLE 6. Argus Media lithium prices

Product	Incoterm	Unit	Location	Frequency
Carbonate 99.5% incl. VAT	EXW	CNY/tonne	China	daily
Carbonate 99.5% EXW China (ex-VAT)	EXW	USD/kg	China	daily
Carbonate 99.5%	CIF	USD/kg	China	twice weekly
Carbonate 99.5%	CIF duty unpaid	USD/tonne	Japan/ Korea	weekly
Hydroxide 56.5% incl. value-added tax (VAT)	EXW	CNY/tonne	China	daily
Hydroxide 56.5% EXW China (excl. VAT)	EXW	USD/kg	China	daily
Hydroxide 56.5%	FOB duty paid	USD/kg	China	twice weekly
Hydroxide 56.5%	CIF duty unpaid	USD/tonne	Japan/ Korea	weekly
Concentrate (spodumene) 6% Li_2O CIF China	CIF duty unpaid	USD/tonne	China	weekly
Concentrate (spodumene) 6% Li_2O FOB Australia	FOB duty unpaid	USD/tonne	Australia	weekly

Source: Authors based on data from Argus Media, n.d.-a.

FIGURE 7. Argus Media lithium prices



Source: T. Kavanagh, personal communication, September 2023.

Asian Metal

Asian Metal collects mineral and metal prices from direct phone communications with market participants: producers, consumers, traders, and governments. It includes prices of deals just closed, being closed, or under negotiation in the spot market (Asian Metal, n.d.).

Asian Metal publishes lithium prices on a wide range of products. In particular, it publishes lithium metal prices, lithium chloride, lithium cobaltate, lithium manganate, and other battery inputs, such as lithium-nickel-cobalt-manganese oxide (LNCMO).

Asian Metal produces a general price methodology note applicable to all the minerals and metal prices published by the agency. The methodology is not publicly available but is available from the agency upon request.

TABLE 7. Asian Metal lithium prices

Product	Incoterms	Unit	Location	Frequency
Lithium carbonate: 99% min.	Delivered	CNY/tonne	China	Unknown
Lithium carbonate: 99.5% min.	Delivered	CNY/tonne	China	Unknown
Lithium carbonate: 99.5% min.	CIF	USD/kg	China	Unknown
Lithium carbonate: 99.5% min.	Delivered	USD/kg	EU	Unknown
Lithium carbonate: 99.5% min.	Delivered	USD/kg	US	Unknown
Lithium carbonate: 99.5% min.	FOB	USD/kg	South America United States	Unknown
Lithium hydroxide monohydrate: LiOH 56.5% min.	Delivered	CNY/tonne	China	Unknown
Lithium hydroxide monohydrate: LiOH 56.5% min. magnets 0.0001% max.	Delivered	CNY/tonne	China	Unknown
Lithium hydroxide monohydrate: LiOH 56.5%min magnets 0.0001% max.	FOB	USD/kg	China	Unknown
Lithium hydroxide monohydrate: LiOH 56.5% min., magnets 0.0001% max.	Delivered	USD/kg	South Korea	Unknown
Lithium metal: 99% min.	Delivered	CNY/tonne	China	Unknown
Lithium metal: 99.9% min.	Delivered	CNY/tonne	China	Unknown
Spodumene: Li_2O 6% min.	CIF	USD/tonne	China	Unknown
Lithium chloride: 99.3% min.	Delivered	CNY/tonne	China	Unknown
Lithium cobaltate: Co 60% min.	Delivered	CNY /kg	China	Unknown
Lithium manganate: Mn 58%	Delivered	CNY/tonne	China	Unknown
Lithium iron phosphate: Li 3.9% min.	Delivered	CNY/tonne	China	Unknown
LNCMO, 523	Delivered	CNY/tonne	China	Unknown
LNCMO, 622	Delivered	CNY/tonne	China	Unknown

Source: Authors based on date from Asian Metal, n.d.

