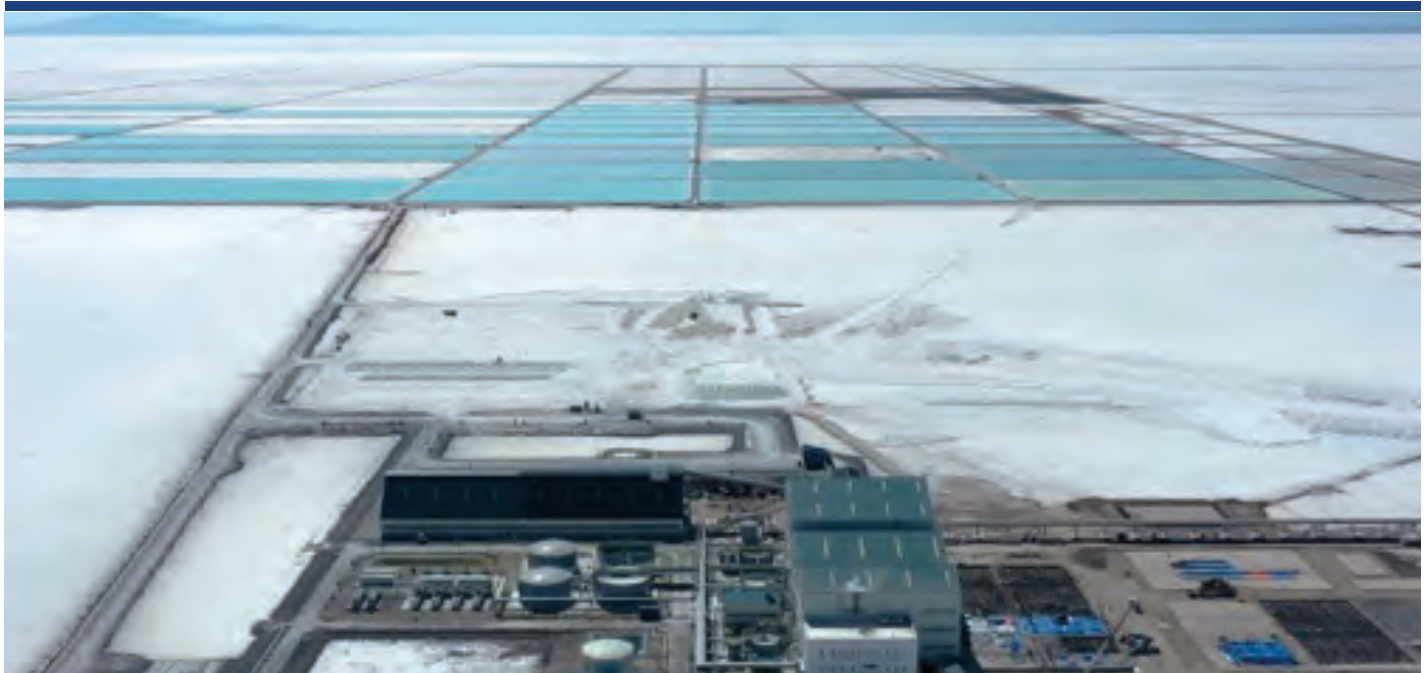




WILLIAM J. PERRY CENTER FOR HEMISPHERIC DEFENSE STUDIES

Regional Insights

JULY 2023 EDITION



Bolivian lithium extraction operations at Salar de Uyuni. Photo credit: Dialogo Magazine.

The Role of the Latin American Lithium Triangle in Critical Mineral Availability

Sydney Knapp, MA

Lithium in the international market is in increasing demand, as the critical metal is integral to electric vehicle (EV) batteries. In August 2022, the United States passed the Inflation Reduction Act, which mandates that 50% of critical minerals in electric vehicles will need to be sourced in the United States or a free trade partner nation by 2024.¹ The percentage is set to rise to 90% by 2028. Currently, the only lithium-producing nations with which the U.S. has a free trade agreement are Australia and Chile, plus Canada, which is developing its first lithium mine. The United States only has one domestic lithium mine with plans for another underway.² In Latin America, the Lithium Triangle of Argentina, Bolivia, and Chile holds over half the world's supply of lithium of which only a fraction is being mined.³ This reality positions Latin American lithium production to be in a critical role in the ambitious global effort to transform transportation industries and power grids.

