



**COMMODITY PROFILE**

**Lithium**

3  
**Li**  
Lithium  
6.94

**1.0 Geological Considerations**

**1.1 Material Properties**

<b>Melting point (180.5°C)</b>	<b>Soft, silvery-white, and malleable</b>	<b>Moderate thermal conductivity</b>	<b>Moderate thermal conductivity</b>	<b>Alloys with aluminum, magnesium, and silicon</b>	<b>Highly corrosive when exposed to air and moisture</b>

**1.2 Major Lithium Producers**

**1.2.1 Top Five Mined Lithium Producers Globally Ranked by Production Share in Metric Tonne (mt) of Li-content (2024e\*)**

Rank	Country	Production (a)	Reserves
		Quantity (mt, 2024e) – (Global share in %)	
1	<b>Australia</b>	88,000 (37%)	7,000,000 (23%)
2	<b>Chile</b>	49,000 (21%)	9,300,000 (31%)
3	<b>China</b>	41,000 (17%)	3,000,000 (10%)
4	<b>Zimbabwe</b>	22,000 (9%)	480,000 (9%)
5	<b>Argentina</b>	18,000 (8%)	4,000,000 (13%)

Source: U.S. Geological Survey, n.d.-a; n.d.-b.

**1.2.2 Top Five Lithium Compounds Producers Globally Ranked by Production Share in mt of Lithium Carbonate Equivalent (LCE\*\*) (2025e)**

Rank	Country	Production (b)
		Quantity (mt, 2025e) – (Global share in %)
1	<b>China</b>	819,005 (63%)
2	<b>Chile</b>	270,500 (21%)
3	<b>Argentina</b>	121,850 (9%)
4	<b>South Korea</b>	61,000 (5%)
5	<b>United States</b>	17,900 (1%)

Source: Benchmark Minerals, 2025 [custom data set; personal communication]

Notes:

\* "e" indicates that the value is an estimate

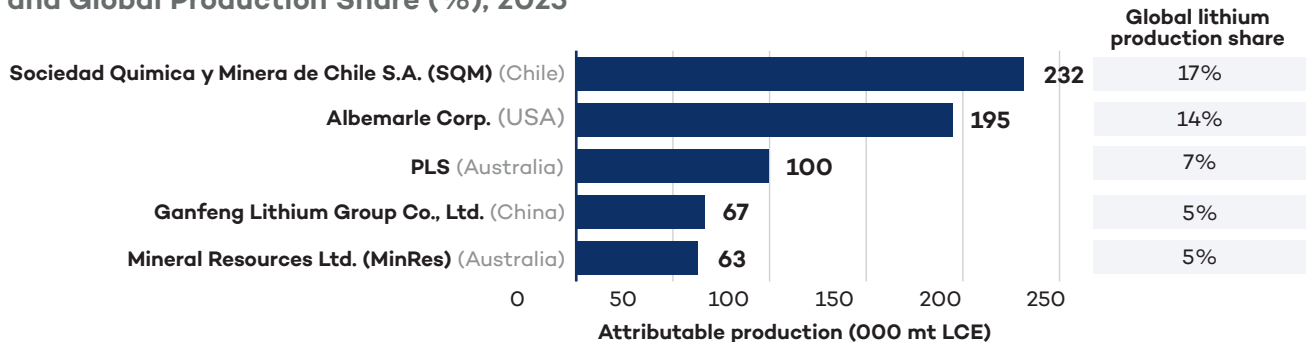
\*\* Lithium carbonate equivalent (LCE) is a standardized reporting unit that expresses the lithium content of different lithium-bearing ores and concentrates as the equivalent mass of lithium carbonate (Li<sub>2</sub>CO<sub>3</sub>). 1 mt of LCE is equivalent to 0.188 mt of lithium metal content.

(a) Mined lithium products include lithium-bearing ores and concentrates, spodumene concentrate, and petalite and lepidolite material.

(b) Lithium compounds include lithium carbonate (Li<sub>2</sub>CO<sub>3</sub>), lithium hydroxide (LiOH), lithium chloride (LiCl), and specialty lithium compounds.

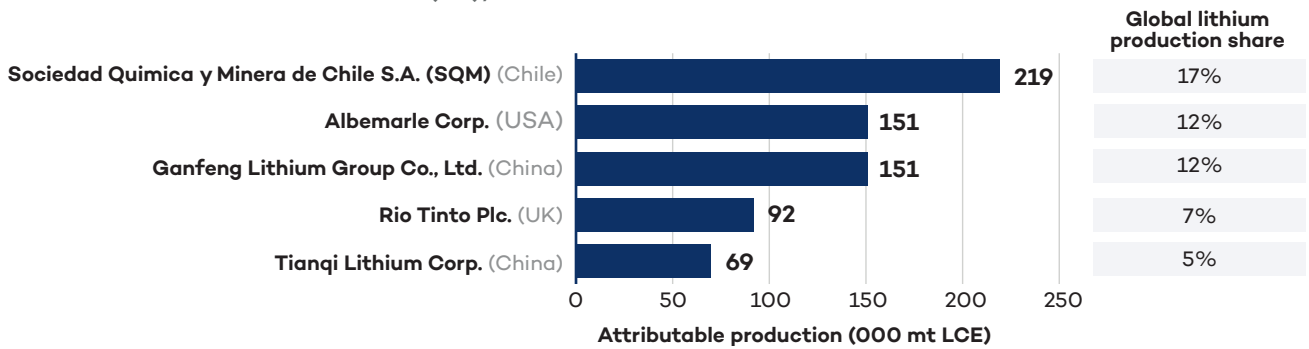
## 1.3 Top Lithium-Producing Companies

### 1.3.1 Top Five Companies by Attributable Mined Lithium Production ('000 mt LCE) and Global Production Share (%), 2025



Source: Benchmark Mineral Intelligence, 2025 [custom data set; personal communication].

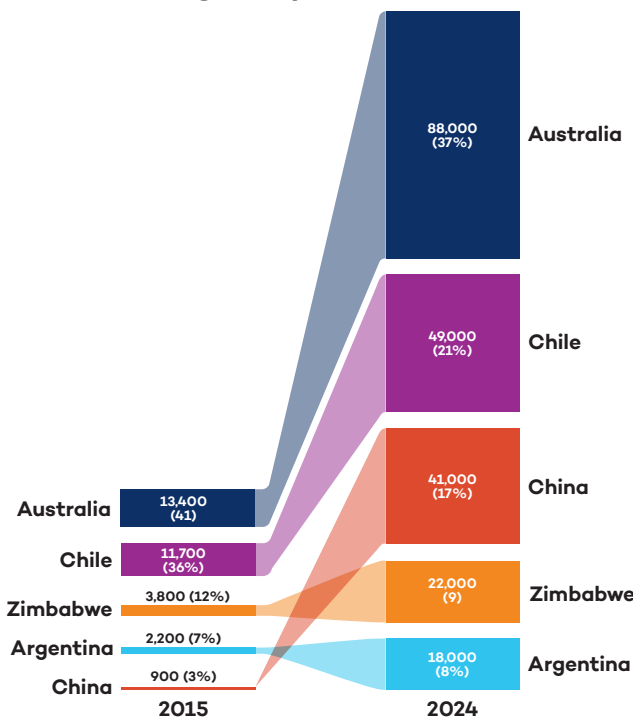
### 1.3.2 Top Five Companies by Attributable Lithium Compounds Production ('000 mt LCE) and Global Production Share (%), 2025



Source: Benchmark Mineral Intelligence, 2025 [custom data set; personal communication].