FIGURE 8. Asian Metals lithium prices

More: • Lithium Carbonate • Lithium Hydroxide • Lithium Metal • Lithium Cobalt Oxide • Lithium Iron Phosphate • Lithium Manganese Oxide • Lithium Hexafluorophosphate • Lithium Nickel Cobalt Aluminum Oxide • Lithium Nickel Cobalt Manganese Oxide • Lithium Chloride • Lithium Ore

Choose Lithium Carbonate 99.5%min CIF China USD/kg
From 2023 Y 6 M 29 D To 2023 Y 9 M 27 D OK

AM Price Methodology

	Product	Specification	Unit	Price	Price in USD*	Change	Update	FCST
[Lithium Price Index]	Spodumene	Li2O 6%min CIF China	USD/mt	2280-2300	2280-2300	↓ 2.55%	2023-09-27	
[Lithium Price Index]	Lithium Metal	99%min Delivered China	RMB/mt	1280000-1300000	178278-181064	↓ 2.27%	2023-09-27	
[Lithium Price Index]	Lithium Metal	99.9%min Delivered China	RMB/mt	1360000-1380000	189420-192206	↓ 2.14%	2023-09-27	
[Lithium Price Index]	Lithium Carbonate	99.2%min Delivered China	RMB/mt	151000-156000	21031-21728	–	2023-09-27	
[Lithium Price Index]	Lithium Carbonate	99.5%min Delivered China	RMB/mt	164000-169000	22842-23538	↓ 1.77%	2023-09-27	
[Lithium Price Index]	Lithium Carbonate	99.5%min CIF China	USD/kg	26.6-27.1	26.6-27.1	↓ 2.89%	2023-09-27	
[Lithium Price Index]	Lithium Carbonate	99.5%min Delivered EU	USD/kg	25.4-25.9	25.4-25.9	↓ 2.66%	2023-09-27	
[Lithium Price Index]	Lithium Carbonate	99.5%min Delivered US	USD/kg	25.8-26.3	25.8-26.3	↓ 2.62%	2023-09-27	
[Lithium Price Index]	Lithium Carbonate	99.5%min FOB South America	USD/kg	23.4-23.7	23.4-23.7	↓ 2.89%	2023-09-27	
[Lithium Price Index]	Lithium Chloride	99.3%min Delivered China	RMB/mt	163000-165000	22703-22981	–	2023-09-27	
[Lithium Price Index]	Lithium Cobaltate	Co 60%min Delivered China	RMB/kg	213-218	29.7-30.4	–	2023-09-27	

Source: F. Gao, Asian Metals, personal communication, October 2, 2023.

Benchmark Mineral Intelligence (BMI)

BMI is a price-reporting agency that specializes in the lithium and lithium-ion battery supply chain (Benchmark, n.d.-c). Established in 2014, BMI was designed to collect key lithium and battery raw material prices such as nickel, graphite, and cobalt and has reached important price-reporting standards (Benchmark, n.d.-a). It publishes a wide number of spot and contract price assessments totalling 16 grades—9 on lithium carbonate, 6 on lithium hydroxide, and 1 on spodumene—and a sustainable lithium price. Furthermore, BMI calculates the world average prices for lithium hydroxide and carbonate as well as a lithium chemical index that is weighted by market volume traded as well as a similar weighted global lithium chemical index.

BMI publishes a dedicated methodology on its lithium prices, with a detailed explanation of each price assessment (Benchmark, n.d.-b). Prices are assessed biweekly for contract prices and weekly for spot prices in the most liquid markets (EXW China and CIF Asia). The assessment follows an IOSCO-certified methodology[8] that is uniquely designed for the lithium market, which is based on transactions recorded in the market, bids and offers, and confirmation from market participants. This is followed by an internal review process and a process for correction and revisions if required.

BMI publishes the following lithium price assessments for lithium carbonate, lithium hydroxide, and spodumene.