¹ U.S Congress, Senate, Inflation Reduction Act of 2022, HR 5376, 117th Cong., 2nd sess., introduced in Senate 3 January, 2022, <https://www.congress.gov/117/bills/hr5376/BILLS-117hr5376enr.pdf>

² Silver Peak Lithium Mine in Nevada is currently the only lithium mine in operation in the United States. This brine extraction mine is operated by Albemarle. There are current efforts to open a second lithium mine in Thacker Pass, northern Nevada that would be an open pit mine operated under the Lithium Nevada Corp. For more information see: <https://ndep.nv.gov/land/thacker-pass-project> and <https://www.leg.state.nv.us/App/InterimCommittee/REL/Document/16038>

³ Jiri Sterba et al., "Lithium Mining: Accelerating the Transition to Sustainable Energy," *Resources Policy*, (2019), 417.

This paper will outline the current dangers of climate change and the benefits of utilizing lithium batteries as an alternative energy source. The current status of Lithium Triangle involvement in lithium mining efforts and potential for expanded production will be examined. Additionally, the environmental consequences of increased mining in light of the growing lithium demand will be analyzed. Finally, the repercussions of increasing sustainability via EVs at the cost of water availability, land rights, and exploiting human capital in Latin America is explored.

Lithium and the Electrification Revolution

The temperature of the Earth has been steadily increasing since the 1850's due to the burning of fossil fuels that trap the sun's heat in Earth's atmosphere.⁴ Scientists have warned that time is running short to prevent an increase in dangerous temperatures.⁵ Abandoning fossil fuels and electrifying industry and transportation is an urgent task. Consequently, there has been a shift to electrify the power grid with renewable energy sources and increase the amount of rechargeable batteries in daily activities. Lithium will play a major role in the shift away from fossil fuels as the key component in rechargeable batteries for handheld electronics and electric vehicles. On November 5th 2022, the U.S Bipartisan Infrastructure Law was signed and includes 7.5 billion USD in funding to increase EV charging stations to accelerate electric vehicle sales by assuring more charging locations on major roadways.⁶ There are also plans to replace all the diesel-powered school buses in the United States by 2030 with electric buses.⁷ To meet electric vehicle needs and those of the international community, the International Energy Agency estimates the world will need roughly 40 times as much lithium as is currently available.⁸

Lithium Extraction

Lithium-ion batteries consist of three metals: nickel, cobalt, and lithium carbonate. Yet, the majority of the volume in lithium batteries is graphite, which serves as the anode (or part of a battery that holds the electrical charge) to produce electricity.⁹ Lithium is a key element in this battery due to its high electrochemical potential among all metals.¹⁰ The lithium carbonate used to create lithium-ion batteries is extracted in three ways: through hard rock, as is practiced in Australia; through sedimentary rock, which is currently being developed in the United States; and through brine extraction, the most common method used in the Lithium Triangle in Latin America.¹¹ In order to mine lithium through brine extraction, water is pumped into the ground, which then rises to the surface as a mix of salty lithium-laden brine. The mix is left in giant ponds for the water to evaporate for twelve to eighteen months under the sun.¹²

⁴ United Nations, "Causes and Effects of Climate Change," *Climate Action*. <https://www.un.org/en/climatechange/science/causes-effects-climate-change>

⁵ Hoegh-Guldberg O, et al, The human imperative of stabilizing global climate change at 1.5°C. *Science*. 2019 Sep 20; p. 365.

⁶ "President Biden's Bipartisan Infrastructure Law," The White House, Accessed: 20 October 2022. <https://www.whitehouse.gov/bipartisan-infrastructure-law/#electricvehicle>

⁷ Michael Birnbuam, "A Profound Change is Coming to American School Buses," *The Washington Post*, 26 October 2022.