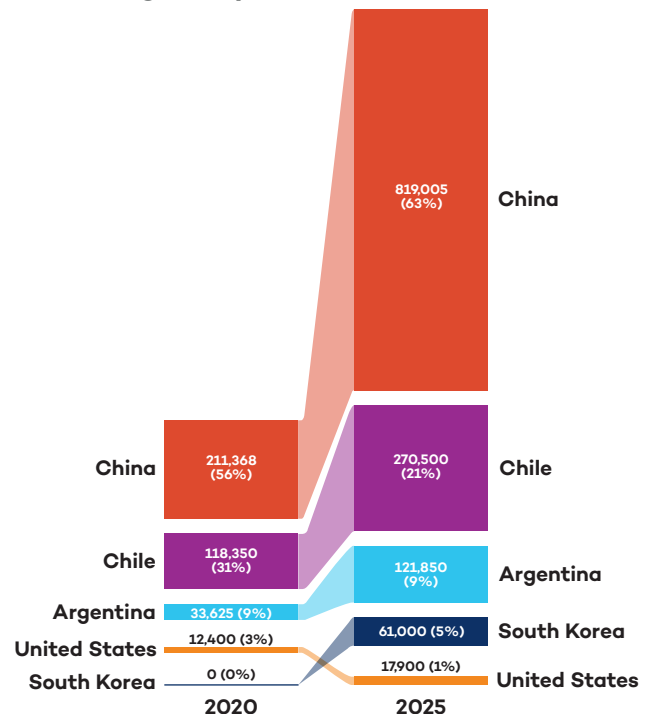
## 1.4 Top lithium producers, 2015 vs 2025

### 1.4.1 Top Five Mined-Lithium Producers 2015 vs 2024 (production in mt Li-content and share of global production in %)



Source: U.S. Geological Survey, n.d.-a; n.d.-b.

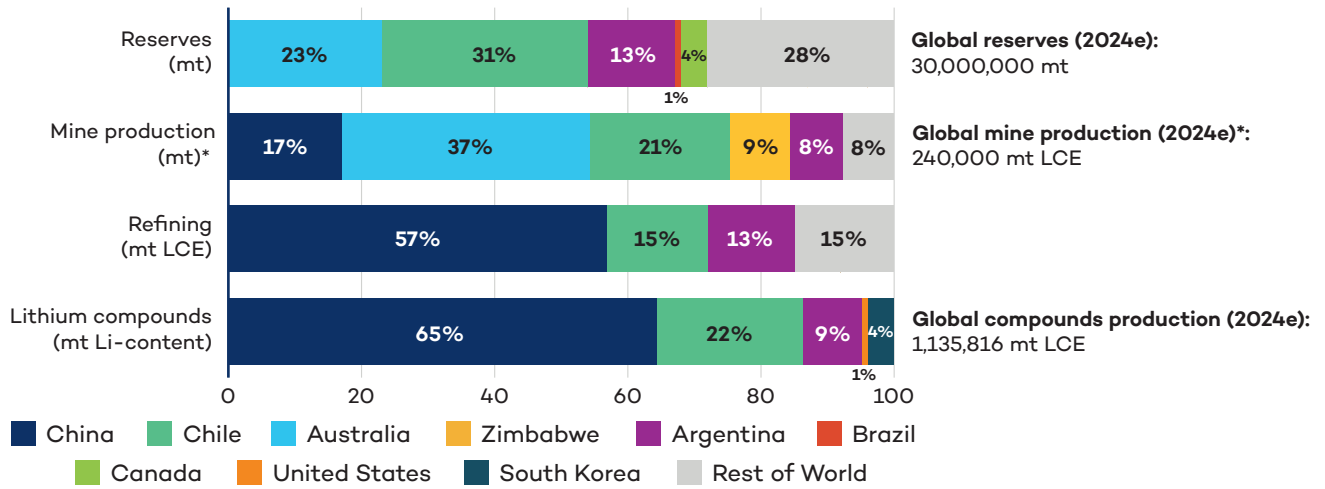
### 1.4.2 Top Five Lithium Compounds Producers 2015 vs 2025 (production in mt LCE and share of global production in %)



Source: Benchmark Mineral Intelligence, 2025 [custom data set; personal communication].

## 1.5 Market Distribution

Global distribution of the lithium value chain: Global reserves, mine production, and refining shares (%), 2024e



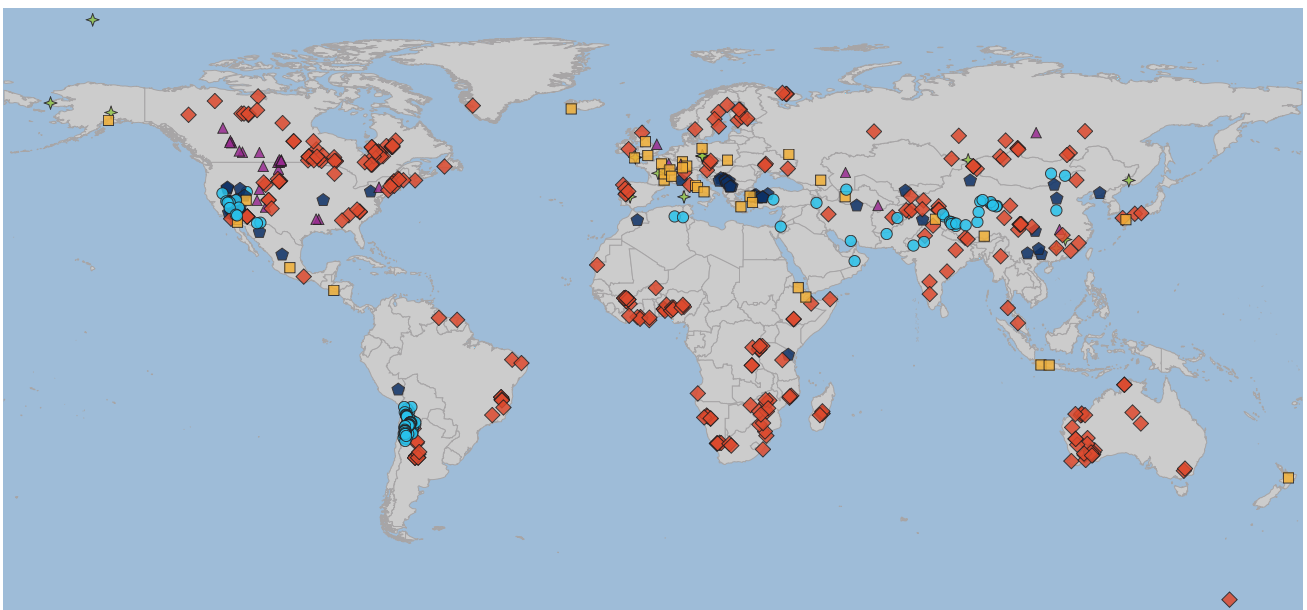
As illustrated, mined lithium production is highly concentrated, with Australia, Chile, and China together accounting for 76% of global output (U.S. Geological Survey, n.d.-a). Lithium refining supply is also highly concentrated, with the top three refining countries supplying 85% of global output in 2024, with 57% derived from China alone. Similarly, China dominates lithium compounds production with a 65% global share in 2024.

**Methodology note:** The figure shows the global distribution of the lithium value chain disaggregated into reserves, mine production, lithium compounds supply, and refining segments. Selected countries represent the top five countries by global share (%) within each category, with the remainder aggregated to "Rest of world."  
\* Excludes U.S. production.

Sources: Benchmark Mineral Intelligence, 2025 [custom data set; personal communication]; British Geological Survey, 2025; International Energy Agency, 2025; U.S. Geological Survey, n.d.-a, n.d.-b.

