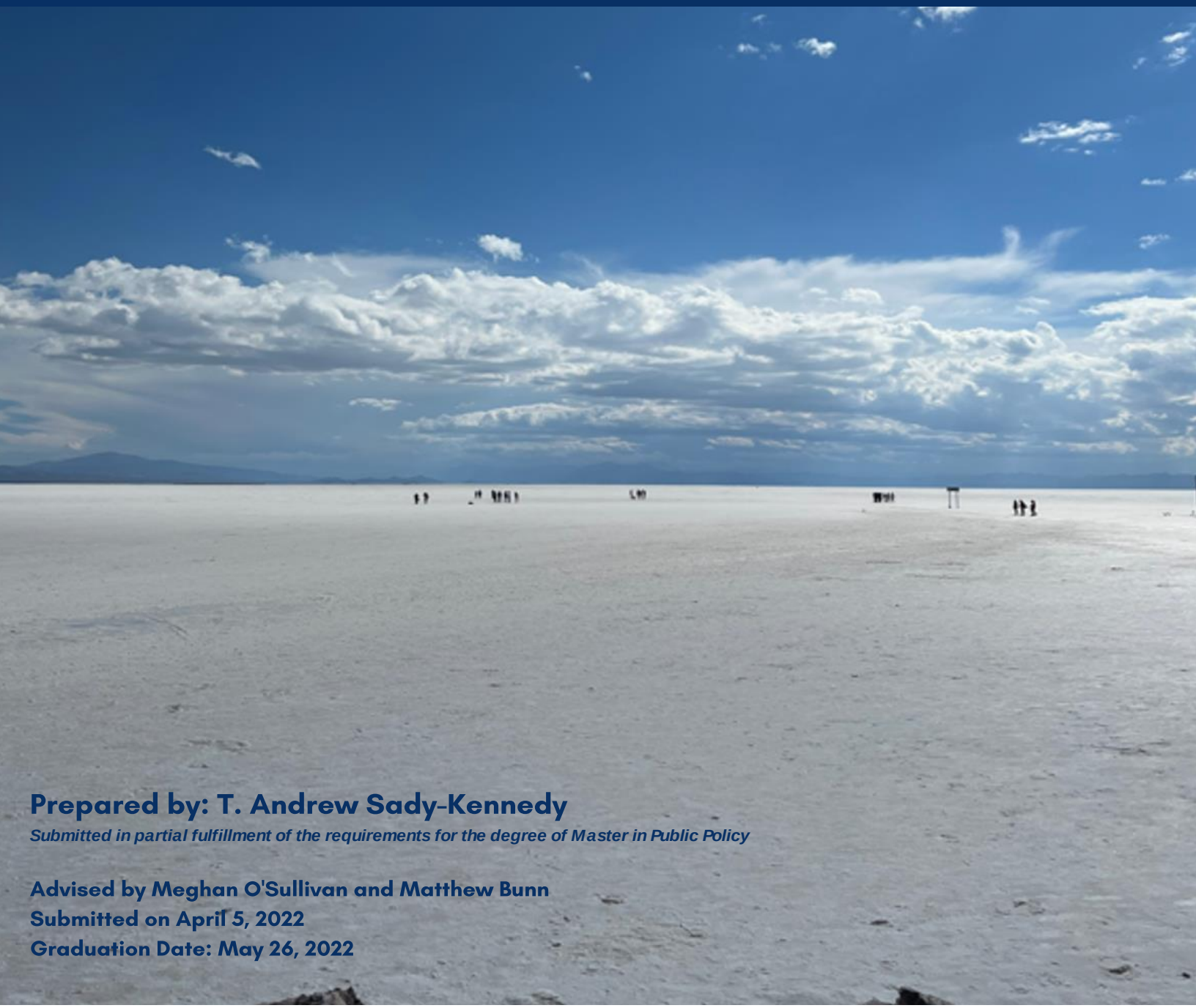
Ally-Shoring the Lithium Supply Chain in the Americas

A Strategic Model for U.S. Critical Mineral Policy

Policy Analysis Exercise Prepared for the Bureau of Energy Resources (ENR), U.S. Department of State



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Cover Photo: Salinas Grandes in Jujuy, Argentina
Credit: Andrew Sady-Kennedy, 11 January 2022

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Executive Summary

As the United States prepares to meet the increasing demand for critical minerals that will be necessary for the clean energy transition, it must focus on how it can create more resilient supply chains. This analysis takes the lithium supply chain as a case study in how the United States can approach its critical mineral policy moving forward.

