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Adversaries in the Altiplano:

Strategic Competition in South America's Lithium Triangle

by Daniel Liebetreu

After four consecutive decades of explosive economic growth, the People's Republic of China (PRC) is wielding its newfound economic and political power in lands both near and far. The release of China's "Go Out" strategy for outward foreign direct investment (FDI) in 1999 and its entrance into the World Trade Organization (WTO) in 2001, led to huge demand in China for commodities and a subsequent global commodities boom from 2003 to 2013. The price of some mineral and petroleum commodities tripled, and the so-called "China Boom" drove development and poverty reduction in commodity exporting countries across the global south.[1] As a result, China has risen as a new economic hegemon in parts of Africa and southeast and central Asia while greatly expanding its economic influence around the world.

In South America, many countries began to hedge their bets, limit their reliance on the United States economy, and more closely align with the Chinese economy during its commodities boom. The PRC became the number one trade partner of Argentina, Brazil, Chile, Peru, and several other smaller countries. Chinese FDI in South America exploded, particularly in extractive industries and agriculture, while Western investment tapered off following the global financial crisis of 2008-2009. The years of the so-called "China Boom" were so fruitful that millions of people escaped poverty and many economies in the region continued growing despite the disruption from the financial crisis. China was touted across the region as a new market for South American goods and a much-needed additional source of finance and investment. A natural partnership was forming.

Now as the world settles into its new normal following the COVID-19 pandemic and the US shifts its focus to resolving internal problems and national security issues in eastern Europe, the natural partnership between China and South America may provide the Chinese with a huge advantage as the strategic competition of the 21st century runs its course. During the two-decade explosion of investment and trade since China joined the World Trade Organization in 2001, Chinese companies have inserted themselves into the supply chains of many key minerals, most critical

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Figure 1. South America's Lithium Triangle

Source: Author's own rendering with the assistance of snazzymaps.com and data from Lee Ann Munk, Scott A. Hynek, Dwight C. Bradley, David Boutt, Keith Labay, and Hillary Jochens. 2016. "Lithium Brines: A Global Perspective." Reviews in Economic Geology, No. 18: 342–343.

among them being lithium. As the U.S. economy transitions to renewable energy, it finds itself at a significant disadvantage in sourcing this key mineral, especially since the most economically viable lithium resources in the world are in South America's *altiplano*, or high plains. This region in Argentina, Bolivia, and Chile—known as the Lithium Triangle (see Figure 1)—is where more than two-thirds of global lithium resources are located.

To gain and maintain a competitive advantage, the United States requires a comprehensive, interagency strategy for the Western Hemisphere that benefits its partners in the Lithium Triangle while addressing the nation's need for natural resources during the green energy revolution. Failure to act may provide the PRC with the opportunity to dominate the lithium-ion battery market for decades to come.

Why Lithium?

This article explores the opportunities and risks facing the United States given the PRC's involvement in South America's lithium supply chains. Since the first rechargeable hand-held video camera employed a lithium-ion battery in 1991, lithium-ion technology has been the gold standard for small, lightweight, and high-powered batteries. The commercialization of lithium-ion technology was one of the catalysts for the mobile phone revolution. These batteries provide the electricity required to power nearly all the wireless electronics that enable our day-to-day activities, including smart phones, tablets, laptop computers, smart watches, and more. Moreover, these batteries are so critical to the nation's economic and military interests that the White House recently stated that "establishing and protecting a high-capacity [lithium-ion] battery manufacturing capability in the United States […] is critical to U.S. national security and is essential to developing resilient defense supply chains that are not under threat from potential adversaries."[2] At the present time, the U.S. is at least a decade away from developing the mining capability to satisfy lithium demand through domestic extraction. As a result, the Lithium Triangle is a critical region to help the U.S. bridge the gap.

Lithium is important because it is the lightest of all the alkali metals. This means that it is the lightest element—number three on the periodic table—in a family of highly reactive metals containing a single valence electron. This single electron in the metal's outer shell makes it so reactive that lithium does not occur in nature in its pure form, only as an element in a compound. In addition, this means it is an excellent conductor of heat and electricity and therefore the ideal metal for use in lightweight batteries.[3]

From a purely economic standpoint, the primary industry employing lithium-ion batteries

is the auto industry through the employment of electric vehicles (EVs). The auto industry has been dominated by the internal combustion engine for more than a century, but now falling battery costs have industry experts predicting EVs to price similarly to their gas-burning competitors within five years.[4] This has caused the market share of EV maker Tesla to eclipse more than $975 billion—more than ten times the value of competitors Ford and General Motors. In China, where government policy is pressuring out new gas-powered autos, EV sales accounted for more than twenty percent of new vehicle sales in August 2021.[5] Nearly every major auto maker has announced plans to make their fleets all-electric in the coming decades, and the lithium-ion battery is the key to the transition.