## 1.6 Reserves, Resources, and Geology

### 1.6.1 Distribution and Geology of Lithium Deposit Types Globally

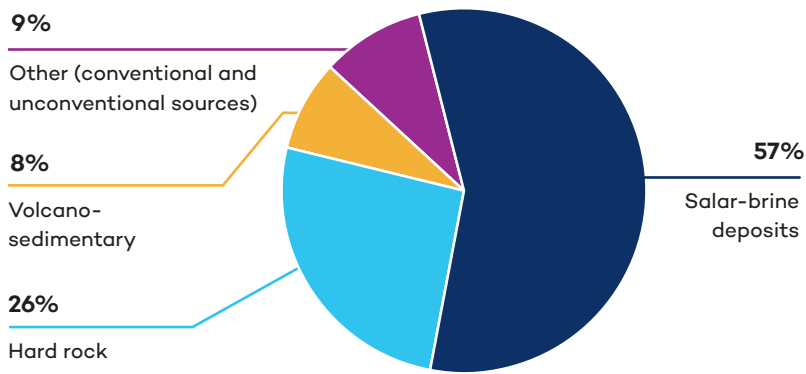


#### Lithium deposit types

- Closed basin brine (salar-brine deposits)
- Geothermal brine (other brine and unconventional sources)
- ◆ Lithium-cesium-tantalum pegmatite, LCT (hard-rock pegmatite deposits)
- ◆ Rare-metal granite, RMG (hard-rock, granite-related deposits)
- ▲ Sedimentary basin brine (other brine and conventional sources)
- ◆ Volcano-sedimentary (volcano-sedimentary deposits)

Source: Benson et al., 2025.

## 1.6.2 Distribution of Global Lithium Reserves Across Deposit Types (%)



### By-production potential:

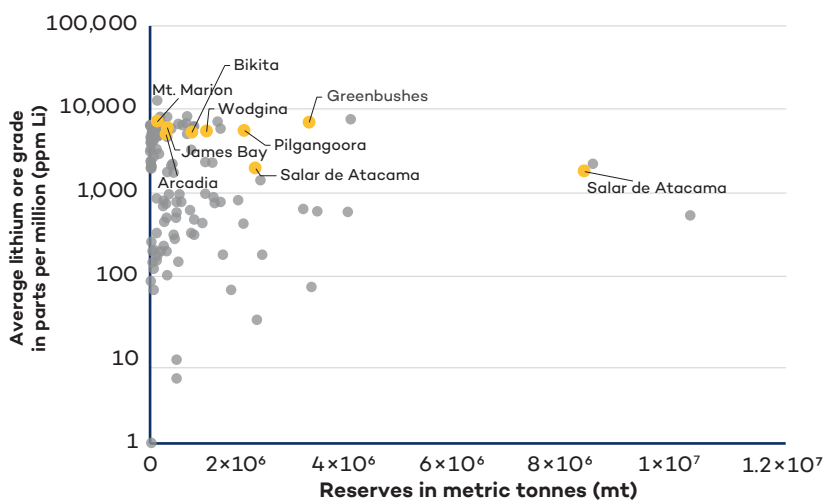
Lithium can be extracted from pegmatites as a by-product in tin, niobium, or tantalum deposits, though the economic viability of by-production depends on market demand, geological conditions, and prevailing processing technologies (U.S. Geological Survey, n.d.-b).

Deposit type	Description	Example by deposit type	Average grade range (% Li <sub>2</sub> CO <sub>3</sub> eq)	Global share (%)
Salar-brine deposits	Hosted in shallow lithium-rich surficial basin systems	Chile, Salar de Atacama	0.0005–1.04	57
Hard rock	Lithium-rich pegmatites or rare metal granite enriched in spodumene or other lithium-bearing ore	Australia, Greenbushes	1.06–6.81	26
Volcano-sedimentary	Lithium-bearing clay formed from weathered volcano-sedimentary rocks (e.g., hectorite, lepidolite, and zinnwaldite)	United States, Basin and Range McDermitt caldera	0.32–4.35	8
Other (conventional and unconventional sources)	Oilfield brines, geothermal brines, lithium-rich groundwater and brine systems	United States, Smackover Formation	0.10–1.54	9

Source: Bunker et al., 2022; Knierim et al., 2024; Kundu et al., 2023; Lithium Harvest, 2025; Zhao et al., 2023.

## 1.7 Ore Grades vs. Reserves

### Relationship between lithium ore grade and reserves



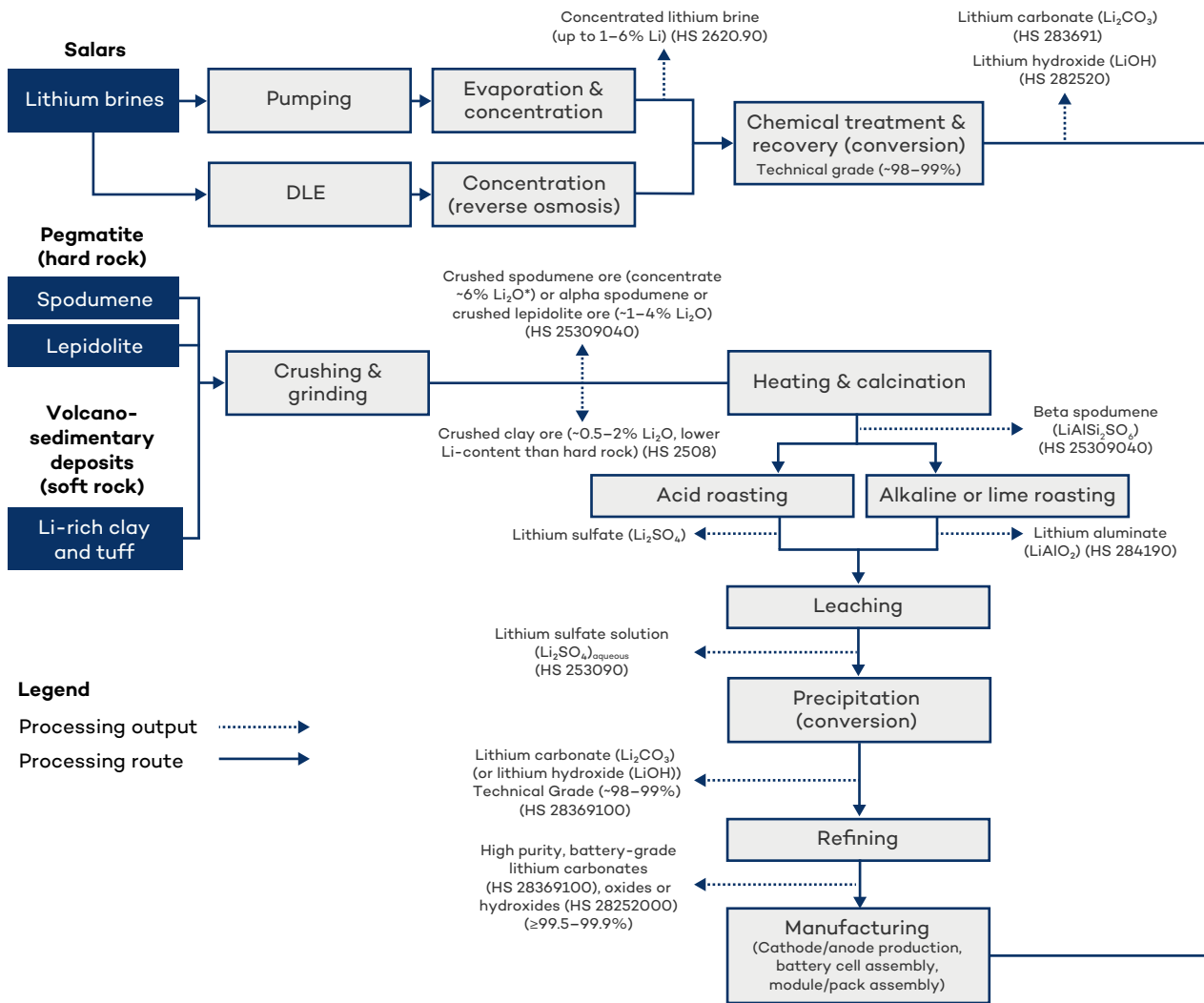
Source: S&P Global Market Intelligence, 2026; Benson et al., 2025.