⁸ Ana Swanson, "This Remote Mine Could Foretell the Future of America's Electric Car Industry," *The New York Times*, 1 September, 2022. https://www.nytimes.com/2022/08/30/business/economy/electric-cars-us-nickel-mine.html?action=click&pgtype=Article&state=default&module=stylin-electric-vehicles&variant=show®ion=MAIN_CONTENT_1&block=storyline_top_links_recirc

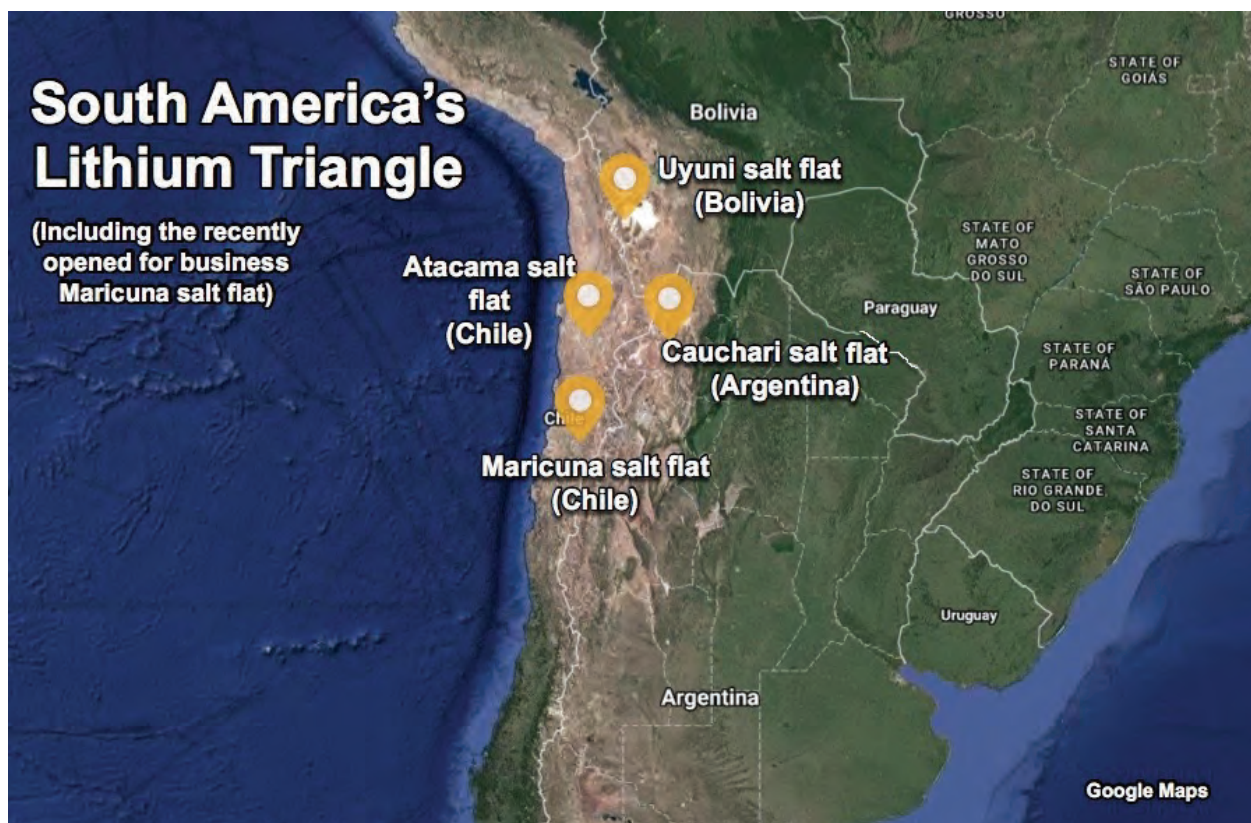
⁹ Richard Backhaus, "Battery Raw Materials – Where from and Where to?" *ATW Worldw.*, vol. 123, no. 9, (2021), 8-13. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8390110/>

¹⁰ Sterba et al., 2019, p. 416.