However, lithium's future is more broad than just electric vehicles. There is huge potential demand coming from battery makers geared toward bulk electricity storage. As more renewables join electrical grids around the world, the necessity for large, cheap batteries to store wind and solar energy will further drive demand. For example, Tesla has been installing batteries and solar panels in new homes in Australia and the US for several years.[6] On a larger scale, utilities companies are looking at investing in large battery packs to store electricity during periods of low demand and provide electricity as surge capacity during periods of increased demand. Some energy experts predict that a critical "tipping point" in the green energy revolution is the point where power companies build battery farms in lieu of a gas or coal plant to deal with high-demand times.

The Lithium Triangle

Due to its share of global reserves and resources, South America's lithium is strategically significant. Argentina and Chile contain about half of the world's current lithium reserves—that is, half of the total lithium that can be economically extracted today. Another quarter of global reserves reside in Australia, with about seven percent in China, and three and a half percent in the US. Meanwhile, global resources are even more highly concentrated in the Lithium Triangle with fifty-eight percent of total resources contained in the salty brines under the salt flats' crusty surfaces.[7] More significantly, these resources contained in underground brines are the cheapest to extract and process into lithium carbonate, especially given the extremely dry climate in the altiplano desert.[8] Table 1 (page 44) shows the global array of lithium resources and reserves listed by country.[9]

There are currently two primary ways to exploit lithium reserves and each extraction operations' method is determined by the way the mineral is geologically arrayed. The more economical extraction via salt brine is used in South America's *altiplano*, as well as in locations in central China and portions of the Nevada desert. The process involves drilling approximately ten meters into the crust of these desert lakes to reach a mineral rich brine, then pumping the salty mixture to the surface into a series of evaporation pools. Once much of the water from the brine evaporates and the mixture is highly concentrated—a process that usually takes twelve to eighteen months—the salt's prize, lithium carbonate ($LiCO_3$), can be removed and shipped to facilities for processing.[10]

The second extraction method comes from spodumene rock, which is common in Australia, China, and North Carolina, and involves pit mines where the rock is pulverized and then shipped to east Asia for processing.[11] These spodumene rock formations contain lithium hydroxide (LiOH), a more highly sought after compound for lithium-ion battery manufacturing because it is chemically easier to convert to cathode materials such as lithium cobalt oxide ($LiCoO_2$), lithium manganese oxide ($LiMn_2O_4$), lithium nickel oxide ($LiNiO_2$), and lithium iron phosphate ($LiFePO_4$).[12] The characteristics and ideal uses for each type of battery are described

Country	Resources (tons LCE)		Reserves (tons LCE)		2021 Production
	Quantity	Percentage	Quantity	Percentage	
Bolivia	21,000,000	24%	ND	ND	ND
Argentina	19,000,000	21%	2,200,000	10%	5,900
Chile	9,800,000	11%	9,200,000	42%	21,500
United States	9,100,000	10%	750,000	3%	ND
Australia	7,300,000	8%	5,700,000	26%	39,700
China	5,100,000	6%	1,500,000	7%	13,300
Canada	2,900,000	3%	530,000	2%	0
Zimbabwe	500,000	1%	220,000	1%	417
Brazil	470,000	1%	95,000	0%	1,420
Portugal	270,000	0%	60,000	0%	348
Others	13,560,000	15%	2,700,000	12%	0

LCE - Lithium Carbonate Equivalent

Table 1. Lithium Resources and Reserves by Country

Source: Author's own rendering. Quantities denoted in tons of LCE and gathered from the U.S. Geological Survey. 2022. Mineral Commodities Summary 2022. Reston: U.S. Geological Survey.

in Table 2 (page 45).