### Top 10 producing mines in 2024:

1. Greenbushes (Australia)
2. Salar de Atacama - Sociedad Química y Minera de Chile S.A., SQM (Chile)
3. Pilgangoora (Australia)
4. Salar de Atacama - Albemarle Corporation (Chile)
5. Wodgina (Australia)
6. Mount Marion (Australia)
7. Bikita (Zimbabwe)
8. Galaxy (Canada)
9. Arcadia (Zimbabwe)
10. West Taijainair (China) (current reserves and grades not available in S&P)

## 1.8 Value Chain

### Simplified lithium value chain and production pathways



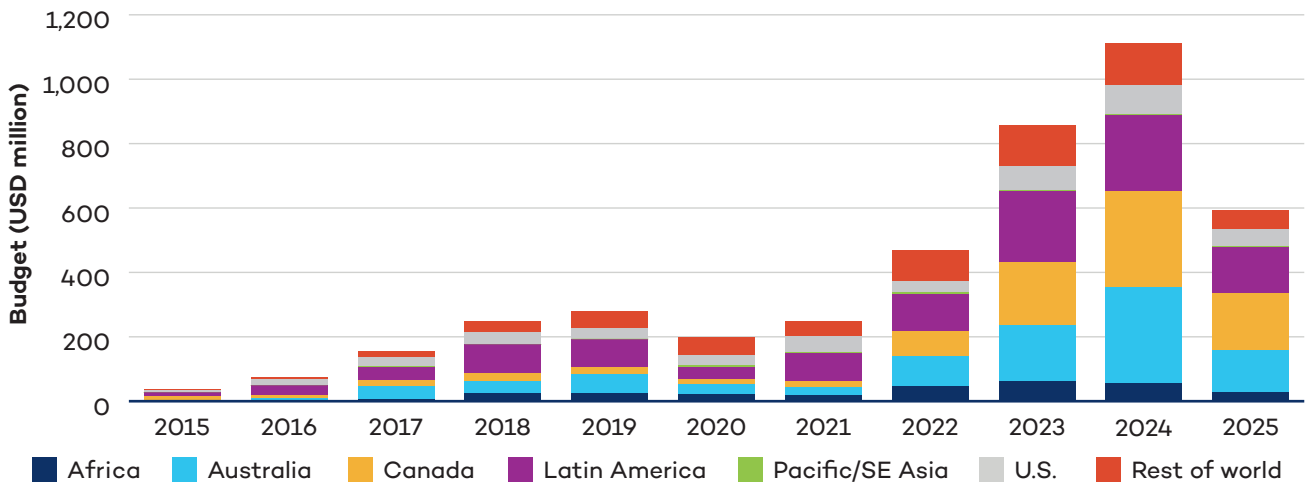
\*Li<sub>2</sub>O refers to lithium oxide and is commonly used to report lithium grades in hard-rock deposits and spodumene concentrates, usually expressed as % Li<sub>2</sub>O by weight. Lithium grades can also be converted to Li-content and lithium carbonate equivalent, using the following approximate conversions: 1% Li<sub>2</sub>O = 0.465% Li-content, and 1 tonne Li<sub>2</sub>O = 2.47 tonnes LCE.

Source: Putzolu et al., 2025; Petrakis et al., 2025; Flexer et al., 2018; Saltworks, 2024.

Global lithium supply is derived primarily from three processing routes: brine-based extraction, hard-rock mining, and to a lesser but emerging extent, lithium-rich clays. Brine operations extract lithium from subsurface brines, which are pumped to the surface and concentrated through evaporation ponds or direct lithium extraction (DLE) to produce lithium-rich concentrates (approximately 1%–6% Li). Hard-rock production involves mining lithium-bearing minerals such as spodumene or lepidolite, while soft-rock production focuses on lithium-rich clays, such as hectorite, smectite, and illite, as well as borosilicates such as jadarite and associated accessory minerals including sepiolite and analcime. Extraction is followed by crushing and grinding to produce ores and mineral concentrates (about 1%–6% Li<sub>2</sub>O), which then undergo thermal treatment and calcination prior to leaching and conversion. Leaching typically produces lithium sulfate solution (Li<sub>2</sub>SO<sub>4</sub>) as an intermediate stage. Across all routes, intermediate products are chemically converted into lithium carbonate (Li<sub>2</sub>CO<sub>3</sub>) or lithium hydroxide (LiOH) at technical grades (~98%–99%), before further refining to battery-grade purity (>99.5%–99.9%) for use in cathode and lithium-ion battery manufacturing.

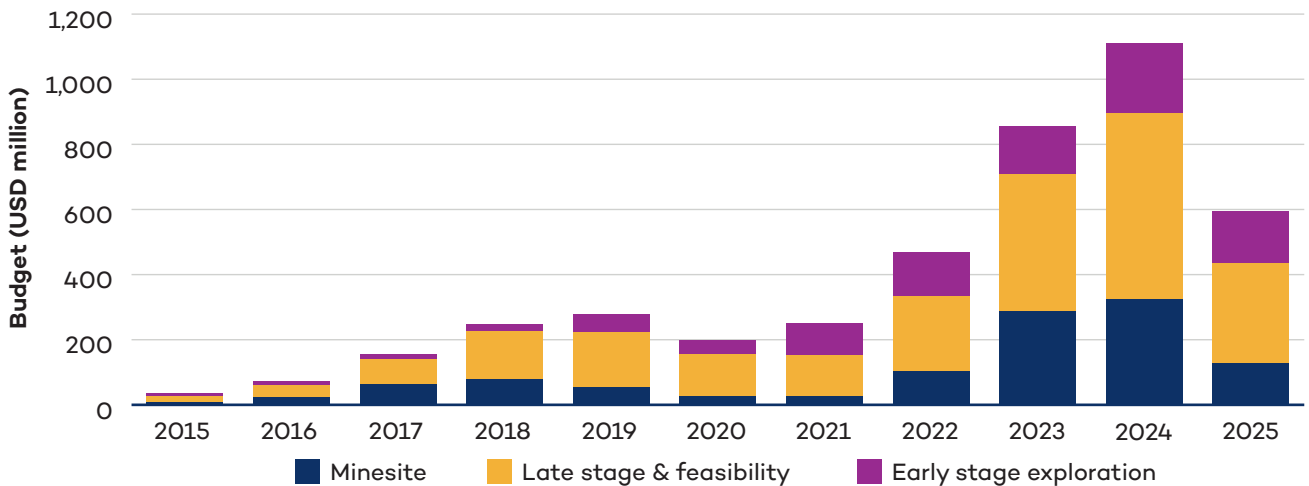
## 1.9 Exploration

### 1.9.1 Global Exploration Budget by Location, 2015–2025 (USD million)



Source: S&P Global Market Intelligence, 2026.

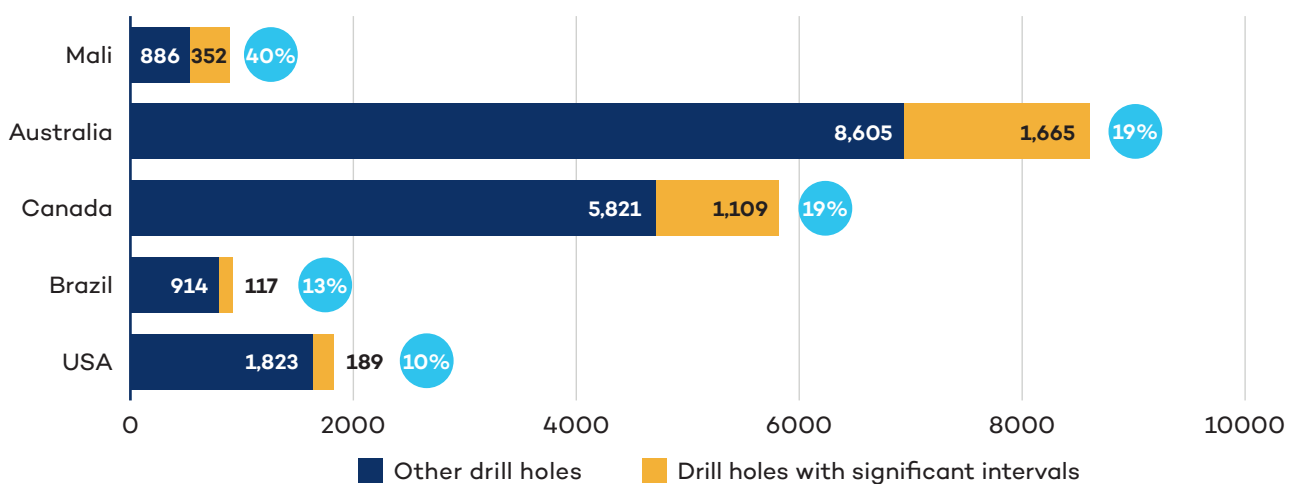
### 1.9.2 Global Exploration Budget by Stage, 2015–2025 (USD million)



Source: S&P Global Market Intelligence, 2026.

