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Issue Brief

South America's 'Lithium Triangle Countries' and Green Transition

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Summary

Critical minerals are essential to achieve green energy transition. Argentina, Bolivia and Chile are assessed to possess 58 per cent of the world's known lithium reserves. While Argentina and Chile accounted for 90 per cent of the total lithium supplies to the US in 2019, China is emerging as a key player in the lithium industry in Bolivia. India has also been increasing its diplomatic outreach to the LTCs for accessing the mineral.

Fossil fuel accounted for 80 per cent of the Total Energy Supply (TES) in 2020.[1] The International Renewable Energy Agency (IRENA) posits that renewables will constitute 91 per cent of the world energy mix by 2050. For renewable energy to achieve this transition, critical minerals (lithium, cobalt, nickel, copper and manganese) used in semiconductors, electric vehicle batteries, rechargeable batteries in wireless electronics, wind turbines, solar panels and energy storage equipment are essential. Additionally, these minerals have strategic use in advanced weaponry, nuclear technologies, aerospace and medical applications.

With more than 20 countries launching their respective legislations and strategies to secure the supply of critical minerals like lithium, the importance of these minerals cannot be overestimated.[2] Lithium, the lightest metal in the world but with high energy density, is used in rechargeable batteries in mobile phones, laptops and other portable electronics. Though lithium reserves are well distributed in sufficient amounts worldwide, their production and processing are highly concentrated. With the ongoing green transition push, end use of lithium has transformed in the last decade, as seen in Table 1.

Table 1: Lithium End Use

End-use	Lithium Consumption 2010 (%)	Lithium Consumption 2021 (%)
Batteries	23%	74%
Ceramics and glass	31%	14%
Lubricating greases	10%	3%
Air Treatment	5%	1%
Continuous casting	4%	2%
Other	27%	6%
Total	100%	100%

Source: World Economic Forum

Due to environmental and geographical concerns of lithium mining, sodium-ion batteries are emerging as an alternative. However, lithium is likely to dominate the battery demand as evidenced by the price of lithium carbonate, which has increased

[1] Hannah Ritchie, Max Roser and Pablo Rosado, **"CO_2 and Greenhouse Gas Emissions"**, Our World in Data, 2020.

[2] **"Geopolitics of the Energy Transition: Critical Minerals"**, International Renewable Energy Agency, 12 July 2023.

from GBP 45 in January 2015 to GBP 445 in January 2023.[3] As a result, geopolitical competition between countries to secure the supply of 'white gold' of energy storage technology may prove to be a gamechanger for lithium-rich countries.

In the 1990s, the US was the largest producer of lithium, in stark contrast to the present producers as listed in Table 2. The Latin American countries of Argentina, Bolivia and Chile have emerged as the lithium bank to fuel green transition. These three countries supply 38 per cent of the world's lithium and are known to possess 58 per cent of the world's known lithium reserves. Hence, these countries in the Andean southwest corner of South America with adjacent borders are known as 'Lithium Triangle Countries' (LTCs). Bolivia holds the world's largest lithium resources that are yet to be commercially developed.[4]

While Australia is currently the largest lithium producer, accounting for 52 per cent of total global production, Australian lithium is extracted from hard rock deposits. LTCs produce lithium from salt brines, which is costlier than extracting the metal from hard rock deposits. However, the lithium so produced requires less processing and therefore can achieve higher margins.[5] The LTCs therefore have a competitive edge, in anticipation of high demand for EVs and green energy.[6]

Table 2: Country-wise lithium production

Rank	Country	2021 Production (tonnes)	% of total
1	**Australia**	55,416	52%
2	**Chile**	26,000	25%
3	**China**	14,000	13%
4	**Argentina**	5,967	6%
5	**Brazil**	1,500	1%

Source: World Economic Forum

Lithium-Iron-Phosphate (LFP) batteries accounted for largest market share of global EV batteries produced in 2022.[7] The LTCs produce lithium carbonate, used to

[3] **"Price of Selected Battery Materials and Lithium-Ion Batteries, 2015-2023"**, International Energy Agency, 11 April 2023.