While the United States possesses the fourth largest reserves of lithium in the world, the demand for lithium is projected to be so large in the next decade that lithium will need to be sourced from all over the world. Lithium demand could increase from around 430 metric tons of lithium carbonate equivalent (LCE) today to as much as 1.8 million metric tons of LCE in 2030.[i] In addition to a supply crunch, a growing dependence on China throughout the supply chain could result in significant foreign policy leverage. Accordingly, the United States must work with its allies and partners to strengthen its position in the supply chain. **This report proposes ally-shoring –the process of rebuilding supply chains to source essential materials from countries that share the same democratic values as the United States– as a solution the Bureau of Energy Resources (ENR) at the U.S. Department of State must implement to address the lithium bottleneck.[ii]**

This report analyzes three distinct ally-shoring models: (1) Incentivizing the Private Sector (2) A Chinese State-Backed Strategy and (3) A National Lithium Company. Ultimately, the report recommends that a combination of the first and second models be pursued depending upon the lithium environment in particular countries. To understand how these models can be implemented in the context of regional allies that provide unique contributions to the global lithium supply chain, this report analyzes Argentina, Chile, and Mexico. In a country like Argentina, in which lithium is open to foreign direct investment without regulation, both the first and second models can be effective; however, in countries where lithium is a strategic resource owned by the government, only the first model should be pursued.

Through expert interviews and data-driven assessments of lithium deposits in these countries, the report demonstrates how ENR should pursue ally-shoring policies in different policy environments.

⇒ **Argentina:** The country will witness the largest increase in its share of global lithium supply in the next decade. As such, the United States must seize this opportunity to pursue a combination of the first two models by providing American firms with diplomatic support, incentives for lithium hydroxide production, and new financing opportunities.

⇒ **Chile:** President Boric and the new administration pose uncertainty for foreign direct investment in the lithium industry. Accordingly, the United States must ensure continued access for both existing and new American firms with lithium operations in the country.

⇒ **Mexico:** An emerging lithium industry in the country could be crucial for North American cooperation on critical minerals. The United States should invest in geological partnerships and lobby for early-stage private sector involvement in what is likely to become a nationalized industry.

For the United States, an ENR-led ally-shoring strategy across all countries should include a combination of the following eight policy recommendations –divided into financial and diplomatic policies (see *Table 1*). The policy recommendations in this report aim to provide a new ally-shoring model for the United States that will help create a more resilient lithium supply chain and thereby protect the nation's economic and national security as it moves forward with the clean energy transition.

Table 1: Across-Country Ally-Shoring Policy Recommendations

Financial Policies	Diplomatic Policies
(1) Expand Eligibility of Federal Grants to Projects Abroad	(5) Create Regional Lithium Partnerships within the Energy Resources Governance Initiative (ERGI)
(2) Create a Critical Mineral Investment Platform	(6) Expand Geological Partnerships in Allied Countries
(3) Institute a Tax Credit for Direct Lithium Extraction (DLE)	(7) Improve Knowledge-Sharing with the Private Sector
(4) New Project Financing Opportunities for Critical Mineral Projects Abroad	(8) Negotiate a Fast-Track Trade Provision for Critical Minerals

Methodology

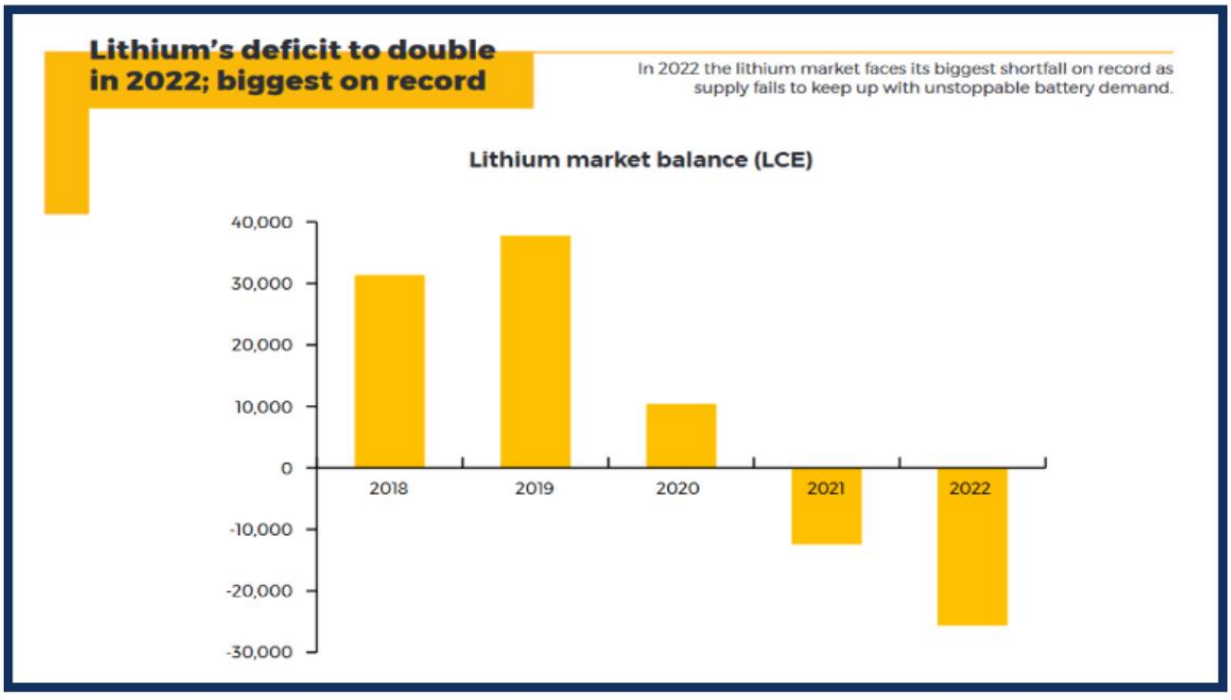
To inform the conclusions of this report, the author conducted a literature review on ally-shoring, a data-driven assessment of lithium deposits across the globe, and interviews with public sector entities, private sector companies, and expert researchers. Interviews with the public sector included U.S. Embassy officials, foreign ministries, and Geological Surveys. Private sector interviews were conducted with lithium companies operating in the United States, Argentina, Chile, and Mexico to incorporate the industry perspective. Lastly, experts ranging from lithium-ion battery consultants, supply chain researchers at think-tanks, and regional experts across Latin America provided insight on a variety of issue areas related to the industry.