## 1.10 Drilling Success Rate

### Top five countries by drill hole success rate 2015–2025 (% share, number of drill holes)



**Methodology notes:** S&P Global Market Intelligence assesses the significance of drill results by considering both the objective of the drill hole and the quality of the intercepted interval. A result is deemed significant if it has the potential to add to or extend known mineralization or resources at a project, and if it surpasses a value threshold determined by prevailing commodity prices.

Source: S&P Global Market Intelligence, 2026.

## 1.11 Future Resources Considerations

### Overview of potential future lithium resources and supply

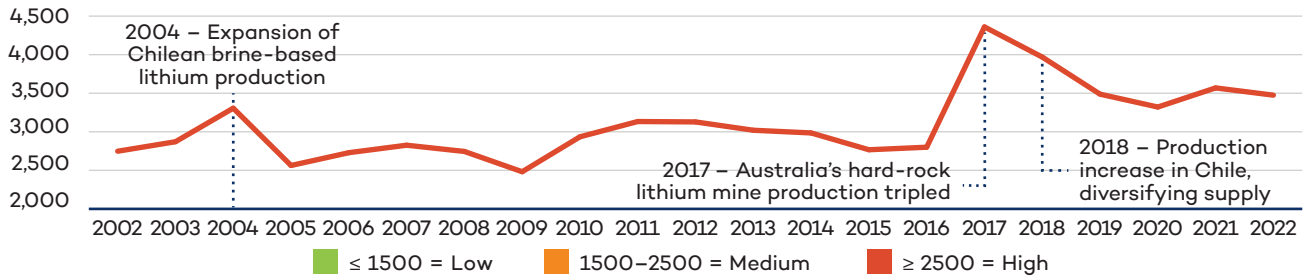
Future sources of lithium	Description	Considerations
Recycled lithium	Closed-loop recycling and reprocessing of lithium-based battery chemistries and cathode and anode materials (Ma et al., 2025).	Global recycling rates of lithium from end-of-life products range from 3% to 50%. While it is increasing, actual lithium recovery from lithium-ion batteries is still limited.
Geothermal brine	Surface or sub-surface geothermal brines with dissolved lithium content (Morrison, 2025).	Geothermal brines are typically richer in dissolved minerals and extremely hot at the subsurface, making extraction technically complex compared with traditional brine methods.
Fracking wastewater	Lithium extraction from wastewater is produced by hydraulic fracking operations (Patel, 2024).	The economic viability of this lithium source remains uncertain. Produced water from hydraulic fracturing can pose significant environmental risks due to its high dissolved salt content, chemical additives, and treatment or disposal requirements.
Sea water	Use of lithium-ion battery electrodes, filters, membranes, and evaporation to extract and concentrate lithium from sea water (Gibbs, 2024; Service, 2020).	Despite an estimated 180 billion tonnes of lithium in the world's oceans ( $\approx 0.2$ ppm), the very high sodium to lithium ratio of roughly 20,000:1 makes separation highly energy and cost intensive, and currently uneconomic at commercial scale.

Sources: Gibbs, 2024; Ma et al., 2025; Morrison, 2025; Patel, 2024; Service, 2020.

# 2.0 Economic and Geopolitical Considerations

## 2.1 Market Concentration Trends

### Mined-lithium market concentration (HHI index)



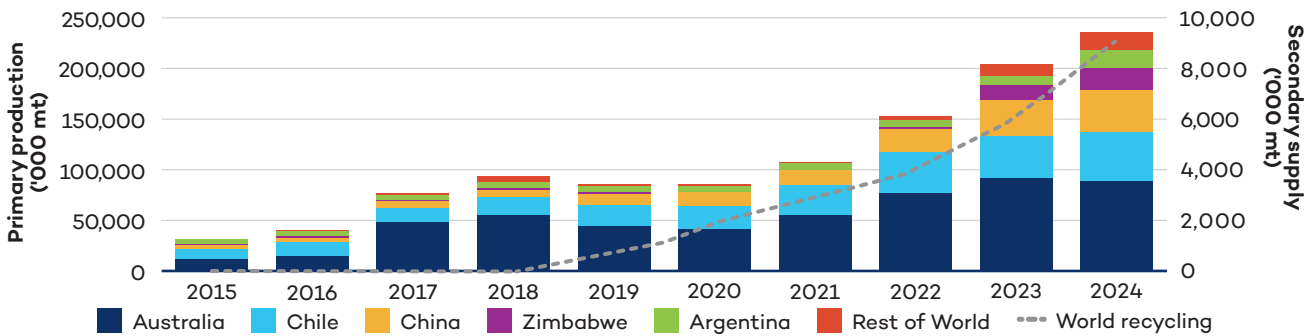
**Methodological note:** Herfindahl-Hirschman Index is a commonly accepted measure of market concentration of an industry. HHI lines by market concentration, green for values below 1,500 (low concentration or competitive market), orange for 1,500–2,500 (moderate concentration, some market power), and red for values above 2,500 (high concentration or limited competition and potential monopoly or dominant players). The year 2022 was the most recent year for which U.S. Geological Survey data was available for the HHI calculation. More recent years (2023 and 2024) could not be calculated because lithium mineral commodity summaries do not provide country disaggregated data.

Source: U.S. Geological Survey, n.d.-a; n.d.-b.

## 2.2 Industrial Considerations

### 2.2.1 Primary vs Secondary Lithium Supply

#### World lithium production by country versus secondary supply, 2015-2024



Sources: U.S. Geological Survey, n.d.-a; n.d.-b.

Historically, lithium production has been dominated by Australia, Chile, China, and Argentina. Since 2022, Zimbabwe has also emerged as an important producer. In addition, secondary supply, mainly from recycling in China, has become a growing source, accounting for around 3.5% of global lithium production in 2024.

### 2.2.2 Pathways for Lithium Extraction

#### Comparison of lithium extraction technologies

Method	Description	Cost-benefits	
<b>Hard-rock mining</b>	Mining, crushing and chemical conversion of mainly spodumene- and lepidolite-bearing ores.	Energy intensive with higher operating costs	Shorter development timelines and predictable production
<b>Brine evaporation</b>	Pumping lithium rich brines into surface level evaporation ponds to concentrate lithium through solar evaporation.	High upfront capital costs, especially for evaporation ponds and infrastructure	Generally lower operating costs once production is established
		High water footprint	
<b>Direct lithium extraction (DLE)</b>	Technologies such as ion exchange sorbents, solvent extraction or adsorption used to extract lithium directly from brine.	Technologies still at early stages of commercial deployment	Reduced land and water use with faster processing potential.

Sources: Lithium Harvest, 2025; Saltworks, 2023.