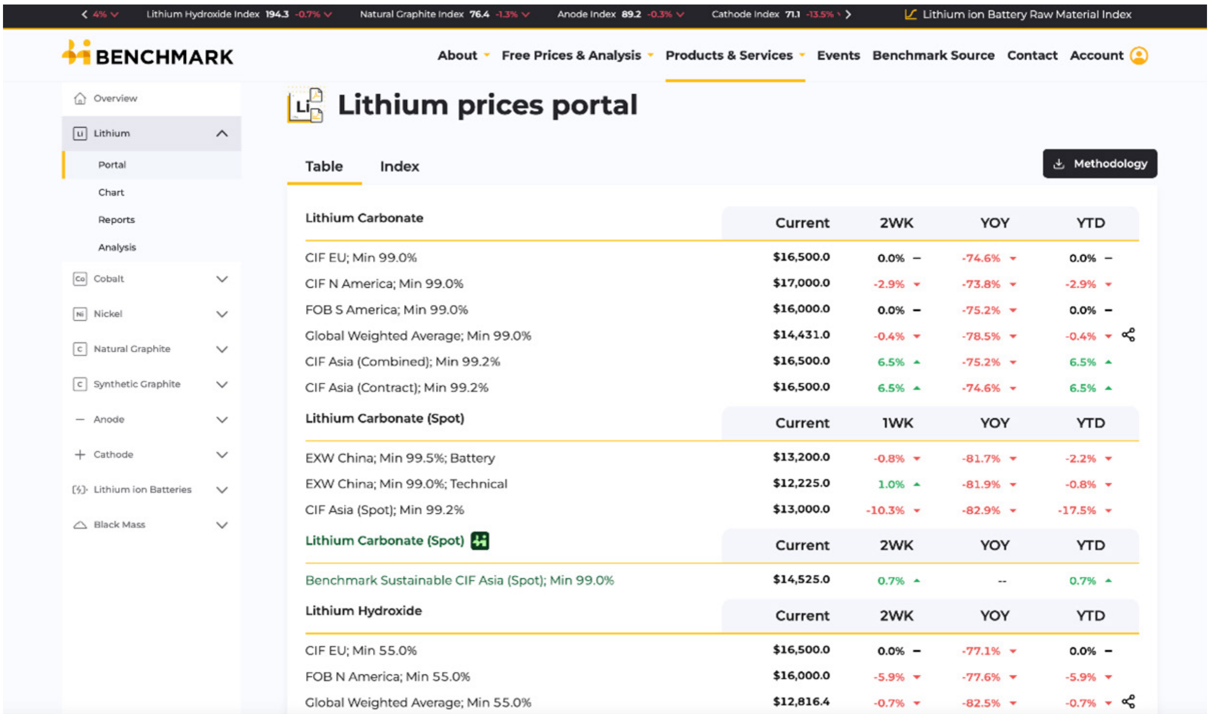
[8] BMI is the only price-reporting agency to have all lithium grades assured to Type 2 standard, the highest form of assurance under IOSCO principles.

TABLE 8. Benchmark Mineral Intelligence lithium prices

Product	Incoterm	Type	Unit	Location	Frequency
Li_2CO_3 min. 99.2%	CIF	Combined	USD/ tonne	Asia (Japan, South Korea, China)	Weekly
Li_2CO_3 min. 99.2%	CIF	Contract	USD/ tonne	Asia (Japan, South Korea, China)	Fortnightly
Li_2CO_3 min. 99.0%	CIF	Spot and contract	USD/ tonne	Europe	Fortnightly
Li_2CO_3 min. 99.0%	CIF	Spot and contract	USD/ tonne	North America	Fortnightly
Li_2CO_3 min. 99.0%	FOB	Spot and contract	USD/ tonne	South America	Fortnightly
Li_2CO_3 min. 99.5%, battery grade	EXW, VAT Included	Spot	CNY/ tonne	China (domestic)	Weekly
Li_2CO_3 min. 99.0%, technical grade	EXW, VAT Included	Spot	CNY/ tonne	China (domestic)	Weekly
Li_2CO_3 min. 99.0%, sustainable	CIF	Spot	USD/ tonne	Asia (Japan, South Korea, China)	Fortnightly
Li_2CO_3 min. 99.0%	Weighted average	Spot and contract	USD/ tonne	Global	Fortnightly
LiOH min. 56.5%	CIF	Spot	USD/ tonne	Asia (Japan, South Korea, China)	Weekly
LiOH min. 56.5%	CIF	Contract	USD/ tonne	Asia (Japan, South Korea, China)	Fortnightly
LiOH min. 55.0%	CIF	Spot and contract	USD/ tonne	Europe	Fortnightly
LiOH min. 55.0%	FOB	Spot and contract	USD/ tonne	North America	Fortnightly
LiOH min. 56.5%	EXW, VAT Included	Spot	CNY/ tonne	China (domestic)	Weekly
LiOH min. 55.0%	Weighted average	Spot and contract	USD/ tonne	Global	Fortnightly
Spodumene concentrate Li_2O content 6.0%	FOB	Spot and contract	USD/ tonne	Australia	Fortnightly

Source: Authors based on data from Benchmark, n.d.-c.