The three countries of ally-shoring focus –Argentina, Chile, and Mexico– were of interest to (ENR) at the U.S. Department of State. In the case of Argentina, the author conducted field research and interviews in Buenos Aires and the province of Jujuy, where he also visited the Salinas Grandes lithium salt flat.

Introduction: The Lithium Bottleneck Facing the United States

As the clean energy transition accelerates, the demand for critical minerals is expected to increase exponentially. Critical minerals are essential components of lithium-ion batteries, used in electric vehicles and energy storage technologies for solar and wind energy, and will be crucial for decarbonizing the transportation and residential sectors. To fuel the clean energy transition, the United States will need more of each of these critical minerals. Projections expect demand for critical minerals used in lithium-ion batteries –which includes lithium, cobalt, nickel, graphite, and rare earth metals– to increase by a factor of at least thirty times by 2040.[iii] While demand for each of these minerals will grow in the coming years, demand for lithium is projected to increase more than most other critical minerals.[iv] **Lithium demand could increase from around 430 metric tons of lithium carbonate equivalent (LCE) today to as much as 1.8 million metric tons of LCE in 2030.**[v] However, lithium demand is projected to outpace the supply of current lithium production in the next decade. This mismatch between lithium supply and demand could lead to a global lithium shortage. According to Benchmark Mineral Intelligence, the lithium supply shortfall is projected to be 26,000 metric tons of LCE in 2022 and will continue to grow (see ***Figure 1***).[vi]

Figure 1: *Lithium Supply and Demand Mismatch*



Source: Benchmark Mineral Intelligence

The existing state of the lithium supply chain poses several risks to the United States' clean energy transition goals. The first is the mismatch between supply and demand that could lead to a global lithium shortage. Lithium production faces several supply constraints, including long project development lead times, environmental stressors, and large capital expenditures that lengthen the process to begin operations. While plenty of lithium reserves exist, the existing supply will not be able to meet the projected demand growth. The United States will need more lithium to fuel the clean energy transition and a global lithium shortage would seriously delay its efforts to decarbonize.

In addition to an incoming supply shortage, a second risk is the heavy geographic concentration of lithium in only a few countries: Australia, Chile, China, and Argentina. The International Energy Agency's analysis on project pipelines between 2019 and 2025 indicates that the geographical concentration of lithium production will not change much in the short-term, apart from an increase in production in Argentina.[vii] In a complex and strategic supply chain for critical minerals, geographic concentration increases dependence on those countries that produce lithium. As such, relationships with those countries and the political stability of their governments become even more important. Developments in major producing countries that result in economic distress or trade restrictions can have a major impact on the entire supply chain and disrupt the United States' supply of lithium.

A third risk is the growing dependence on China throughout all channels of the supply chain that could give it foreign policy leverage in the future. By means of forward investment both domestically and in major producing countries, China has acquired a strong position in every respect of the lithium supply chain from the upstream extraction to midstream processing and refining, and downstream lithium-ion battery production.[viii] Through large investments in Australia and Latin America, Chinese companies have secured lithium offtake agreements, the byproduct of which is subsequently processed and refined in China. As it stands, China processes and refines 58 percent of the world's lithium. When solely accounting for lithium hydroxide –the preferred compound for use in lithium-ion batteries– China's share of world processing and refinement rises to 80 percent.[ix] This dimension presents the largest bottleneck; lithium hydroxide is projected to overtake lithium carbonate in terms of the share of lithium demand by 2030.[x]

China's stronghold on the lithium industry could allow it to dictate market prices on lithium processing, battery production, and electric vehicle sales. Trade restrictions or export bans could also impact the United States' supply of lithium. The most relevant instance of an export ban occurred in 2010 when China imposed a country-specific embargo on rare earth exports to Japan.[xi] **More recently, China's Ministry of Industry and Information proposed export limits to a subset of critical minerals, which highlights the reality of supply chain dominance as a source of geopolitical leverage.**[xii] Given the geopolitical trade conflict with China, it could wield its position to guide the future of the global clean energy transition.