Converting lithium carbonate from a salt brine into lithium hydroxide requires an additional chemical process utilizing either soda ash/sodium carbonate (Na_2CO_3) or slaked lime/calcium hydroxide ($Ca(OH)_2$). This adds an additional cost to processing and, if done on sight at a salt brine operation, can add significant infrastructure requirements due to the road or rail network required to bring in the soda ash or slaked lime.

An additional factor in salt brine lithium extraction is the concentration of lithium in the brines. Since lithium is extremely common—in fact it is even present in ocean water at very low concentrations—the concentration of lithium determines whether extraction is economically viable. In general, brines with a lithium concentration over 100 parts per million (ppm or mg/L) are considered potentially viable.[13] The highest known concentrations of lithium in salt brines occur in the lithium triangle's *altiplano* region, in some locations reaching more than 1,500 ppm. Table 3 (page 46) shows the concentration of lithium in known salt brines across the lithium triangle.

Argentina

At an altitude of thirteen thousand feet in northwest Argentina's *altiplano* (or high plains) sits one of the country's most spectacular landscapes. Thousands of years of erosion has created beautiful white expanses hiding the second largest collection of lithium resources in

Type of Cathode	Cathode Chemistry	Anode	Debut	Battery Characteristics		Industrial Applications
				Advantages	Disadvantages	
Lithium Cobalt Oxide (LCO)	LiCoO2	Graphite	1991	Very high specific energy and storage	Expensive, relatively short life span, low thermal stability	Mobile phones, laptops, digital cameras
Lithium Magnesium Oxide (LMO)	LiMn2O4	Graphite	1996	Fast charging and high-current discharging, safer than Li-Cobalt	One third less capacity relative to Li-Cobalt	Power tools, medical devices
Lithium Nickel Magnesium Cobalt Oxide (NMC)	LiNiMn-CoO2	Graphite	2008	Provides high capacity and high power	Slightly lower voltage and less stable than LCO and LMO	EV powertrains, E-bikes, medical devices
Lithium Iron Phosphate (LFP)	LiFePO4	Graphite	1996	Very flat voltage discharge curve, one of safest Li-ions	Lower nominal voltage, no tolerance for moisture	EV powertrains, industrial energy storage
Lithium Nickel Cobalt Aluminum Oxide (NCA)	LiNiCoA-lO2	Graphite	1999	High specific energy, good specific power, and a long life span	Least stable cathode, expensive due to cost of cobalt	Medical devices, industrial, electric powertrain (Tesla)
Lithium Titanate (LTO)	LMO or NMC	Li2TiO3 (tita-nate)	2008	Long life, fast charge, wide temperature range, extremely safe	Low specific energy and expensive	EV powertrains **Emerging technology**

Table 2. Characteristics of Lithium-Ion Cathodes

Source: Created by author from various sources, primarily Martin Obaya and Mauricio Céspedes. 2021. Análisis de las redes globales de producción de baterías de ion de litio: implicaciones para los países del triángulo del litio. Documentos de Proyectos (LC/TS.2021/58), Santiago de Chile: Comisión Económica para América Latina y el Caribe (CEPAL): 59.

the world. Based solely on the numbers, Argentina's lithium industry has a tremendous amount of potential—the country's 19.3 million tons of known lithium resources are second in the world behind only Bolivia.[14] While the country has just two fully functioning extraction projects, the output of these two combines to make up the fourth largest production by any country in the world (behind Australia, Chile, and China respectively.) Moreover, those two projects alone sit on giant *salares* (salt flats) that make up the world's third largest lithium reserve. In addition, Argentina has more than sixty other projects in either the exploration, construction, or pilot phase looking to turn the *altiplano*'s vast resources into economically viable reserves.[15]

For mining firms, Argentina's lithium is compelling for more than just its quantity. The quality is excellent as well. All of Argentina's known lithium resources contain between 400 and 650 parts per million (ppm or mg/L) of lithium in the brine, and anything over 100 ppm is considered over the threshold to be economically viable.[16] For comparison, this is about three times more concentrated than the salt flat chemistries in the United States. But these remarkable *salares* sit in one of the driest and most remote places on earth, and the lack of water presents both advantages and unique challenges for the lithium extraction process. Naturally, the dry climate is good for the evaporation process used across the lithium triangle, however the brine extraction process requires huge amounts