¹¹ Nicole Greenfield, "Lithium Mining is Leaving Chile's Indigenous Communities High and Dry (Literally)," *National Resources Defense Council*, 26 April 2022. <https://www.nrdc.org/stories/lithium-mining-leaving-chiles-indigenous-communities-high-and-dry-literally>

¹² Samar Ahmad, "The Lithium Triangle: Where Chile, Argentina, and Bolivia Meet," *Harvard International Review*, 16 January 2020. <https://hir.harvard.edu/lithium-triangle/>

The evaporation leaves a sludge mixture that is combined with sodium carbonate to produce lithium carbonate, which is exported to processing facilities to create lithium-ion batteries.¹³



Northern Chile and Argentina and southern Bolivia are known as the lithium triangle.

Credit: Mining.com and Cecilia Jamasmie

Current Mining Efforts in the Lithium Triangle

Argentina

The northwest region of Argentina is home to a section of the Atacama Desert that is estimated to hold billions of dollars of lithium beneath its crust. According to an Argentine government commission aimed at improving lithium mining, there are currently 23 mining operations across four provinces in the region.¹⁴ These endeavors are led by Minera EXAR S.A., a company based in Argentina but created and financed by Ganfeng Lithium and Lithium Americas, Chinese and Canadian companies, respectively.¹⁵ Additional efforts are in the works to bring Argentina's state oil firm YPF Lito into the Catamarca province.¹⁶ The investment from YPF and the total expected yield from Minera EXAR have not yet been revealed since the time from investment in a lithium mining project to the production of usable lithium averages about five years. Minera EXAR is expected to begin production in 2023.

¹³Javiera Barandirán, "Lithium and Development Imaginaries in Chile, Argentina and Bolivia," *World Development*, vol. 113, (2019), 381-391.

¹⁴"Litio: Consensuan Agenda de Trabajo y Temáticas Prioritarias en el Marco de ProNaPre," *Argentina.gob.ar*, 6 September 2022. <https://www.argentina.gob.ar/noticias/litio-consensuan-agenda-de-trabajo-y-tematicas-prioritarias-en-el-marco-del-pronapre> The provinces included are Jujuy, Salta, Catamarca, and La Rioja.

¹⁵ Link to Minera EXAR website: <https://www.mineraexar.com.ar/>

¹⁶ Mendiguren: 'Argentina Vuelve a Estar en el Radar del Mundo y la Cadena del Litio es uno de los Motores que nos va a Llevar al Desarrollo,' *Argentina.gob.ar*, 25 August 2022. <https://www.argentina.gob.ar/noticias/mendiguren-argentina-vuelve-estar-en-el-radar-del-mundo-y-la-cadena-del-litio-es-uno-de-los>

Bolivia

Despite having the world's largest lithium deposit in the salt flat of Uyuni, Bolivia restricts private companies from mining their natural resources.¹⁷ In 2007, Bolivia's Congress approved a proposal to create a public corporation for lithium extraction in Uyuni named Comibol which then developed and patented a lithium extraction plan.¹⁸ In 2018, Bolivia partnered with ACI Systems Alemania and planned to invest \$1.3 million USD in lithium mining.¹⁹ These developments have not yet come to fruition given the political climate in Bolivia that currently restricts international participation in the lithium market. Consequently, Bolivians have attempted to produce lithium but lack the industry know-how and ability to produce on a large scale without foreign assistance, resulting in a meager performance in the lithium market.²⁰ Due to these political and technical limitations, in 2021 Bolivia produced the same amount of lithium that Chile produced in one-and-a-half days.²¹



Caption: SQM mining operations in northern Chile.

Photo credit: SQM Mining

¹⁷ Javiera Barandirán, "Lithium and Development Imaginaries in Chile, Argentina and Bolivia," *World Development*, vol. 113, (2019), 381-391.

¹⁸ Javiera Barandirán, "Lithium and Development Imaginaries in Chile, Argentina and Bolivia."

¹⁹ Samar Ahmad, "The Lithium Triangle: Where Chile, Argentina, and Bolivia Meet."

²⁰ Sarah Esther Maslin, "The Lithium Curse: Why Bolivia has Failed to Turn Minerals into Gold," *The Economist*, 20 May 2022.