As the lithium supply chain stands, the United States finds itself severely underprepared to meet the exponential increase in demand over the next decade and beyond. Within the lithium supply chain, this report focuses explicitly on upstream extraction and midstream processing and refining operations that fuel downstream lithium-ion battery production. Current efforts to accelerate the lithium industry in the United States are necessary to meet the demand for lithium but will not be sufficient on their own. Securing the lithium needed for the clean energy transition will require investment and coordination together with America's allies and partners, as recommended in the 100-day White House review of Executive Order 14017 on America's Supply Chains in June 2021.[xiii] **In this context, this report will assess how the Bureau of Energy Resources (ENR) at the U.S. Department of State can work with its allies and partners to increase global lithium supply and build a more resilient supply chain.** In addressing the upstream and midstream channels, the United States can secure a larger supply of lithium for eventual downstream end-use in lithium-ion batteries. Accordingly, the report will address the following policy questions:

⇒ **How can the United States ensure that it can meet its needs for lithium in the future, given expected exponential growth in demand in the coming years?**

⇒ **What policies can ENR employ to build a more resilient and diverse lithium supply chain together with the United States' allies and partners?**

This report will proceed in four broad sections. First, it provides an overview of current domestic lithium production and a realistic assessment of what can be achieved in the United States. Second, the report presents ally-shoring as a necessary solution for the lithium bottleneck facing the United States and considers three different models the United States could implement to ensure that it can meet the country's needs for lithium in the future. Third, the report analyzes how ally-shoring could be implemented in the cases of Argentina, Chile, and Mexico. Lastly, the report provides detailed policy recommendations and concludes with the precedent that ally-shoring the lithium supply chain can set for other critical minerals.

Section I: Domestic Lithium Production in the United States

This section identifies existing lithium deposits within the United States and evaluates how these deposits will contribute to the country's lithium needs. **The United States possesses the fourth largest amount of identified lithium reserves in the world; ten percent of global reserves.**[xiv] A study on global lithium deposits by the British Geological Survey identified nine different deposits in the United States (see ***Appendix B*** for the map).[xv] Four distinct types of deposits were found: volcanic-sedimentary clay, brine, geothermal, and pegmatite hard-rock (see ***Table 2***). The vast majority are volcanic-sedimentary clay deposits, but the United States' varied deposits indicate that it is well positioned to coordinate with other countries that are experts in each distinct deposit type.

Table 2: Lithium Deposits in the United States

Volcanic-Sedimentary Clay	Brine	Geothermal	Pegmatite Hard-Rock
(1) McDermitt (Thacker Pass) (2) Kings Valley (3) Bonnie Claire (4) Boron (Rhyolite Ridge) (5) Clayton North	(6) Silver Peak	(7) Salton Sea (8) Magnolia	(9) Kings Mountain

Source: British Geological Survey

Only one lithium operation currently contributes to domestic lithium production, Albemarle's Silver Peak brine operation in Nevada.[xvi] Albemarle plans to double Silver Peak's lithium production from 5,000 to 10,000 metric tons of LCE by 2025.[xvii] In addition to this operation, Albemarle also owns the **Magnolia** and **Kings Mountain** deposits in Arkansas and North Carolina, respectively.

Other deposits are close to beginning lithium production. Controlled Thermal Resources, for instance, has taken strides to kickstart lithium production at the **Salton Sea** deposit in California. This geothermal deposit could be revolutionary for domestic lithium production. Many companies are investing in direct lithium extraction (DLE) technology to bring this lithium deposit to production by 2024. If the Salton Sea's eleven geothermal plants were to produce lithium, they could provide about ten times the current lithium demand of the United States.[xviii] Lithium

Americas has also made significant progress at the **McDermitt** deposit, known as Thacker Pass. They expect to begin production in 2022 with approximately 30,000 metric tons of LCE annually with plans to double production capacity by 2026.[xix]

Despite the rush to bring many new lithium deposits to production, environmental opposition and permitting regulations on mining sites in the United States pose challenges to scaling up domestic lithium production.[xx] **Thea Riofrancos**, a lithium-ion battery supply chain researcher, suggested that "fast-tracking permitting processes" could incentivize increased investment, in a similar fashion to what recently occurred at Thacker Pass.[xxi] This deregulation process must involve local communities as well as clear communication from companies on the benefits they can provide to local populations that live near lithium mines.[xxii]

Domestic efforts to strengthen the United States' position within the lithium supply chain have also focused largely on battery recycling; however, in the short-term, recycling will not contribute significantly. **Chris Berry**, a lithium-ion battery minerals consultant, explains that:

> "Recycling will be additive to supply but by no means will it come close to substituting mine supply significantly before the middle of the next decade. If we double lithium demand between now and 2025, you are going to need about 130,000 to 140,000 tonnes per year of lithium capacity to come online every year. This is an unprecedented capacity expansion and recycling, mainly through the processing of battery scrap, will supplement a small piece of this growth. **The impact of recycling on supply will really be felt from 2030 onwards.**"[xxiii]

While the Bipartisan Infrastructure Law possesses three sections (40208 to 40210) that focus on advancing a domestic recycling industry, additional efforts that go beyond recycling will be necessary to contribute to lithium supply in the short-term.[xxiv] In terms of what can be achieved domestically, **Scott Hynek** at the U.S. Geological Survey believes that "while the scale in the United States is small, there is potential for some real hot spots."[xxv] Efforts to accelerate both upstream lithium extraction and midstream processing and refining operations are just beginning, exemplified by the Department of Energy's National Blueprint for Lithium Batteries (2021-2030) and $3 billion investment to strengthen the United States' supply chain for lithium batteries.[xxvi] Despite possessing the capacity to add a significant amount of lithium carbonate and hydroxide to the market, the United States is too far behind to meet the demands of the clean energy transition through domestic production alone. To make an impact on the lithium industry, the United States will need to expand its lithium strategy to incorporate allies and partners. **The oncoming lithium supply shortage coupled with China's stronghold on midstream processing and refining of raw materials will require a sustained effort to accelerate production that goes beyond reshoring production domestically.**

Section II: Ally-Shoring as a Solution for the Lithium Bottleneck

The supply chain disruptions caused by the COVID-19 pandemic initiated a call for reshoring production of critical products to the United States. Reshoring alone, however, will not be sufficient for the United States to meet the exponential increase in lithium demand and mitigate the risk of Chinese geopolitical leverage. Most of the United States' lithium supply will continue to come from international sources over the next decade. As such, ally-shoring production of critical materials to America's allies and partners will be central to shifting the lithium supply chain and increasing global production. **Broadly defined, ally-shoring is the process of rebuilding supply chains to source essential materials from countries that share the same democratic values as the United States.**[xxvii] **Ally-shoring brings production of critical materials closer to home, ensures that supply is spread out among trusted allies and partners, and fosters increased regional collaboration, while also decreasing dependence on China within the supply chain.** As identified by the U.S.-Mexico Foundation, government ally-shoring policies revolve around four main mechanisms.[xxviii] These mechanisms include:

- ⇒ Providing incentives for the private sector to reroute supply chains
- ⇒ Identifying opportunities for co-production and material sourcing
- ⇒ Working with allies to facilitate trade and develop efficient border infrastructure
- ⇒ Establishing clear rules and standards for institutions

Any ally-shoring model a government pursues should adhere to these four mechanisms. In an ideal world, the market alone would incentivize private sector investment to reroute on its own; however, this shift will require public sector support since the market naturally adheres to globalization. For this reason, this report considers three models with varied government participation that the United States government could pursue: **(1) Incentivizing the Private Sector (2) A Chinese State-Backed Strategy and (3) A National Lithium Company (see *Table 3*).**

Different policies should be considered within each model and the report will distinguish between these policies below. A short analysis of each model will provide context as to the implications of the model's effect on global lithium supply and its viability of success. **Ally-shoring is highly dependent on country context, and for this reason, more than one model may be appropriate within a specific country.**

Table 3: Ally-Shoring Models

Model 1: Incentivizing the Private Sector	Model 2: A Chinese State-Backed Strategy	Model 3: A National Lithium Company
ENR implements policies to incentivize the private sector in existing operations abroad and encourage investment in new upstream extraction and midstream processing operations.	ENR works with foreign governments to provide American companies with increased diplomatic support and state-backed financial support to make early-stage investments abroad.	ENR creates a state-backed lithium company and chooses where to invest in lithium production abroad.

Model 1: Incentivizing the Private Sector

Most literature on ally-shoring –sparked by the supply chain disruptions of the COVID-19 pandemic– focuses on this first model, which relies a great deal on private sector participation. **In this model, the government implements simple risk reduction measures for American private sector firms seeking to produce and process lithium in other countries as well as providing support to allied governments to boost production prospects abroad.** Government policies under this model could include tax incentives for private sector firms and geological or diplomatic partnerships with foreign governments.

This is the most viable of the three models given the United States' historical private sector led approach; however, these incentives fall at the lower end of government participation and may not be as impactful. **This model alone may be insufficient to put the United States in a position of strength within the lithium supply chain since private sector firms could still opt out due to the large risks involved.** These risks include price volatility, long lead times from discovery to production, differing geological contexts of lithium deposits, environmental challenges, and local resistance to lithium mining and its effects on communities (see ***Illustrations 1 and 2***).