Basin	Country	Basin Floor Area (km2)	Avg Li (mg/L)	Total Lithium Resources (Mt)	Precip (mm/yr)	Evap (mm/yr)	Aridity Class	Significant Impurities	Process Technology
Salar de Atacama	Chile	2,115	1,800	6.3	39	1,440	Arid	None	Pure Evaporation
Salar de Maricunga	Chile	136	920	0.2	52	950	Arid	Calcium	Chemical-Evaporative
Salar de Surire	Chile	106	340	0.0	247	1100	Semiarid	TBD	TBD
Salar del Hombre Muerto	Argentina	581	521	0.8	91	1106	Arid	None	DLE
Salar del Rincon	Argentina	421	400	0.2	61	1233	Arid	Sulfates	DLE (T)
Salar de Olaroz	Argentina	480	650	1.0	90	1246	Arid	Sulfates	Chemical-Evaporative
Salar de Cauchari	Argentina	480	510	1.0	90	1246	Arid	Sulfates	Chemical-Evaporative
Salar de Llullaillaco	Argentina	128	450	0.0	30	1148	Hyperarid	TBD	TBD
Salar de Uyuni	Bolivia	13768	321	10.2	62	1318	Arid	Magnesium & Sulfates	Chemical-Evaporative & DLE (T)
Salar de Copaisa	Bolivia	3055	243	0.0	320	1316	Semiarid	Magnesium & Sulfates	Chemical-Evaporative & DLE (T)
Salar de Pastos Grandes	Bolivia	142	1062	0.0	57	1094	Arid	Magnesium & Sulfates	TBD

Table 3. Salt Brine Compositions in the Lithium Triangle

Source: Author's own rendering. Data from Alex Grant. 2021. "Is There Enough Lithium to Make All the Batteries?" Geothermal Lithium Extraction Prize DLE Webinar, August 12. https://www.youtube.com/watch?v=gbV8S5t1JYg; and Lee Ann Munk, Scott A. Hynek, Dwight C. Bradley, David Boutt, Keith Labay, and Hillary Jochens. 2016. "Lithium Brines: A Global Perspective." Reviews in Economic Geology, no. 18: 342–343.

of water to pump the brines out of the ground and into the evaporation pools. Unfortunately, based on distances and the lack of infrastructure, water cannot be brought in from the outside without a massive investment in roads and/or pipelines. Moreover, provincial governments and mining companies have struggled to reach agreements with the indigenous tribes that have occupied this land for millennia and rely on the scarce water for drinking and farming. To overcome these challenges, Argentina's lithium industry requires investment and technology. Where they obtain this investment and know-how might help determine who controls lithium supply chains for the next several decades.

The current groundwork for Argentina's lithium policies were laid in the 1990s, a period of rapid economic and ideological change centered around deregulation, privatization, and decentralization. There are two legacy results of this: mining in Argentina is a relatively new industry (as opposed to the industries in Bolivia and Chile which are written into those countries' constitutions) and therefore does not have an outdated, cumbersome regulatory framework; and the regulatory frameworks that do exist are held at the provincial level.[17] This decentralized approach has led to two distinctly different provincial development models. In the provinces of Catamarca and Salta, foreign and private domestic companies are awarded mineral rights based on proposals to explore, invest, and extract resources. These provincial governments are focused on augmenting the investing firm's output as a means of increasing tax revenue. A 2019 Interamerican Development Bank study terms this the "extractivist" model focused on maximizing the quantity extracted by promoting investment, innovation, and research and then utilizing taxes to support other government initiatives.[18] In contrast, in the province of Jujuy, the provincial government has established a provincial-level state owned enterprise focused on industrializing the entire process from exploration and extraction to processing and manufacturing. This "industrialization" model collects a percentage of all lithium carbonate produced in the region and uses it to attract companies that conduct value-added production.[19]

Argentina presents an excellent investment opportunity for American lithium mining and lithium-ion battery firms...

Argentina presents an excellent investment opportunity for American lithium mining and lithium-ion battery firms and will be a critical actor in the green energy revolution because it offers the best opportunity for investment due to the openness in Catamarca and Salta provinces. In addition, the different provincial models provide advantages and disadvantages that could appeal to U.S. companies and create opportunities for investment and innovation. While the fiscal uncertainty involved in investment in Argentina is unlikely to subside, the potential upside is too great to ignore.