FIGURE 9. BMI lithium prices



Lithium Carbonate	Current	2WK	YOY	YTD
CIF EU; Min 99.0%	$16,500.0	0.0%	-74.6%	0.0%
CIF N America; Min 99.0%	$17,000.0	-2.9%	-73.8%	-2.9%
FOB S America; Min 99.0%	$16,000.0	0.0%	-75.2%	0.0%
Global Weighted Average; Min 99.0%	$14,431.0	-0.4%	-78.5%	-0.4%
CIF Asia (Combined); Min 99.2%	$16,500.0	6.5%	-75.2%	6.5%
CIF Asia (Contract); Min 99.2%	$16,500.0	6.5%	-74.6%	6.5%
Lithium Carbonate (Spot)	**Current**	**1WK**	**YOY**	**YTD**
EXW China; Min 99.5%; Battery	$13,200.0	-0.8%	-81.7%	-2.2%
EXW China; Min 99.0%; Technical	$12,225.0	1.0%	-81.9%	-0.8%
CIF Asia (Spot); Min 99.2%	$13,000.0	-10.3%	-82.9%	-17.5%
Lithium Carbonate (Spot)	**Current**	**2WK**	**YOY**	**YTD**
Benchmark Sustainable CIF Asia (Spot); Min 99.0%	$14,525.0	0.7%	--	0.7%
Lithium Hydroxide	**Current**	**2WK**	**YOY**	**YTD**
CIF EU; Min 55.0%	$16,500.0	0.0%	-77.1%	0.0%
FOB N America; Min 55.0%	$16,000.0	-5.9%	-77.6%	-5.9%
Global Weighted Average; Min 55.0%	$12,816.4	-0.7%	-82.5%	-0.7%

Source: C. Rawles, BMI, personal communication, February 1, 2024.

Fastmarkets

Fastmarkets is a price-reporting agency that reports lithium carbonate and lithium hydroxide price assessments on a North Asian (China/Japan/Korea) CIF basis, Europe DDP basis, and domestic China EXW (VAT included) basis since 2017 (Fastmarkets, n.d.-b). It also reports spodumene prices on a China CIF basis. Most spot prices are reported weekly, and contract prices are reported monthly, except the two most liquid markets, battery-grade lithium carbonate and lithium hydroxide, delivered China/Japan/Korea CIF, which are reported daily.

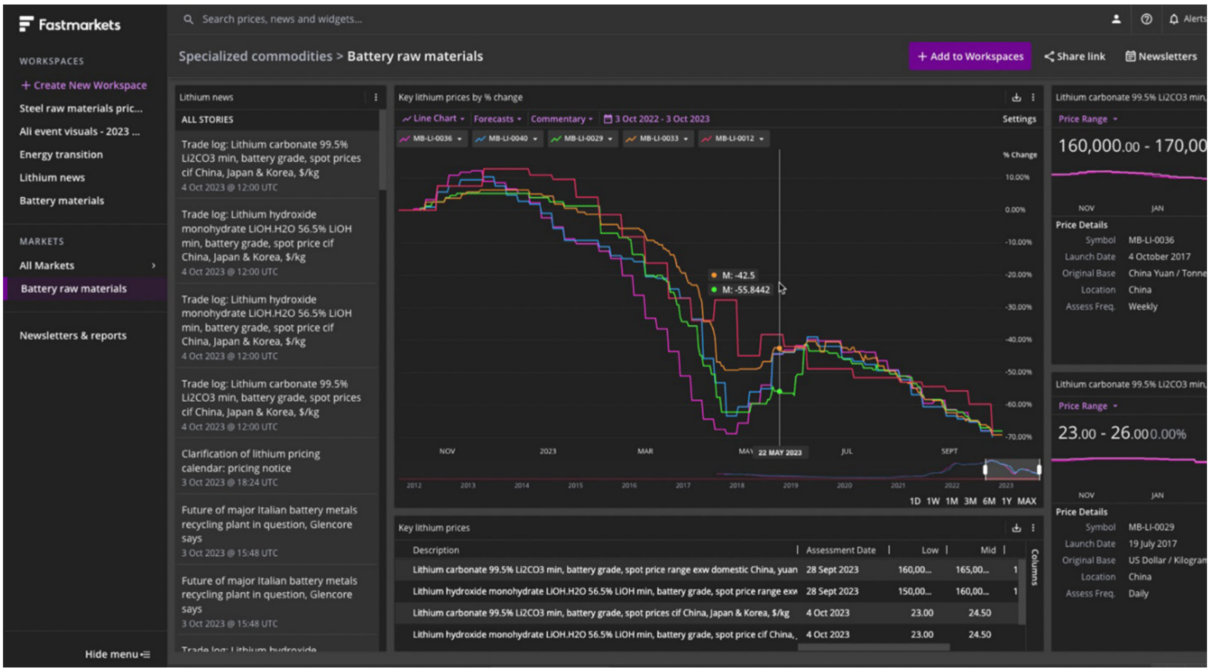
Fastmarkets' price methodology uses the following assessment price definition: "The prevailing level at which a commodity of stated specification has or could be expected to have transacted over a defined period of time" (Fastmarkets, 2022). After collecting numerous data points on lithium transactions—as well as offers, bids, transactions heard second hand, and indications—they assign different weights to transactions depending on how confident they are that those data points reflect the open and competitive market, normalize prices for different types of commercial conditions, and discard the data points they have less confidence in and deem less significant. Publication is done daily, weekly, or monthly, depending on the products, after a standardized peer review process, with opportunities for correction if required.