***Illustration 1 (left)**: Sign at the Salinas Grandes lithium salt flat in Jujuy, Argentina with anti-lithium messaging which says: "Salinas Grandes is one of Argentina's seven wonders. The originating communities say, 'no to lithium, yes to water and life in our territories.'"*

***Illustration 2 (right)**: Anti-lithium messaging on Highway 52 in Jujuy, Argentina which says: "Lithium kills our matter and spirit."*

Photo Credits: Andrew Sady-Kennedy, 11 January 2022

Model 2: A Chinese State-Backed Strategy

The Chinese government has pursued an aggressive lithium industrial policy combining investment in its own resources domestically with mining projects internationally.[xxix] Its approach to securing lithium resources is positioned closer to the far-right end of government involvement in ally-shoring. In its industrial planning, the Chinese government usually aims to develop two to three leading companies in each stage of the supply chain.[xxx] Within the lithium industry, its two main players are Tianqi Lithium and Ganfeng Lithium. **Each of these privately owned companies makes large-scale investments in early-stage lithium extraction projects abroad to secure lithium offtake agreements and acquire equity stakes in major companies in resource-rich countries.** For example, Ganfeng Lithium made a $174 million financing investment at the Caucharí-Olaroz mine in Argentina to guarantee a 70 percent "Offtake

Entitlement" for the first 20 years of production.[xxxi] These investments are typically backed by state-owned banks, which allows for more risky investments.[xxxii] After securing lithium offtake in other countries, lithium carbonate is shipped to China and converted into lithium hydroxide. China has pursued this strategy by acquiring a major stake in Chile's Sociedad Química y Minera (SQM), making early-stage financial investments in Argentina and Mexico, and securing lithium offtake and mine ownership throughout Australia.[xxxiii]

Thus far, the United States has fallen behind in the push for securing lithium supply, while China has become a leader in the critical mineral space through a decade of strategic foresight. Is it possible for the United States to pursue the Chinese state-backed strategy successfully? It very well could; however, much of this depends on government financial backing, which is not typical of the United States' industrial policy. **This strategy could leverage direct government investment for lithium projects from the Development Finance Corporation (DFC) and the Build Back Better World (B3W) Partnership.** While the Chinese model would require a great deal of government financing, it can be a successful strategy for securing the rights and ownership of more lithium deposits around the world. This would enable the United States to acquire more lithium offtake through early-stage financial investment, and thereby diversify the supply chain.

Model 3: A National Lithium Company

A third model to consider is the creation of a national lithium company. **ENR would take the lead on the creation of a national lithium company and coordinate its activities abroad with foreign governments to co-produce and co-process lithium.** This would be at the very far right end of the ally-shoring spectrum as it would require full financial and operational capacity at a government level. In this model, ENR would coordinate with its counterparts in foreign countries on a lithium production mine of interest and have the national lithium company operate the mine. This might entail ENR advocating for co-production of lithium at a certain deposit in a foreign country that is jointly backed through U.S. government financing support, and diplomatic partnerships on lithium offtake and regulatory schemes in foreign countries. To secure lithium offtake agreements, the United States would need to provide its own resources, including geological expertise of lithium deposits, technical capacity for production, and most importantly, a national lithium company that would build and operate the lithium production site.

This type of industrial policy would increase lithium production abroad and secure lithium offtake for the United States; however, it would be extremely difficult to achieve politically. A national lithium company is unlikely given the United States' historical approach to industrial policy and is the least viable of the three proposed models. Nonetheless, it is an important model to consider as increased American participation in the lithium industry is necessary and such a model could shift how critical mineral policy is pursued.

Section III: Lithium Ally-Shoring Policies in the Americas

In the previous section, three ally-shoring policy models were considered. Each model may be applicable in different scenarios dependent on country context. **This section analyzes these models through the lens of three important countries within the lithium supply chain: Argentina, Chile, and Mexico.** Cooperation with each of these regional allies is both feasible and beneficial to American national interests. Through an analysis of the current upstream and midstream sectors of each country, this report highlights where government assistance may be most fruitful and what specific ally-shoring model and policies would make most sense for ENR and the rest of the United States government in each country.

Why Invest in Argentina, Chile, and Mexico?

To secure the lithium needed for the clean energy transition, the United States must coordinate with its allies and partners around the globe, but particularly with its Latin American neighbors. Most of the countries possessing lithium reserves, except for Australia and China, are located within the Americas. **Altogether, the Americas possess over two-thirds of the world's known lithium reserves, or 72 percent of all lithium deposits.**[xxxiv] The largest lithium reserves in Latin America can be found in Bolivia, Argentina, and Chile, often termed "the Lithium Triangle", as well as in Mexico, Peru, and Brazil. While some of these countries do not yet contribute to global lithium production, they have the potential to impact the lithium industry in the coming decade. This report chooses to focus on an ally-shoring strategy in Argentina, Chile, and Mexico as principal candidates because of their long-standing partnership as regional neighbors and their potential impact on the lithium industry in the coming decade.