In terms of strategic competition, the Chinese have a leg up on American firms because of the size of recent investments and the geopolitical trends given Argentina's recent admission to the BRI. However, there are still plenty of opportunities to get involved that could be beneficial to long-term U.S. strategic interests. The sheer quantity and diversity of lithium extraction projects warrants investigation by U.S. policy makers into programs that provide American companies a comparative advantage. One policy possibility is an EXIM Bank program that provides loan guarantees to American companies investing in lithium extraction in Argentina. While American capital has been reluctant to invest in Argentina in recent decades, the next two cases will demonstrate why Argentina may be the best investment option in South America's lithium triangle.

Bolivia

The second country in the Lithium Triangle is the Plurinational State of Bolivia, a landlocked country with the largest known lithium resources on the planet. For more than a decade, lithium has been a central theme in Bolivian politics as the country grapples with how to best exploit its mineral resources and fend off deep-seeded anxiety stemming from the country's history of exploitation by foreign powers dating back to the Spanish Empire's silver mines in the 16th century.[20] This complicated history has shaped the discussion around mineral extraction and led to a highly centralized, state-driven extraction model based on a popular and widely successful model it uses for natural gas. However, gas was put under state control after the investment of billions of dollars of foreign, private equity in the 1990s.[21] Unlike with lithium, the Bolivian government did not have to build a capable oil and gas sector from the ground up, only continue to profitably manage an already established industry that accounted for more than half the country's annual exports.

For more than a decade, lithium has been a central theme in Bolivian politics as the country grapples with how to best exploit its mineral resources...

Unfortunately, the state-controlled lithium industry is inefficient and way behind its competitors in Argentina and Chile. In addition, the chemical composition of Bolivia's lithium resources—their brines contain very high amounts of magnesium—requires special technologies known as Direct Lithium Extraction (DLE) that does not yet exist at scale. To tackle the technology problem, the Bolivian government has turned to joint ventures with foreign firms, although previous joint ventures have rarely made it past the pilot phase. For example, the largest and most recent joint venture—a deal between the state-owned lithium enterprise *Yacimientos de Litio Boliviano* (YLB) and the German green-technology manufacturer ACI Systems—was canceled by Evo Morales just days before he escaped into political exile in November 2019. Fortunately, after the political turmoil that ended the Morales administration and a difficult bout with the coronavirus under an interim government in 2020, Bolivia is beginning to settle into the post-Morales era. Morales' former Minister of Economy Luis Arce won a fair election in late-2020 and has restored hope to the Bolivian lithium industry. In early 2021, YLB held another round of competitions in search for a DLE technology that makes the extraction of lithium from Bolivian salt brines economically viable. Thus, the country with the largest lithium resources in the world hopes to drastically expand extraction and processing during this decade but cannot make the leap on its own.

Currently there are six companies—four Chinese billion-dollar firms, an American startup called Livent, and the Russian state uranium company—in the pilot stage of the DLE extraction competition vying to prove that their DLE technology can make Bolivia's lithium competitive. Incredibly, despite the political turmoil and unfriendly business environment, the chemical composition of the Bolivian salt brines is likely the single biggest factor that explains why the nation with the largest lithium resources in the world has long struggled to capitalize on this mineral wealth. If the Bolivians can ally with a team capable of overcoming this technical hurdle, the trajectory of global lithium markets could be determined by operations in Bolivia's *altiplano* for decades to come.

Looking at the strategic competition between the United States and PRC, Bolivia may be the perfect case where the advantages of engagement with both the Americans and Chinese could coincide. If the Bolivians have the flexibility

built into their competition to select multiple winners, they could capitalize on the strengths of both an innovative American company and a massive Chinese firm. An American startup could provide the DLE technology that finally makes the Bolivian brines economically viable while a billion-dollar Chinese state-owned enterprise could help bring the operation to scale. Much will still hinge on the capabilities of YLB and the institutions within the Bolivian government, but after more than a decade of slow progress, the Bolivians could be on the precipice of a breakthrough.

Chile

In Chile, the most economically open and prosperous nation in Latin America is facing a potential economic policy course reversal. Following the massive protest movement of late 2019 known as the *Estallido social* (literally translated as "social outburst"), the Chilean people voted to rewrite their neoliberal constitution and forge a new social contract that is more inclusive and environmentally friendly. Then in December of 2021 they elected a thirty-six-year-old Socialist named Gabriel Boric who has suggested that Chile should nationalize the nation's lithium industry utilizing a model similar to the current Chilean state copper company. Boric hopes to use the additional funds generated by a nationalized lithium industry to pay for broad reforms to the pension, healthcare, and public education systems. However, on September 4th, 2022, the Chileans rejected the newly proposed constitution since it was deemed to swing too far to the left. Therefore, Chile remains politically deadlocked, and the uncertainty this has created will likely impact foreign investment in the lithium sector for years to come.