## 2.2.3 Substitutability

### Substitutability by application: Alternatives and challenges

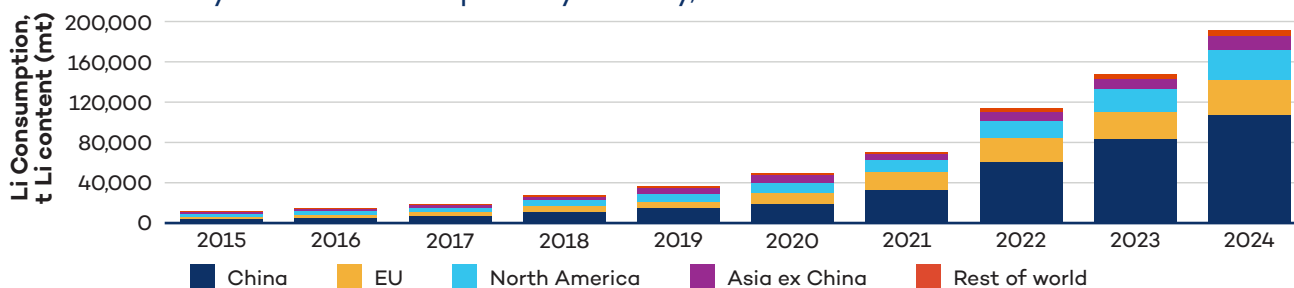
Application	Substitute/alternative	Substitution potential and risks
<b>Batteries</b>	Lithium-free battery chemistries	Other battery chemistries such as nickel–metal hydride (NiMH), sodium ion, nickel–iron batteries (FeNi) and Vanadium redox flow batteries (VRFBs) are alternatives, notably stationary storage and hybrid electric vehicles. However, their lower energy density and in some cases, lower efficiency limit their competitiveness in light-weight high performance applications. In primary batteries, zinc is the main potential substitute in anode material due to its low cost and availability.
<b>Greases</b>	Calcium and aluminum soaps	Calcium and aluminum-based soaps can be used as substitutes for lithium stearates greases, in some applications, often at lower costs. Calcium sulfonate grease has a higher dropping point compared to conventional lithium grease and provide strong corrosion protection, water resistance, and mechanic stability. Though it is less pumpable, depending on formulation and application conditions.
<b>Glasses and ceramics</b>	Sodic/potassic fluxes, calcium and aluminum fluxes	Sodium and potassium compounds can be used as partial substitutes for lithium in some glass and ceramic flux applications. Though such substitutions often involve performance trade-offs.

Sources: Aikin, 2022; U.S. Geological Survey, n.d.-a; SCREEN, 2020.

## 2.3 Consumption and Price

### 2.3.1 Lithium Consumption by Country

#### Lithium battery-related consumption by country, 2015–2024

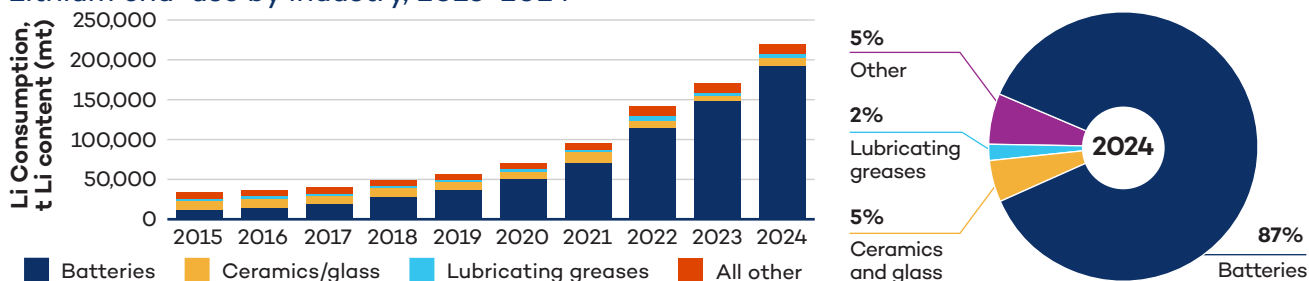


Sources: U.S. Geological Survey, n.d.-a; n.d.-b.

World lithium consumption for batteries increased from 12,000 mt of contained lithium in 2015 to 191,000 mt in 2024. China accounted for a significant share of this global growth, with its lithium consumption for batteries increasing nearly 30-fold over the same period. Additional growth in lithium consumption for battery manufacturing is being driven by the European Union and North America.

### 2.3.2 Lithium Consumption by End-Use

#### Lithium end-use by industry, 2015–2024

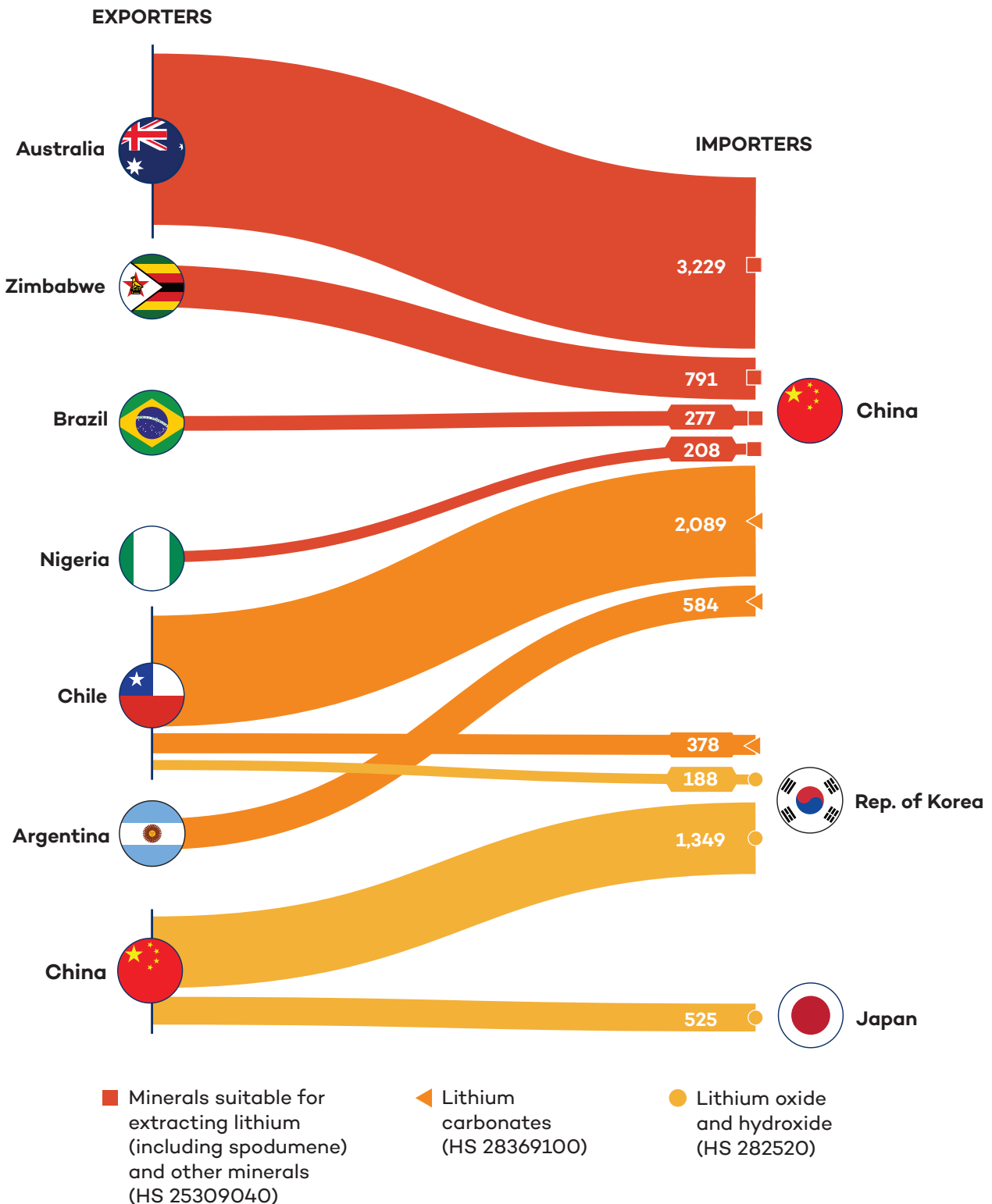


Sources: International Energy Agency 2024a, U.S. Geological Survey, n.d.-a; n.d.-b.