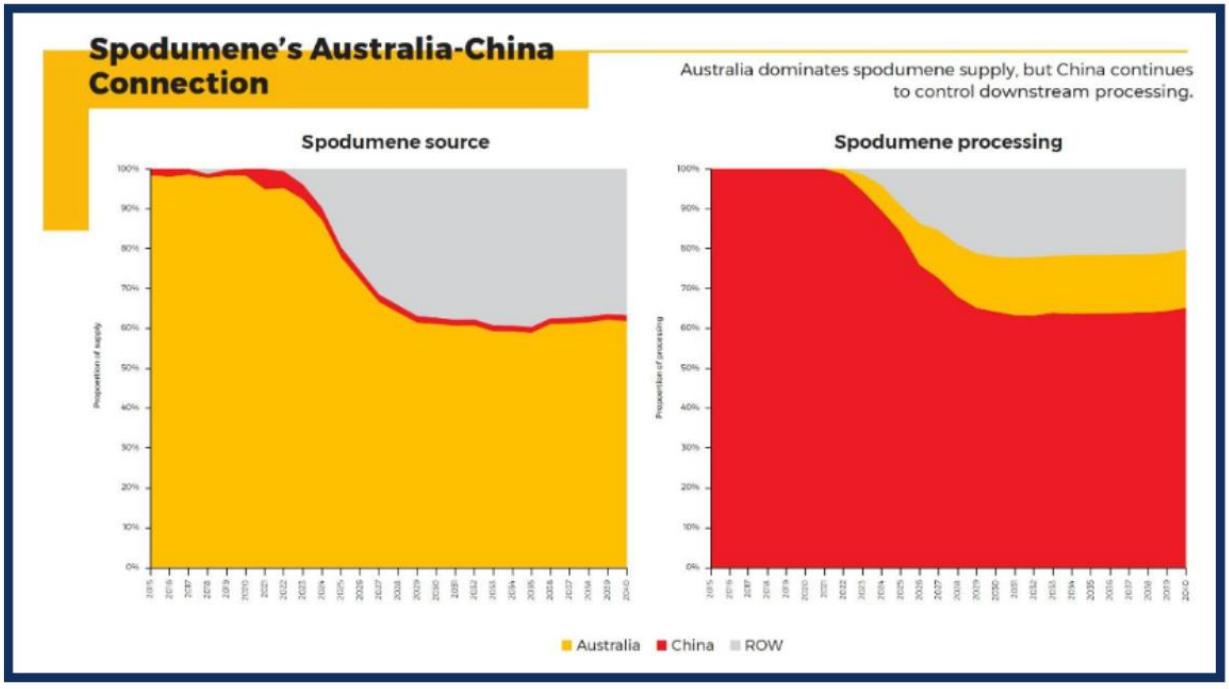
First, Argentina is projected to have the most growth in upstream lithium extraction within the next decade and will play an important role in supply for the United States. The presence of American firms in Argentina, namely Livent Corporation and Lilac Solutions, strengthens the case to double down on an ally-shoring strategy. Second, Chile has historically been one of the two largest lithium producers in the world and will continue to be essential for the United States' lithium supply. Albemarle Corporation's main source of lithium emanates from Chile's Salar de Atacama. **Together, Argentina and Chile contribute 91 percent of the United States' lithium imports.**[xxxv] Lastly, Mexico could be a crucial North American partner on critical minerals given its recent discovery of several lithium deposits. **Mexico's natural advantages as a candidate for ally-shoring lithium production include proximity to the United States, its trade relationship through the U.S.-Mexico-Canada Agreement (USMCA), and a strong automotive sector.**

These three candidates should become central players in the United States' strategy to secure the lithium it needs for the clean energy transition and rebuild a resilient lithium supply chain. Other important lithium-producing countries were also considered in this analysis and are mentioned in certain parts of the report (see ***Figure 2***).

Figure 2: Other Ally-Shoring Candidates Considered for Analysis

Two other standout candidates for ally-shoring within the lithium supply chain are Bolivia, the country with the largest amount of lithium reserves, and Australia, the world's largest producer of lithium. While both were considered for analysis, ultimately it was determined that they would not have as much of an impact as Argentina, Chile, or Mexico in the long-term for the United States. Bolivia has had many challenges to successfully commercialize its reserves, and while it may do so in the long-term, this report focuses on candidates that could make a larger impact today. EnergyX received a bid to use direct lithium extraction (DLE) technology in Bolivia, and prospects for production could result favorably, however, the timeline for production remains uncertain. Australia was ultimately not analyzed in depth since its lithium reserves are nearly all already in production, and of the lithium produced, most of the offtake is already secured by China (see ***Figure 3***). While Australia is a key ally for the United States and will continue to contribute to the lithium supply chain immensely, the opportunity for expanded partnership is greater with candidates in the Americas.