As it stands today, Chile's long history of lithium extraction has fostered a well-regulated industry that does not hold the same potential as the other two countries in the lithium triangle. However, U.S. policy makers should not take their eye off of Chile's lithium industry due to the involvement of the world's largest lithium producer: the private American mining company Albemarle. Since Albemarle is one of just two lithium producers in Chile, it is vital to U.S. interests that the Chileans maintain a market-based model. Similarly, the PRC views the Chileans as a critical partner in its globalized development model. The Chinese are the Chileans largest trade partner and biggest importer of Chilean copper and fresh produce. In addition, Chinese lithium giant Tianqi Lithium Corporation made a massive $4.1 billion investment in 2018 to purchase a non-majority stake in *Sociedad Química y Minera* (SQM), the Chilean owned mining firm that constitutes the other half of Chilean lithium production.[22]

...Chile's long history of lithium extraction has fostered a well-regulated industry...

Despite the ongoing political turmoil, Chile remains an example of balance between government oversight and the free market to manage economic interests and the interests of local populations and environmental groups. The central government has managed this delicate balance through strong institutions—the National Lithium Council and CCHEN—and the quotas they set based on environmental factors. Both well-established operations have increased their annual lithium output as demand has increased and technology has made further exploitation ecologically sustainable. In this regard, Chile should serve as an industry standard.

In terms of strategic competition, Chile is an example of where the US and China can coexist while benefiting both the host nation and the lithium industry more broadly. Both Albemarle and Tianqi Lithium have made huge investments in Chilean lithium to meet growing global demand. These types of investments

create jobs, contribute taxes to the local and national governments, and increase the royalties Chile will make from its lithium reserves. As Chile debates the merits of nationalization, it is important to consider that both superpowers (who happen to account for more than half of Chilean trade) have a vested interest in maintaining the status quo.

Finally, as the most established lithium provider in the region, Chile remains a critical player to the near-term supply of lithium, especially given the involvement of US-based Albemarle. Given the current discussions surrounding the potential nationalization of Chilean lithium, the U.S. State Department must continue to foster relationships in Santiago to ensure fair treatment of U.S. firms and help maintain Chile's reputation as a friendly destination for American foreign direct investment.

...the United States has fallen behind the PRC in securing a reliable supply of lithium...

Recommendations

Since the United States has fallen behind the PRC in securing a reliable supply of lithium for its EVs, smartphones, and defense technologies that require light, high-energy density batteries, the author has identified three ways in which the United States can engage the region while better supporting US interests. First, the government must publish a national strategy for the Western Hemisphere that promotes economic development, enhances American companies' opportunities to sustainably invest in the region's mineral wealth, and counters the growing influence of authoritarian extra-hemispheric actors. Second, the government must create an industrial policy that provides upstream investment in lithium related technologies like DLE to help U.S. companies gain and maintain a technological advantage over Chinese and other foreign firms. Finally, the U.S. must enact a "whole-of-government" approach to provide financing and incentives for American companies investing abroad in strategic supply chains. By adopting these policies, the U.S. can ensure access to South America's lithium reserves while also regaining credibility with South American governments and populations that have begun turning to the PRC for financing, investment, and overall leadership in the international system.

Recommendation One: Publish a National Strategy for the Western Hemisphere

Unlike the PRC, the U.S. has not published a national strategy for Latin America outlining clear priorities and lines of effort for engagement with the region. Given China's growing influence, this is problematic. China continues to emphasize "trade, investment, and financial cooperation" as described in their 1+3+6 plan released in 2014, and their latest strategy for the region has added a focus on the extraction of "geological and energy mining resources".[23] While the Western Hemisphere may not be the primary theater for strategic competition, the US has the capacity to engage with allies, partners, and other nations in multiple theaters simultaneously. To maintain stability in the Americas and secure a reliable supply of lithium, the US must develop and enact a comprehensive strategy.