TABLE 9. Fastmarkets lithium price assessments

Product	Incoterm	Type	Unit	Location	Frequency
Min. 99.5% Li_2CO_3, battery grade	CIF	Contract	USD/kg	China/ Japan/Korea	Monthly
	CIF	Spot	USD/kg	China/ Japan/Korea	Daily
	EXW	Spot	CNY/tonne	Domestic China	Weekly
	DDP	Contract	USD/kg	Europe	Monthly
	DDP	Spot	USD/kg	Europe	Weekly
Monohydrate 56.5% $LiOH.H_20$ min., battery grade	EXW	Spot	CNY/tonne	Domestic China	Weekly
	CIF	Contract	USD/kg	China/ Japan/Korea	Monthly
	DDP	Contract	USD/kg	Europe	Monthly
	DDP	Spot	USD/kg	Europe	Weekly
	CIF	Spot	USD/kg	China/ Japan/ Korea	Daily
Monohydrate 56.5% $LiOH.H_20$ min., technical and industrial grades	DDP	Contract	USD/kg	Europe	Monthly
	DDP	Spot	USD/kg	Europe	Weekly
	CIF	Contract	USD/kg	China/ Japan/Korea	Monthly
	CIF	Spot	USD/kg	China/ Japan/Korea	Weekly
	EXW	Spot	CNY/tonne	Domestic China	Weekly
0BMin. 99% Li_2CO_3, technical and industrial grades	CIF	Contract	USD/kg	China/ Japan/Korea	Monthly
	CIF	Spot	USD/kg	China/ Japan/Korea	Weekly
	EXW	Spot	CNY/tonne	Domestic China	Weekly
	DDP	Contract	USD/kg	Europe	Monthly
	DDP	Spot	USD/kg	Europe	Weekly
Spodumene min. 6% Li_2O	CIF	Spot	USD /tonne	China	Fortnightly
	CIF	Contract	USD /tonne	China	Monthly

Source: Authors, based on data from Fastmarkets, n.d.-b.

FIGURE 10. Fastmarkets lithium price assessments



Source: J. Yang, personal communication, October 19, 2023.

S&P Global Commodity Insights

S&P Global Commodity Insights reports Platts lithium carbonate, lithium hydroxide, and spodumene prices (S&P Global, n.d.-c). Its lithium carbonate and hydroxide prices, which represent actual spot market prices for battery-grade material, are evaluated every day on a CIF North Asia, CIF Europe, and DDP China basis. Additional attributes are considered and could be adjusted to return to the base standard specifications of S&P Global Commodity Insights. The lithium spodumene price is assessed daily on an FOB Australia basis, reflecting physical spot market prices, with a minimum of 6% lithium oxide content exported from Western Australian ports.