[4] **"Lithium Data Sheet- Mineral Commodity Summaries 2020"**, US Geological Survey, January 2020.

[5] **"Essential Insights: Lithium Costs & Margins"**, S & P Global, 2019.

[6] Patricia I. Vasquez, **"The Lithium Triangle: The Case of Post-Pandemic Optimism"**, Wilson Center, October 2020.

[7] Ibid.

produce Lithium-Iron-Phosphate (LFP) batteries, which are considered cheaper, durable and safer than Nickel-Manganese-Cobalt (NMC) batteries.[8] The supplies for NMC batteries are risk prone, given that Chinese firms own cobalt mines of major producers like the Democratic Republic of Congo (DRC). Further, countries like Indonesia, which account for half of global nickel production,[9] have an export ban on nickel. The ongoing Russia–Ukraine war is a further risk factor.

Argentina

Argentina possesses the world's second largest lithium reserves (at 21 per cent) and is the world's fourth largest lithium producer. It has two operational lithium salt flat mines in the north-western provinces, while 20 others in same region are in different stages of exploration.[10] While Chile and Bolivia have listed 'lithium' as a strategic mineral, Argentina treats lithium similarly to other minerals and has liberalised the mining sector by opening it for foreign investment since 1990s.

There is relative autonomy to the provinces in mining the mineral, with a 1993 law giving tax breaks to mining firms. These companies are also entitled to keep more than 70 per cent of the profit, while paying royalty of only 3 per cent to the government.[11] Consequently, lithium exports have risen 234 per cent Year-On-Year (Y-O-Y) in 2022 and accounted for one-fifth of the country's total mining exports.[12]

Investments in the country's lithium sector reached an estimated US$ 1.5 billion in 2022. Companies from the US, China and Europe are vying to increase their stakes in the mining companies of Argentina. Though US companies have been extracting lithium in the country for 20 years, Chinese firms are rapidly expanding their footprints. Chinese companies significantly hold stake in six of the nine lithium production projects in Argentina.

Ganfeng Lithium, the world's second largest lithium processor and third largest producer of lithium salts, has pledged to invest US$ 2.7 billion and produce 74,000 tonnes of lithium carbonate in the coming years. Simultaneously, US-based Livent

[8] Tom Moerenhout and Juan Carlos Jobet, **"Chile's New Lithium Strategy: Why It Matters and What to Watch For"**, Centre on Global Energy Policy, Columbia University, 2 May 2023.

[9] Erwida Maulia, **"Nickel Surplus Seen Widening in 2023 as Indonesian Output Soars"**, Nikkei Asia, 16 June 2023.

[10] Eri Silva, **"Argentina's Lithium Lncentives Push Industry Prospects Above Neighbors"**, S&P Global, 26 January 2023.

[11] Ibid.

[12] Lucila Sigal, **"Argentine Mining Exports Hit 10-ear High as Lithium, EVs Take Off"**, *Reuters*, 22 March 2023.

Corp and Argentina's Allkem expect to double their output to 42,500 tonnes of lithium carbonate in the coming years.[13] South Korea's steelmaker Posco Holdings Inc. aims to invest US$ 4 billion in Argentina, with a target to produce 100,000 tonnes of lithium hydroxide.[14]

Most of these foreign investments are made in the upstream stage of the supply chain (which involves mining, refining and processing). Going forward, Argentina could also aim to partner with companies engaged in downstream stages of supply chain – assembly of batteries and EV manufacturing.[15]

Bolivia

Among the three Andean countries, Bolivia has largest lithium reserves, 24 per cent of the world's total, and hosts the world's largest salt flat—Salar de Uyuni (single-biggest lithium deposit). Despite having the largest reserves, Bolivia stands nowhere among the world's top producers. The government has majority stakes in extraction and processing of lithium but inconsistent policies have marred optimum extraction of the resource.[16]

Unlike lithium extraction through solar evaporation in Chile and Argentina, rainy season and wetter grounds in Bolivian salt flats lead to a time-intensive extraction process. Additionally, the extractive process is highly water intensive, given higher quantities of impurities. This has also led to protests from environmentalists and indigenous groups.