The Western Hemisphere Security Strategy Act (WHSSA) proposed by Senate Foreign Relations Committee members Bob Menendez and Marco Rubio in February of 2022 could serve as the catalyst for this strategy development. The legislation would require the development of "a multi-year strategy [...] for purposes of enhancing diplomatic engagement and security assistance and cooperation, promoting regional security and stability, and advancing United States strategic interests in the Western

Hemisphere".[24] This is an encouraging first step, but the proposed legislation falls short by not incorporating regional development initiatives or a plan to counter the huge PRC investments in energy, infrastructure, and natural resource exploitation.

To be most effective, the WHSSA should require a strategy that incorporates three national priorities: security and stability in the Western Hemisphere in the face of extra hemispheric actors, democracy promotion and institutional reform, and access to vital minerals required for the green energy transformation. The proposed legislation includes the first two elements, but the third is equally critical and interrelated. Since a key element of the administration's energy transition strategy is ensuring cheap, reliable access to lithium for America's innovative green technology companies, it should also be incorporated into the strategy that covers the region with the largest lithium resources in the world. In addition, the new strategy must incorporate all elements of national power and leverage the capabilities of organizations like the United States International Development Finance Corporation (DFC), which will be discussed in further detail in recommendation three. In summary, without a strategy that clearly aligns all available ways and means to deliberate lines of effort, the U.S. will struggle to accomplish its strategic objectives in the Western Hemisphere and lead the global green energy revolution.

Recommendation Two: Develop Industrial Policy to Maintain the Advantage

Over the course of the next decade, technology and access to resources will determine which lithium and battery companies succeed and which ones fail. The U.S. government must do everything in its power to help American companies achieve success. To give its companies a comparative advantage in the strategic competition with the PRC, the U.S. government must develop an industrial policy that ensures the U.S. leads the green energy revolution. Through limited, yet effective policies, the government can guide the free market through the green energy transition by procuring charging stations and other EV infrastructure, subsidizing EV purchases and bulk battery storage, and slowly removing the current subsidies that support the oil and gas industry. While America's economic dynamism stems from its adherence to limited government, the ensuing climate crisis warrants a fundamental shift in economic policy directed at limiting fossil fuel consumption and expanding green energy's role in the electrical grid and transportation sector. While the climate provisions in the recently passed Inflation Reduction Act are a step in the right direction, more deliberate legislation is still necessary.

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For comparison, the PRC is effectively employing an industrial policy known as "Made in China 2025" focused on upgrading Chinese industry through targeted investment, trade policy, and innovation enhancing education and training programs. The policy describes Xi Jinping's vision of achieving global dominance in ten critical industries, to include information technology and artificial intelligence, robotics, and green technology.[25] Policy makers in Washington finally understand the threat China poses to U.S. economic interests. It is time to create an industrial policy to counter that threat.

Effective U.S. industrial policy should focus on specific industries that support the green energy transformation and relate to industries where U.S. companies are competing with Chinese firms. One example related to this article's scope is Direct Lithium Extraction

(DLE). The government should provide research grants to companies and research institutions involved in upstream DLE research. While traditional lithium extraction through evaporative ponds is slow and only recovers 45-55% of the lithium in the brines, ongoing research in DLE has demonstrated the potential to extract 80-90% of dissolved lithium while utilizing much less time and water. Since every lithium brine deposit has a unique chemistry, the government should focus on upstream investment in research that could impact a variety of lithium operations (for example, research involving membrane materials) and then leave private businesses to tailor their processes to the individual chemistries of their respective brines. Government funded research could have given American companies a huge advantage in the DLE competition in Bolivia, but Livent and EnergyX, who was disqualified from the competition in June of 2022, were left to fend for themselves in a competition with several billion-dollar Chinese state-owned firms. Well formulated and executed industrial policy could provide U.S. lithium producers greater access to resources at home and abroad; much needed financing for research and development in green technologies like DLE; and an advantage over foreign battery and EV manufacturers.

For the countries in the lithium triangle, America's greatest strength is its ability to combine innovative technologies with private equity.

Recommendation Three: Provide Financing and Loan Guarantees to U.S. Companies

For the countries in the lithium triangle, America's greatest strength is its ability to combine innovative technologies with private equity. Unfortunately, when there is too much risk due to geopolitical or economic instability, the equity holders are unwilling to invest. However, if the U.S. government can mitigate some of the risk, the private financing will diligently seek promising investment opportunities and rapidly flow to wherever there is potential. While the U.S. government does not want to "pick winners" per se, it can play a role by minimizing investment risk due to the strategic nature of the lithium extraction projects in these three countries.