S&P Global Commodity Insights publishes its Platts general pricing methodology (S&P Global, 2024a) as well as a price specifications guide for nonferrous metals (S&P Global, 2024b). It collects information on bids/offers and deals, verifies the information with market participants, normalizes prices when required, and discards non-representative data. It also publishes individual data points that are the basis for their assessment, such as actual transactions and bids and offers, so-called “heards,” accessible through free registration (S&P Global, n.d.-b).

TABLE 10. S&P Global Commodity Insights Platts lithium prices

Product	Incoterms	Unit	Location	Frequency
Lithium carbonate min. 99.5% Li_2CO_3	CIF	USD /tonne	North Asia	Daily – 16:30 SG
Lithium carbonate min. 99.5% Li_2CO_3	CIF (import parity)	CNY /tonne	North Asia	Daily – 16:30 SG
Lithium carbonate min. 99.5% Li_2CO_3	DDP	CNY /tonne	China	Daily – 16:30 SG
Lithium carbonate min. 99.5% Li_2CO_3	CIF	USD/tonne	Europe	Daily – 16:30 UK
Lithium hydroxide min. 56.5% $LiOHH_2O$	CIF	USD /tonne	North Asia	Daily – 16:30 SG
Lithium hydroxide min. 56.5% $LiOHH_2O$	DDP	CNY /tonne	China	Daily – 16:30 SG
Lithium hydroxide min. 56.5% $LiOHH_2O$	CIF	USD/tonne	Europe	Daily – 16:30 UK
Lithium spodumene min. 6% Li_2O	FOB	USD /tonne	Australia	Daily – 16:30 SG
Lithium spodumene 0.1% differential to spodumene 6% FOB Australia	FOB	USD /tonne	Australia	Daily – 16:30 SG

Source: Authors based on S&P Global, n.d.-c.

Shanghai Metals Market

Shanghai Metals Market (SMM) is a comprehensive online marketplace offering both ferrous and nonferrous metals (SMM, n.d.-a). Focused on the Asian markets, and the Chinese market in particular, SMM publishes price assessments for lithium carbonate and hydroxide, battery grade and industrial grade, as well as lithium metal, spodumene concentrate, and different types of lithium-bearing minerals (SMM, 2020).

SMM publishes methodological notes for its different price indices, which include battery-grade lithium carbonate and lithium hydroxide (SMM, n.d.-b). For instance, for the SMM battery-grade lithium carbonate price index assessment, a note contains standards and management methods: “These standards are formulated to establish a transparent and verifiable SMM price setting mechanism and provide market participants with an important pricing reference” (SMM, 2021). An SMM Price Administration Committee provides oversight on the methodology and its implementation.

SMM analysts collect price data information from multiple sources, confirm them with market participants, and assess/rank their reliability. They also discard non-reliable data. For example, “prices resulting from transactions between affiliated enterprises, sell-offs under financial or legal pressure and any other non-repeatable trading practices.” They normalize the price data in order to publish a spot-price index assessment. SMM price index meets IOSCO principles (SMM, 2020).

SMM publishes price assessments for other lithium products beyond battery-grade carbonate and hydroxide, which follows the same methodologies as other leading pricing indices.

TABLE 11. SMM lithium prices (all price ranges including VAT)

Product	Incoterms	Unit	Location	Frequency
Lithium carbonate (99.2% industry level zero/domestic)	EXW	CNY /tonne	China	Daily
Lithium carbonate (99.5% battery grade/domestic), magnetic content ≤0.003%	EXW	CNY /tonne	China	Daily
Lithium hydroxide monohydrate (56.5% industry grade/domestic)	EXW	CNY /tonne	China	Daily
Lithium hydroxide monohydrate (56.5%, battery grade, coarse particle/domestic), $LiOH•H_2O$≥98%, particle size of battery-grade lithium hydroxide is in the range of 300–400 microns	EXW	CNY /tonne	China	Daily
Lithium metal (≥99%, industrial, battery/domestic)	EXW	CNY /tonne	China	Daily
Lithium metal (battery grade): Li≥99.9%	DDP	CNY /tonne	China	Daily
Spodumene concentrate (6%, CIF China): Lithium oxide 5.5–6%, prices converted proportionally 6%	CIF	USD/tonne	China	Daily

Other ore prices reported by SMM but not subject to a rigorous price assessment:

- spodumene (Li_2O:1.2%-1.5%) (weekly update) (USD/mt)
- spodumene (Li_2O:2%-2.5%) (weekly update) (USD/mt)
- spodumene (Li_2O:3%-4%)(weekly update) (USD/mt)
- lepidolite (Li_2O:1.5%-2.0%) (USD/mt)
- lepidolite (Li_2O:2.0%-2.5%) (USD/mt)
- montebrasite (Li_2O:6%-7%) (USD/mt)
- montebrasite (Li2O:7%-8%) (USD/mt)

Source: Authors, based on data from SMM, n.d.