Consequently, a project with Germany's ACI Systems was stalled as local communities in the Potosi region were demanding more benefits and royalties.[17] The government is now welcoming investments in Direct Lithium Extraction (DLE) technology, a process which ensures faster speed, higher yields and lower water use, to overcome its geographical constraints.[18]

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[13] **"Argentina Confirms New Chinese Investment in Lithium Production"**, *Buenos Aires Times*, 1 June 2023.

[14] **"South Korea's Posco to Invest $4 bln in Lithium Project in Argentina"**, *Reuters*, 22 March 2022.

[15] Patrick Gillespie and Silvia Martinez, **"Poverty Rises to 39%, Hurting Economy Before Election"**, *Bloomberg*, 31 March 2023.

[16] Richard Martin, **"Bolivia Vies to Join Lithium Producers Club After Years of Disappointment"**, S&P Global, 11 July 2022.

[17] **"Bolivians Protest Over Lithium Deal with German Company"**, *Deutsche Welle*, 10 August 2019.

[18] Patricia I. Vásquez, **"Lithium Production in Chile and Argentina: Inverted Roles"**, Wilson Centre, January 2023.

The Bolivian government recently signed a deal worth US$ 1.4 billion with Russian state nuclear firm Rosatom and China's Citic Guoan Group to develop lithium mines.[19] Another US$ 1 billion agreement was signed with Contemporary Amperex Technology, a Chinese consortium to tap lithium reserves using DLE technology, which is also the world's largest EV battery maker.

Chile

Chile is the world's largest lithium producer from brines, and stands third in terms of total lithium reserves. The country boasts of highest concentration of finest quality lithium brine salt flats in Salar de Atacama, 40 of which are currently mined by only two companies- Albemarle, a US-based company and SQM, a Chilean chemical company, under strict production quotas.

There is a requirement to sell up to 25 per cent of output at preferential prices to local buyers, a different model from neighbouring Bolivia, where the state has full control of the sector, and Argentina, in which the state simply grants concessions for companies to operate. On the other hand, the second-largest reserves in the country's Salar de Maricunga region have been left unexploited and uncommercialised due to corruption, red tape and environment sustainability issues.[20]

The country unveiled 'National Lithium Strategy' in April 2023, which aims to develop lithium extraction in salt flats through a PPP wherein private sector will be allowed to exploit and mine the white metal but control of the mine will rest with the government. Chile aims to create a National Lithium Company, on the lines of Codelco, the national copper mining company and also the world's largest copper producer.

Resource Geopolitics and Climate Change

The demand for these minerals owing to high-end electronics manufacturing are projected to rapidly rise, with limited availability of functioning mines, skills and cutting-edge technology. Given the demand, price of lithium is predicted to rise 40-fold by 2040.[21] In order to exploit such opportunities, Latin American countries like

[19] Daniel Ramos, **"Bolivia Taps China, Russia's Rosatom in Bid to Unlock Huge Lithium Riches"**, *Reuters,* 30 June 2023.

[20] Ibid.

[21] **"National Lithium Strategy"**, Government of Chile, 22 June 2023.

Bolivia, for instance, need to have in place the right mix of private sector participation and government control for optimum commercial exploitation.

While Argentina and Chile accounted for 90 per cent of the total lithium supplies to the US in 2019, China is a key player in the lithium industry in Latin American region, especially so in Bolivia.[22] It is also a dominant player in downstream as well as upstream processing of the mineral. To counter China's dominance, the US has forged many alliances with like-minded countries.