One policy option that could appeal to American private equity is a loan guarantee program for companies investing in the Lithium Triangle. This would be a leap from current Export-Import Bank (EXIM Bank) policies toward Argentina and Bolivia, two countries whose currency issues have scared away public investment support. However, the strategic significance of lithium and the rapidly rising price per ton of lithium carbonate is changing the risk tolerance for both public and private actors. Stephen Promnitz, Chief Executive Officer (CEO) of lithium firm Lake Resources, has recommended that the U.S. government explore export credit agency support in which the US government partners with downstream participants like EV manufacturers and battery makers. These conglomerates then provide financing for mining and processing companies in exchange for preferred access to lithium exports. Export credit agencies like the EXIM Bank and the recently formed U.S. International Development Finance Corporation (DFC) offer what Promnitz describes as the "key financing factor" that could provide the US with a decisive advantage.[26]

Support and financing from the DFC could be a game-changer for American lithium companies and EV and battery manufacturers. The agency is a development financier that, according to the Congressional Research Service, was designed in part to respond to China's BRI.[27] It was formed in December 2019 to combine several government funds

and agencies including the Overseas Private Investment Corporation and the Development Credit Authority (formally part of the United States Agency for International Development, or USAID). The agency provides direct loans, loan guarantees, political risk insurance, equity investment, and feasibility studies. In addition, potential projects in South American lithium extraction align with the agency's stated priorities of innovation, investment in the Western Hemisphere, and addressing climate change. Given Argentina's currency problems and the uncertainty generated by Bolivia and Chile's recent political transitions, when the U.S. government publishes its national strategy for the Western Hemisphere mentioned in recommendation number one, the DFC should be featured in a prominent role.

Conclusion

Given the role of lithium in modern battery technology, the world's lightest metal will continue to power the ongoing green energy revolution for decades to come. In addition, lithium-ion batteries will continue to shape defense technologies related to communications, drones, robotics, mobile computing, and more. Due to these critical roles for lithium in economics and defense, it is concerning how far the United States has fallen behind China in ensuring reliable access to the metal. With demand projected to outpace supply by up to thirty percent by 2030, the Lithium Triangle has become a vital region for U.S. interests.

With the objective of securing its lithium supply chains and gaining a competitive advantage over the PRC in the economic, diplomatic, and military realms, the U.S. government must develop and implement a comprehensive strategy for increased engagement in the Western Hemisphere. This strategy must be tied into a broader industrial policy related to American competitiveness during the green energy revolution. These two objectives align in Argentina, Bolivia, and Chile, where access to their lithium reserves has become a critical component in the twenty-first century's strategic competition.

Fortunately, the U.S. has several means to accompany these ends and ways. For example, by increasing American financing in the region through aid and loan guarantees the US can provide protection for American investors considering projects in these three South American markets. In addition, the U.S. government can increase funding for research and development in battery and DLE technologies to maintain America's technological advantage. Through expanded diplomatic initiatives and more funding DFC, the US government can better support American companies competing abroad in strategic areas against Chinese firms. Furthermore, this diplomacy and regional engagement should strive to align U.S. strategic objectives with those of the countries in the Lithium Triangle, thus enhancing local development and strengthening America's partnerships in South America. Since strategic competition affects all aspects of American foreign and economic policy, the most comprehensive and integrated strategies will have the greatest impact. ***IAJ***

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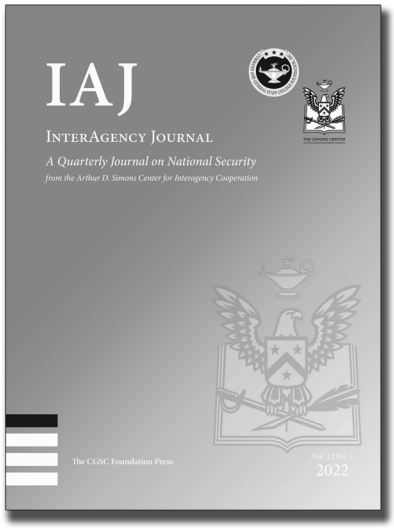

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