TABLE 12. SMM lithium prices on September 28, 2023

Lithium compound | Lithium ore

Price description	Price Range	Avg.	Change	Date
Spodumene Domestic China (Li2O:5%-5.5%) (RMB/mt)	12,200-14,500	13,350	-150	Sep 28, 2023
Spodumene Domestic China (Li2O:4%-5%) (RMB/mt)	10,200-13,750	11,975	-125	Sep 28, 2023
Spodumene Domestic China (Li2O:3%-4%) (RMB/mt)	6,300-11,300	8,800	-300	Sep 28, 2023
Spodumene (Li2O:1.2%-1.5%) (weekly update) (CNY/mt)	1,292.36-1,615.46	1,453.91	-143.6	Sep 28, 2023
Spodumene (Li2O:2%-2.5%) (weekly update) (CNY/mt)	2,189.84-3,015.52	2,602.68	-179.5	Sep 28, 2023
Spodumene (Li2O:3%-4%) (weekly update) (CNY/mt)	5,097.66-6,641.32	5,869.49	-538.49	Sep 28, 2023
Lepidolite (Li2O:1.5%-2.0%) (CNY/mt)	1,950-3,800	2,875	-50	Sep 28, 2023
Lepidolite (Li2O:2.0%-2.5%) (CNY/mt)	3,800-5,400	4,600	-100	Sep 28, 2023

Source: K. Zhu, personal communication, October 20, 2023.

Comparability Adjustments

Characteristics of the Product

Lithium Chemicals

As discussed in the section on commercial agreements, the most important determinant of the price of lithium carbonate or lithium hydroxide monohydrate, which are both used to produce battery cathodes, is their specifications. Buyers buy a specific product (lithium carbonate or lithium hydroxide) of a given grade (battery or technical/industrial) with given specifications. It is critical that producers have a qualified quality assurance system for the lithium chemicals to be recognized as battery grade in the market and priced accordingly. Otherwise, the product may have to be sold as a technical/industrial grade at a lower price, even if it meets the quality specifications of battery grade.

If the product does not meet specifications as stipulated in the contract, the buyers can reject it. If the product meets the specifications, then the exact percentage of valuable material (lithium) or contaminants in a shipment does not affect the price. For example, if a contract provides for a lithium carbonate of a minimum 99.2% purity and the final product is 99.3%, the buyer does not receive a price premium for the higher purity. Or if a contract provides for a maximum amount of sodium, a contaminant, of 0.065%, the price is not affected if the final level of sodium is below this amount—it is binary, i.e., is the product within the specifications, as stipulated in the contract or not.

Lithium Mineral Concentrates

As discussed in the section on commercial agreements, the most important determinant of the price of lithium mineral concentrates is the content of lithium in the form of lithium oxide.

The current practice for spodumene concentrates is to contract for a standard product of 6% Li_2O, whose prices are transparent and published by price-reporting agencies, as documented in the earlier section. The price is then adjusted proportionally to the effective Li_2O content as long as it is above a minimum amount, e.g., 5%. For example, if the lithium oxide content in a specific shipment of spodumene concentrate is 5.2%, then the price is discounted accordingly from the standard product of 6% Li_2O. The adjustment is generally done in a linear manner, within a limited range. Outside of these limited ranges, the relationship between lithium oxide content and price is not linear. This is important to note as acceptable minimum lithium oxide content could be lower than 5%.

As for lithium chemicals, if the product does not meet specifications, the buyers can reject it. However, the specifications are less strict for concentrates than for chemicals, as contaminants will be removed when concentrates are refined into either lithium carbonate or lithium hydroxide. Contaminants in the concentrates, and in lower price environments, other characteristics such as moisture and particle size, will generate discounts, as long as they meet contract specifications and there were no valuable, payable by-products at the time of writing.