<https://www.economist.com/1843/2022/05/30/the-lithium-curse-why-bolivia-has-failed-to-turn-minerals-into-gold>

²¹ Bolivia produced 540 tons of lithium carbonate in one year. This is largely attributed to the state control of Bolivian natural resources under former President Evo Morales. James Broughel, "How the Inflation Reduction Act Could Cause a Lithium Crunch," *Forbes*, 14 September 2022.

<https://www.forbes.com/sites/jamesbroughel/2022/09/14/how-the-inflation-reduction-act-could-cause-a-lithium-crunch/?sh=1098eaa342c1>

Chile

Lithium production in Chile began in the 1980s and now contributes around one-third of global lithium produced through private companies. The Chilean government is creating a movement to develop public companies for lithium mining to reduce some of the power held by private lithium miners. This movement is being supported by the Mexican government and organized in conjunction with Argentina and Peru, who are also trying to create national companies for their mining enterprises.²² The two largest companies mining lithium in Chile are Albemarle, based in Charlotte, North Carolina, and Sociedad Química Minera (SQM), based in the Atacama region of Chile that began mining in 1996.²³ Chile is also home to numerous processing locations for lithium to convert high-grade lithium carbonate into the usable material for lithium-ion batteries.

Environmental Consequences of Lithium Mining

In light of the environmental challenges of a warming planet caused by human-generated gases, the mining of lithium presents significant challenges, particularly with regard to water usage and degradation of arable land.

Water

In the Lithium Triangle, extracting one ton of lithium requires an estimated 500,000 gallons of water.²⁴ A study by Ingrid Garcés from the Chilean University of Antofagasta estimates that the number is closer to two million liters of water evaporated per ton of lithium produced.²⁵ Further studies in this area conducted by CORFO (Corporación de Fomento de la Producción de Chile), which has mined lithium and copper in Chile for thirty years, found that the rate of water exploitation in the Salar de Atacama is exceeding the capacity for nature to replenish its sources.²⁶ The area of northern Chile is one of the driest on the planet and fresh water sources are rapidly diminishing. Tropical glaciers in the Chilean Andes are predicted to disappear by the 2060s,²⁷ as evaporation has exceeded the water collected from precipitation.²⁸

Land degradation and local residents

Water diversion into the mining industry has created a water shortage with a substantial impact on the local farmers and livestock in a region predisposed to arid conditions. Some communities rely on tankers for potable water sources.²⁹ Water loss also contributes to biodiversity loss, soil degradation, and discarded salt scarring local land.³⁰ In conjunction with increasing irregular climate patterns, accelerated water deprivation can potentially force local indigenous communities to relocate on account of resource scarcity.³¹

²² Samar Ahmad, "The Lithium Triangle: Where Chile, Argentina, and Bolivia Meet." With supporting statements from Romina Lucrecia López Steinmetz and Shao Bing Fong, "Water Legislation in the Context of Lithium Mining in Argentina," *Resources Policy*, vol. 64, (2019).

²³ Amanda Maxwell and James Blair, "Lithium Mining Must not Dry up the Atacama Desert," *NRDC*, 12 May 2022. <https://www.nrdc.org/experts/amanda-maxwell/lithium-mining-must-not-do-more-harm-good>

²⁴ Bárbara Jerez, Ingrid Garcés, and Robinson Torres, "Lithium Extractivism and Water Injustices in the Salar de Atacama, Chile: The Colonial Shadow of Green Electromobility," *Political Geography*, vol. 87, (2021).

²⁵ Buytaert, Wouter; et al, 2017: Glacial melt content of water use in the tropical Andes. *Environmental Research Letters* 12:11. Link: <https://iopscience.iop.org/article/10.1088/1748-9326/aa926c>; David Rounce, et al., "Global glacier change in the 21st century: Every increase in temperature matters," *Science*, Vol 379, Issue 6627, pp. 78-83, 05 Jan 2023.

²⁶ Romina Lucrecia López Steinmetz and Shao Bing Fong, "Water Legislation in the Context of Lithium Mining."

²⁷ Greenfield, 2022.