Global lithium consumption increased from 33,400 mt in 2015 to 220,000 mt in 2025. Lithium consumption for batteries grew more than 16-fold between 2015 and 2024, driven largely by China’s rapid expansion of battery manufacturing for electric vehicles (EVs) (International Energy Agency, 2024a). Battery manufacturing currently accounts for 87% of total lithium demand, a share that has risen steadily since 2015. In 2015, batteries represented 35% of lithium demand, followed by ceramics and glass at 32%, lubricating greases at 9%, and other uses at 24% (U.S Geological Survey, n.d.-a).

## 2.4 Lithium Trade Overview

Top major country-to-country lithium trades by value, 2024 (USD million, 2024)



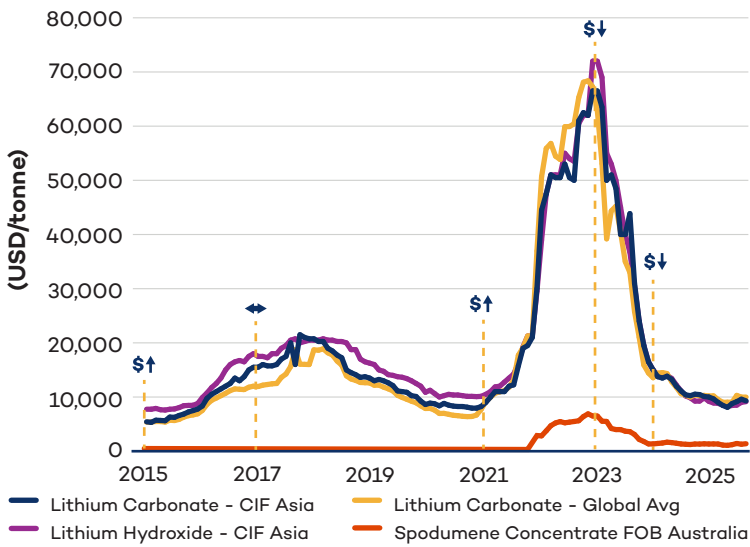
**Methodological note:** Exports are estimated based on mirror import data because imports are often tracked more diligently to collect import duties. This may bias trade values upwards because reported import values include the cost of insurance and freight (CIF), while export values do not. The top lithium trades are exports of lithium ores and carbonates to China for refining and then consumption in batteries that are either exported or built into products that themselves are either exported or consumed domestically.

Source: UN Comtrade Database, 2025.

## 2.5 Geopolitical Considerations

### 2.5.1 Price Trends

Lithium historical pricing, 2015–2025, USD/metric tonne

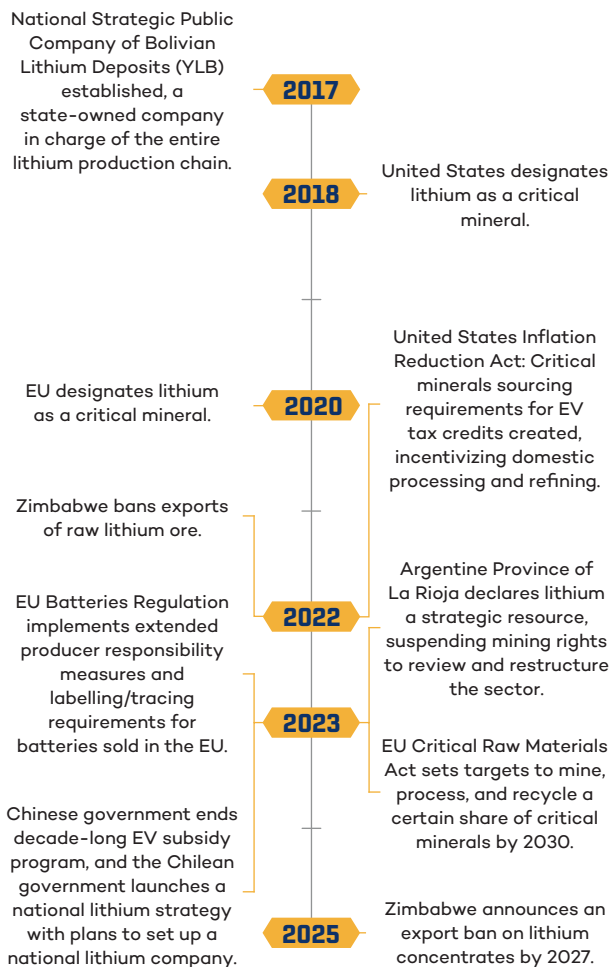


- \$↑ 2015** Prices rise on expectations that increasing world demand will continue.
- \$↔ 2017** Australian expansions increase world mine production 74% compared to 2016, depressing prices.
- \$↑ 2021** Major surge in prices and spot markets as EV demand intensifies and short-term supply constraints appear.
- \$↓ 2023** Prices plunge due to increased mine capacity, revoked Chinese EV subsidies, and slower EV sales worldwide.
- \$↓ 2024** Lithium oversupply and weak EV sales worldwide cause the price of lithium to fall.

Source: S&P Global Market Intelligence, 2026; U.S. Geological Survey, n.d.-b.