Economic Circumstances

As outlined earlier, demand for clean energy sources, in the context of the energy transition and the increased demand for electric vehicles, directly impacts the lithium market. These economic factors led to the creation of lithium carbonate and lithium hydroxide price assessments. From a transfer pricing perspective, this allows tax administrations to account for the temporal factors arising from global supply and demand by referencing price assessments that correspond to the period in which related-party sales contracts are entered into and/or when the specific transactions occurred (i.e., the date of when the good was sold if referencing an index assessment). This is particularly important, given that the current volatility of the lithium market and the relevant period in which the transaction occurred will have a significant bearing on the price.

In short, by referencing a lithium price assessment from a reputable price-reporting agency, one is able to account for global supply and demand factors, as well as economically significant aspects of the product—i.e., its grade, purity, and specifications.

Factors around the general structure of the production entities might have a material bearing on the lithium prices. For several years, most lithium was produced by an oligopoly of producers: Albemarle, Sociedad Quimica y Minera de Chile, and Livent Corporation. Other producers have been added to this list, including China's Tianqi Lithium and Allkem, based in Australia. Recently, both Livent and Allkem have announced their plan to merge to create a company that they forecast will have the world's third-largest production capacity by 2027 (Arcadium Lithium, n.d.). This will mean the existence of a few dominant players in the lithium industry that could be able to influence the market price of lithium.

The general structure of the consumption entities should also be considered. At the time of writing, most large economies involved in the battery value chain had one to three major companies, with fewer than a dozen significant cathode producers globally. This type of market structure, combined with the strategic nature of the battery supply chain and the intervention of governments to secure supplies, could have an impact on prices in the future.

The production history, the general reliability of a lithium producer, and the size of the production mine itself may influence the price. Generally, a track record of stable production (including the stable quality of lithium) and larger mines can attract a premium on price. Smaller or newly developed mines may offer discounts to attract buyers. This would be expected to decrease over time as a mine establishes its supplier credentials. For instance, it is common for new lithium producers to sell their lithium carbonate or hydroxide production as technical grade during the first few years of production while they refine their processes and learn to comply with battery-grade specifications. As a result, their earlier production is sold at a discount compared to the later, battery-grade production.

Contractual Terms

Outside of the factors discussed earlier in this framework, the other economically significant adjustment relevant to the sale and purchase of lithium is the assignment of transportation responsibilities. The quantum of this adjustment is dependent on the product, volume, packing (i.e., bulk vs big-bags) and the proximity of the mine or port to the chemical plant.

The other consideration is if the related-party trade is delivered into another port on a CIF basis. As mentioned, the only markets large enough for price-reporting agencies to produce reliable market assessments are in East Asia: China, Japan, and Korea. These price assessments use either CIF incoterms for international sales or EXW for Chinese domestic sales. When using these assessments in the price-discovery process, tax administrations should take into account the cost of transportation from their country's borders (i.e., FOB) to the place of delivery used in the price assessments (i.e., CIF).

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Appendix A. Sources of Information for Lithium

Provider	Use	Reference
Argus Media	Lithium pricing information	Argus Media, n.d.-b
Asian Metals	Lithium pricing information	Asian Metal, n.d.
Benchmark Mineral Intelligence	Lithium pricing information	Benchmark, n.d.-c
Fastmarkets	Lithium pricing information	Fastmarkets, n.d.-a
S&P Global Commodity Insights	Platts Lithium pricing information	S&P Global, n.d.-a
Shanghai Metals Market	Lithium pricing information	Shanghai Metals Market, n.d.-a
Platform for Collaboration on Tax (IMF, OECD, UN, & WBG)	Additional information on commodity pricing	OECD, n.d.
USGS	Lithium production and reserves information	United States Geological Survey, 2023

Note: Websites accessed in July 2023.

Source: Authors.

Determining the Price of Minerals: A transfer pricing framework for lithium

In the mining sector, government revenue depends on mineral products being priced and measured accurately. This can be especially complex for semi-processed minerals such as lithium, which is primarily used for battery production. The schedule presented in this report applies the mineral pricing framework – as documented in the joint OECD/IGF work *Determining the Price of Minerals: A Transfer Pricing Framework* – to identify the primary economic factors that influence the price of lithium in applying the Comparable Uncontrolled Price method and ensure that developing countries are able to tax lithium exports appropriately.

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