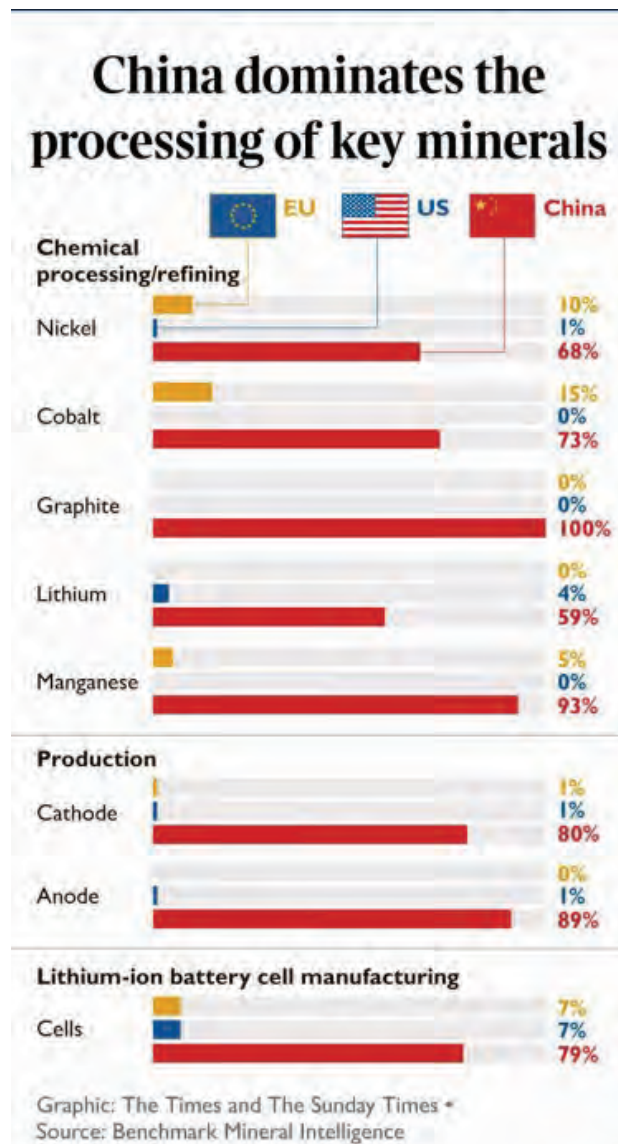
²⁸ Luis Felipe López-Calva, "Lithium in Latin America: A New Quest for 'El Dorado,'" *United Nations Development Program*, Latin America and the Caribbean, 26 May 2022. And Amit Katwala, "The Spiraling Environmental Cost of our Lithium Battery Addiction," *Wired*, 08 May 2018. <https://www.wired.co.uk/article/lithium-batteries-environment-impact>

²⁹ Greenfield, 2022

³⁰ Luis Felipe López-Calva, "Lithium in Latin America: A New Quest for 'El Dorado,'" *United Nations Development Program*, Latin America and the Caribbean, 26 May 2022. And Amit Katwala, "The Spiraling Environmental Cost of our Lithium Battery Addiction," *Wired*, 08 May 2018. <https://www.wired.co.uk/article/lithium-batteries-environment-impact>

³¹ Greenfield, 2022.

Some companies have included local workers and municipalities in their profits, however, these offerings have not been comparable to the income earned by the large mining companies.³² Local communities, specifically in the Atacama, have had their legal rights undermined by the formal negotiations between the provincial government in Argentina and the mining companies that are undercutting indigenous property rights by over-representing the mining industry.³³ Local residents also note that “nothing stays in Chile, it all goes other places. We don’t have electric cars, we suffer from contamination. But at what cost?”³⁴ There are a few examples of success stories, such as the Jujuy salt flats in Argentina, which hire 65 percent of their employees from local indigenous communities with guarantees to be paid above the minimum wage.



China dominates the processing of key minerals required to electrify the transportation industry.

Graph credit: The Sunday Times and Benchmark Mineral Intelligence

³² Ahmad, 2019. One example highlighted the offer from Minera Exar to pay local communities in Chile between \$9,000-60,000 USD annually.

³³ Samar Ahmad, “The Lithium Triangle: Where Chile, Argentina, and Bolivia Meet.”