For instance, the Mineral Security Partnership (MSP) consisting of Australia, Canada, Finland, France, Germany, Japan, Korea, Sweden, the European Union, apart from the US, aims to secure minerals supply chains. The alliance includes Japan and South Korea, which along with China make up for more than 90 per cent of the battery cells supply chain, for different categories and components. The US has also taken steps like pressurising the Netherlands to pause the export of semiconductor advanced machinery equipment and has sought to restrict China's access to high-tech microchips and critical technology.[23] In retaliation, China has restricted the export of gallium and germanium to the US, two of the many critical minerals used to manufacture semiconductor chips.[24]

While lithium exploration may prove to be lucrative for the Andean economies, the ubiquitous devastating impacts of climate change cannot be ignored. Lithium extraction through salt flats is a water-intensive process which can deprive the region of water, which is already facing severe drought conditions. For instance, Argentina is experiencing its worst drought in over 60 years, gravely impacting its processed soy, wheat and corn exports, which are the country's main source of export revenue.

Argentina could move towards sustainable techniques like DLE and climate smart-agriculture practice to sustain its economy and environment as well as fully exploit its mineral resources like lithium. Similar to protests in Bolivia, recent protests against displacement and chemical infiltration in the groundwater have also erupted in Argentina. Water depletion in Chile's Salar da Atacama, one of the driest places on Earth has impacted the regional biodiversity ecosystem, especially the population of flamingos. Time-intensive processing of extracting lithium through solar evaporation takes more than a year, which affects local climate cycle, and in turn indigenous population.

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[22] **"From 2016-2019, over 90% of U.S. Lithium Imports Came from Argentina and Chile"**, US Department of Energy, 14 February 2022.

[23] **"China to Restrict Exports of Chipmaking Materials as US Mulls New Curbs"**, *Reuters*, 4 July 2023.

[24] **"Factbox: Companies Respond to China's Curb on Gallium and Germanium Exports"**, *Reuters*, 7 July 2023.

India and LTCs

India has also been increasing its diplomatic outreach to the LTCs for accessing the mineral. Former President Ramnath Kovind's State visit to Bolivia and Chile in 2019 is a case in point, where he was accompanied by business delegation. Discussions on lithium mining to achieve India's ambitious target of EV Vision 2030 were held during that visit.[25] In January 2023, Union Minister of State (MoS) Meenakshi Lekhi also paid a four-nation visit to Latin America and the Caribbean region. In Bolivia, discussions focused on long-term partnership in the lithium and battery sector, and partnership in metals and mining sector.[26]

Further, India has launched ambitious plan to manufacture Advanced Chemistry Cell (ACC) under the PLI scheme with a budgetary outlay of Rs 18,100 crore, to boost battery production.[27] However, India still imports 100 per cent of its lithium metal, mostly from East Asian countries like China, Hong Kong, Taiwan and Republic of Korea for battery production.[28]

States like Telangana are also aspiring to become the EV manufacturing hub of India. The state government has put in place institutional mechanisms to forge collaborations with joint venture partners to secure access to lithium in the LTCs, for its battery and ACC manufacturing ecosystem.[29] Even as it seeks such critical minerals overseas, India also aims to exploit lithium deposits in places like Jammu and Kashmir. New Delhi has also been inducted as a partner in the US-led MSP alliance.

[25] **"President Kovind Visits Croatia, Bolivia and Chile"**, Ministry of External Affairs, Government of India, 2 April 2019.

[26] **"Meenakshi Lekhi meets Bolivia's Foreign Affairs Minister, Discusses Bilateral Relations"**, ANI, 23 January 2023.

[27] **"Allotment Made for 50 GWh of Battery Capacity to 4 Successful Bidders for Incentive Under (PLI) Scheme for Advanced Chemistry Cell (ACC) Battery Storage"**, Press Information Bureau, Ministry of Heavy Industries, Government of India, 24 March 2022.

[28] **"Lithium Import and Production"**, Press Information Bureau, Ministry of Mines, Government of India, 21 March 2022.

[29] N. Ravi Kumar, **"Telangana Eyes Latin America for Lithium Salts to Power EV, ESS Ecosystem"**, *The Hindu*, 11 August 2023.

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