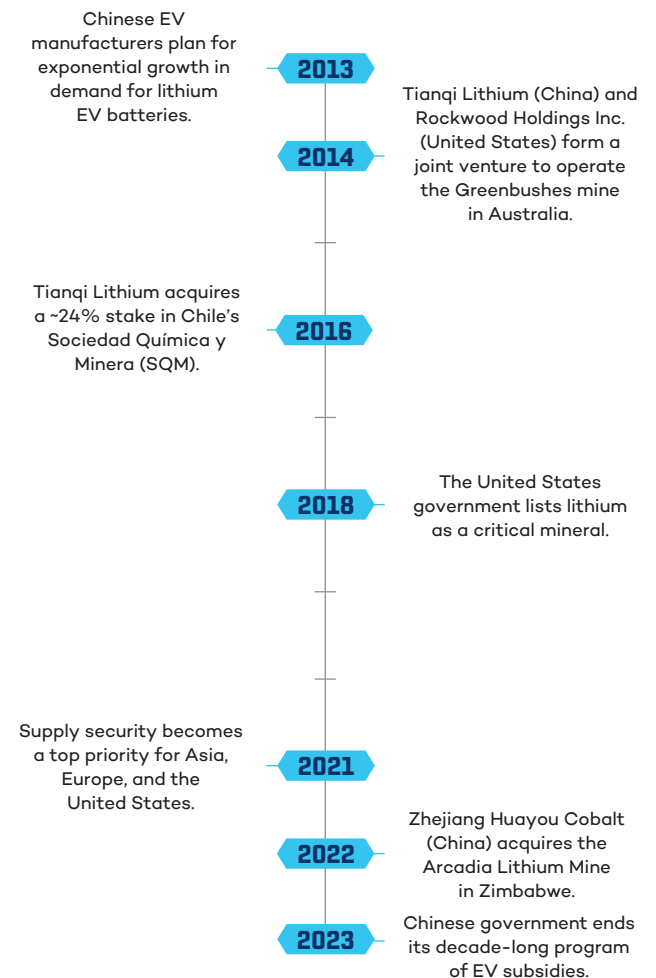
### 2.5.2 Regulatory Timeline

Timeline of restrictions impacting lithium value chains, 2015–2024



### 2.5.3 Geopolitical Dynamics Timeline

Timeline of geopolitical events impacting lithium value chains, 2015–2024



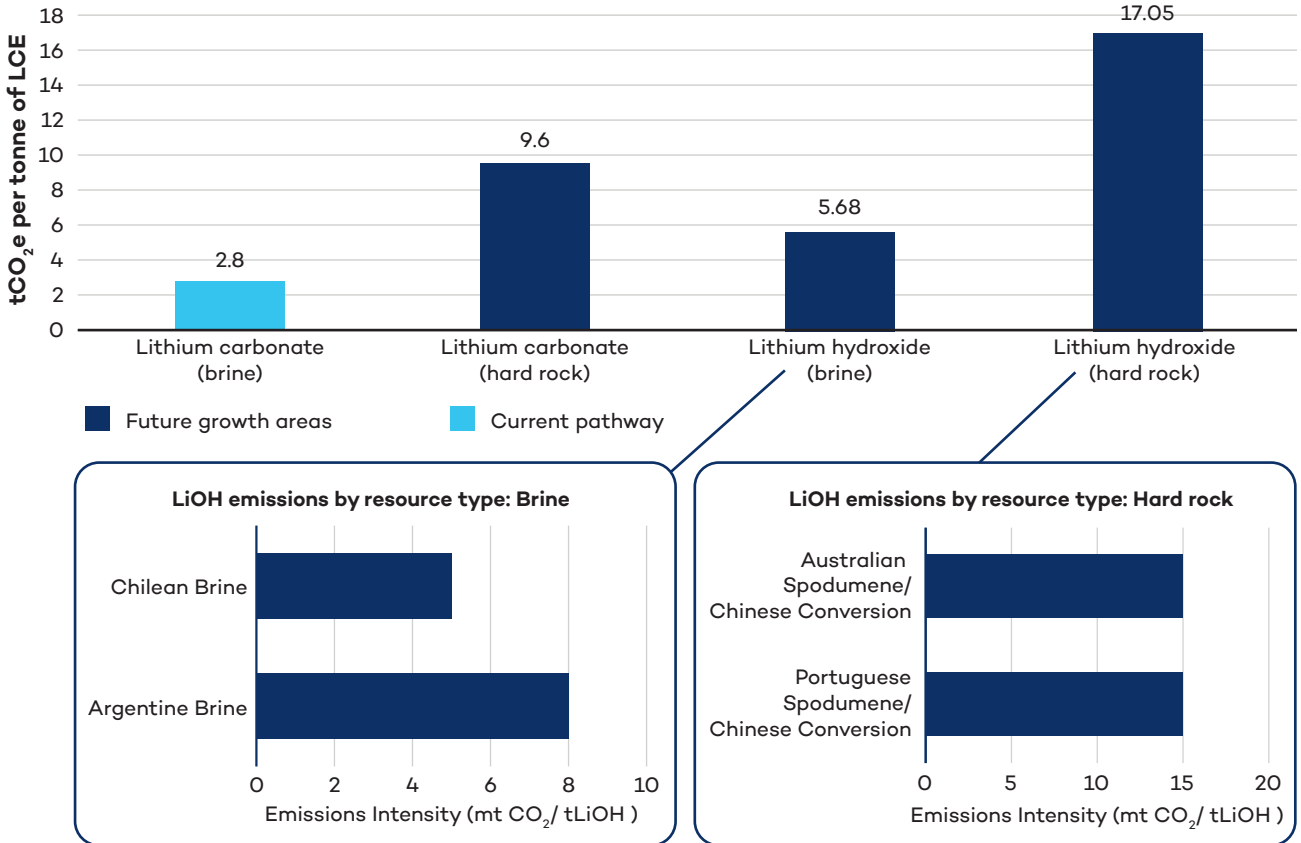
Source: U.S Geological Survey, n.d.-a.

Sources: Atta, 2024; Carlo, 2017; Duranona et al, 2023; European Parliament, 2023, 2024; Energy News, 2025; U.S. Department of Treasury, 2023; U.S. Geological

## 3.0 Environmental and Social Considerations

### 3.1 Emissions Profile

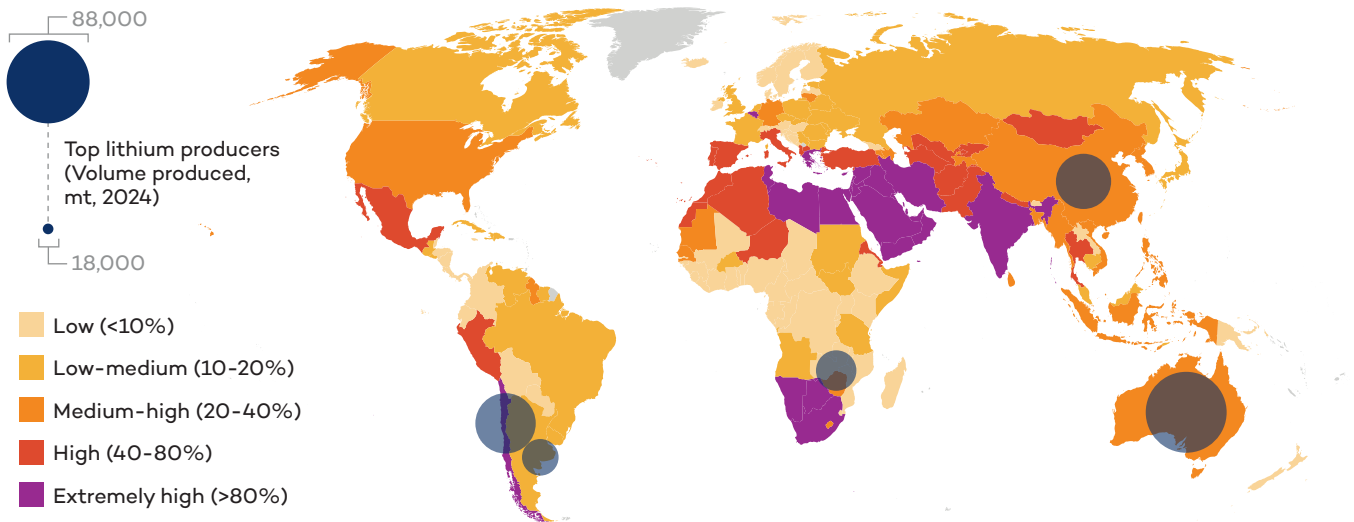
GHG emissions intensity of lithium by resource type and processing route (tCO<sub>2</sub> per metric tonne of LCE)



Sources: IEA, 2021; Gielen & Lyons, 2022.

### 3.2 Water Scarcity Risk

Baseline water scarcity risk in key lithium-producing regions



**Methodology Note:** Baseline water stress measures the ratio of total water demand (domestic, industrial, irrigation, and livestock uses) to available renewable surface and groundwater supplies. Higher values indicate more competition among users.

Sources: U.S. Geological Survey, n.d.-a; World Resources Institute, 2025.

### 3.3 Sustainability Standards and Initiatives

Voluntary sustainability standards, frameworks, and bodies impacting the lithium value chain

#### **Global Battery Alliance (2017)** **Battery Passport**

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Emerging digital product passport frameworks, an emerging global sustainability reporting and certification scheme for batteries, including lithium-based chemistries with associated technical guidance used to score environmental, social and governance impacts from cradle to gate.

#### **Extended Minerals Reporting Template (2024)** **Version 2.0**

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Released in April 2025 by the Responsible Minerals Initiative (RMI), Version 2.0 expanded its mineral scope to include lithium alongside graphite, nickel, and copper, aiming to advance responsible mineral sourcing, due diligence, and traceability across a wider range of commodities.

#### **International Lithium Association (2021)** **ILiA**

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An international not-for-profit industry association for the lithium industry whose research, advocacy, and technical support work extends across the lithium value chain.

*Note: Although a broader range of cross cutting sustainability standards and initiatives (SSIs) apply to lithium value chains indirectly, this timeline includes only SSIs that are explicitly lithium specific or directly focused on lithium based supply chains.*  
Source: Sources: Global Battery Alliance, n.d.; International Lithium Association, n.d.; RMI, 2025.

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