³⁴ Nicole Greenfield, “Lithium Mining is Leaving Chile’s Indigenous Communities High and Dry (Literally).” According to Statista, the units of electric vehicles sold in Chile in 2021 was 856 units, which was 4 times greater than 2020 which saw 236 EVs sold in Chile in a population of 19.2 million residents.

<https://www.statista.com/statistics/1135054/number-electric-vehicle-wholesale-sales-chile/#:~:text=In%202021%2C%20the%20total%20number.Chile%20amount-ed%20to%20856%20units.>

³⁵ Samar Ahmad, “The Lithium Triangle: Where Chile, Argentina, and Bolivia Meet.”

The Problem – increasing demand, limited supply

A study conducted by McKinsey projected that global demand for electric vehicles will grow six-fold from 2021 to 2030.³⁶ To meet the rising needs for lithium batteries, which are integral to EVs, S&P Global predicted that lithium supply will triple by 2025. However, this amount may still fall short of the metal needed.³⁷ The estimated increase in lithium also aligns with the Inflation Reduction Act mandate to import lithium exclusively from free trade partner nations. Australia, Canada, and Chile will thusly be at the forefront of lithium production for the United States in coming years. The International Energy Agency (IEA) indicates that if countries adhere to their Global Sustainable Development goals for lithium production, the amount of required lithium is already outpacing supply.³⁸ The growing lithium demand outlined in stated country policies, which is less than demand from Sustainable Development Goals, is projected to surpass available lithium between 2028 and 2029.³⁹

Conclusion

This article suggests that being able to tap into the Latin American Lithium Triangle, particularly Chile, will be a key factor in lithium expansion for the United States given Chile's lithium availability, existing infrastructure, and potential for expansion. However, lithium carbonate mining for the purpose of global sustainability efforts should not undermine localities or exacerbate environmental conditions. If the purpose of electrifying the power grid and transitioning to vehicles powered with lithium ion batteries is to enhance global sustainability, then this standard should be enforced from the genesis of lithium extraction until batteries are recycled and retired.

Author biography: Sydney Knapp works at the William J. Perry Center for Hemispheric Defense Studies in the Registrar Office. She formerly interned at United States Southern Command in the Civil Affairs Division and is a recent graduate of the University of Miami with a Bachelor of Science (BS) degree in Communication Studies and master's degrees in International Administration and Liberal Studies.

³⁶ Russell Hensley, Kevin Laczkowski, Timo Möller and Dennis Schwedhelm, "Can the Automotive Industry Scale Fast Enough?" McKinsey Quarterly, 12 May 2022. <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/can-the-automotive-industry-scale-fast-enough?cid=other-eml-onp-mip-mck&hlkid=722c1b7d3d1f43f6afcb35e5af104d30&hctky=13668541&hdpid=894dec51-1cb7-409c-99af-83222f46504f>

³⁷ Emmanuel Latham and Ben Kilbey, "Lithium Supply is set to Triple by 2025. Will it be Enough?" *S&P Global*, 24 October 2019. <https://www.spglobal.com/en/research-insights/articles/lithium-supply-is-set-to-triple-by-2025-will-it-be-enough>

³⁸ "Committed Mine Production and Primary Demand for Lithium, 2020-2030," as appears in "The Role of Critical Minerals in Clean Energy Transitions," *International Energy Agency*, 26 October 2022. <https://www.iea.org/data-and-statistics/charts/committed-mine-production-and-primary-demand-for-lithium-2020-2030>

³⁹ "Committed Mine Production and Primary Demand for Lithium, 2020-2030," as appears in "The Role of Critical Minerals in Clean Energy Transitions," *International Energy Agency*, 26 October 2022

Regional Insights

Disclaimer: Regional Insights is a publication of the William J. Perry Center for Hemispheric Defense Studies. The views represented are those of the author and do not necessarily reflect those of the Perry Center, the Department of Defense, or the U.S. Government. Copies of Perry Center publications can be obtained on the Perry Center website at: <https://wjpcenter.org/>

**William J. Perry Center
for Hemispheric Defense Studies**
260 5th Ave., Bldg. 64
Abraham Lincoln Hall
Fort McNair
Washington, DC 20319-5066
www.williamjperrycenter.org

Editor-in-Chief: Dr. Pat Paterson