Figure 3: China's Dominant Share of Spodumene Processing



Source: Benchmark Mineral Intelligence[xxxvi]

Argentina: Projected to Become a Top Three Producer

Argentina has the second largest lithium reserves in the world and is the fourth largest lithium carbonate producer –behind Australia, Chile, and China– contributing six percent of global supply at 33,000 metric tons of LCE in 2021.[xxxvii] Of the Latin American countries possessing lithium reserves, Argentina operates in the market that is most open to private sector investment. The federal government has not imposed any regulation on foreign investment in the lithium sector and allows the market to dictate industry development. For this reason, several projections and experts agree that within the next decade Argentina is the country that is expected to bring the most additional lithium production online.[xxxviii] Benchmark Mineral Intelligence's Lithium Forecast predicts that lithium production will increase by 360 percent in 2025.[xxxix] Furthermore, **Arnaldo Visintín**, a lithium-ion battery expert at Argentina's National Scientific and Technical Research Council (CONICET), explained that he is "confident Argentina will become the number one producer of lithium carbonate produced from lithium brines in the coming years."[xl] In addition to having the best prospects for increasing upstream extraction, Argentina also provides 54 percent of the United States' current lithium imports.[xli] Together, these two considerations make Argentina one of the principal candidates for ally-shoring lithium production.

Lithium Production and Supply Chain Dynamics

Argentina's lithium production emanates from two current projects: Livent Corporation's Mina Fénix at the Salar del Hombre Muerto, and the joint Allkem Limited –formed from the merger of Orocobre and Galaxy Resources– Toyota Tsusho, and Jujuy Energía y Minería Sociedad del Estado (JEMSE) project at the Salar de Olaroz. A third project at Salar de Caucharí-Olaroz is set to begin production in mid-2022 and will add about 40,000 metric tons of LCE annually. It is a joint venture between Ganfeng Lithium and Lithium Americas Corporation. Of the many other projects in advanced stages in Argentina, the Kachi lithium brine project is one in which an American company, Lilac Solutions, has partnered with Lake Resources and will acquire up to a 25 percent stake in the project based on the performance of its new technology.[xlii] Lilac Solutions has developed a new DLE technology to extract lithium from brines without the need for evaporation ponds, a method which has already worked at the pilot plant stage.

In terms of midstream processing and refining operations, Argentina currently produces ten percent of lithium processing and refining operations in the midstream of the lithium supply chain, behind only China and Chile.[xliii] However, there are no current projects that produce lithium hydroxide. Nonetheless, POSCO, the South Korean steelmaker, recently announced its plan to create the first lithium hydroxide plant in Argentina at its Sal de Oro project in the Salar del Hombre Muerto, set to begin production in 2024. POSCO explains that the plant will be built

in two parts. It will produce lithium phosphate as an intermediate product in an upper plant, which will then be sent to a lower ground plant which converts lithium phosphate into lithium hydroxide using an electro-chemical method.[xliv] The company's original investment plan of $840 million, which included a $760 million one-time capital expenditure (CAPEX) to construct the facility and annual operating expenditures (OPEX) of nearly $80 million, was increased to $4 billion in March. Moreover, POSCO plans to increase production capacity from 25,000 metric tons of lithium hydroxide to 100,000 metric tons.[xlv]

Argentina's lithium exports have typically been shipped to the global market from Chilean ports on the Pacific coast due to proximity, but recent trends highlight a shift towards using Argentine ports on the Atlantic coast. According to **David Guerrero**, an independent lithium consultant, "there are three main reasons for this shipping decision, which include slower transit times from Pacific ports, generally speaking higher port costs, and delays due to Chilean mining companies priority use of Pacific ports."[xlvi] Ships leaving Chilean ports, namely Antofagasta and La Negra, have slower transit time due to the amount of cargo that must be picked up along other Pacific ports before arriving to the final destination. Argentine ports, such as Buenos Aires, Rosario, and Campana, on the Atlantic coast have faster transit time because they move directly to their destination from these ports. In addition, Argentina has a higher volume of trade with both the United States and China. Finally, lithium firms operating in Chile hold priority on shipments leaving Chilean ports. Accordingly, these internal dynamics reinforce delays for companies operating in Argentina. From a company perspective, **Franco Mignacco** –President of Minera Exar– explains that "the project at Caucharí-Olaroz will be using trucks to transport lithium carbonate to the port of Buenos Aires since there are more restrictions and delays at the port of Antofagasta in Chile."[xlvii] In this context, shipping decisions are extremely important for companies deciding where to invest in projects.

Analysis and Policy Recommendations

Argentina's free market approach indicates that both Model 1 –Incentivizing the Private Sector– and Model 2 –A Chinese State-Backed Strategy– are appropriate models. Due to Argentina's emerging position within the supply chain, ally-shoring efforts should be centered around strengthening the United States' presence in the country, increasing lithium carbonate plants, and incentivizing lithium hydroxide production.

Finding (1): Argentina has many lithium brine deposits worthy of investment to produce both lithium carbonate and lithium hydroxide; however, U.S. companies have not invested nearly as much as China over the last decade.

Many American firms have avoided investment in Argentina's lithium projects due to risks that include currency unpredictability and long project development lead times, while Chinese firms

have made these investments.[xlviii] For instance, China's Ganfeng Lithium holds the majority ownership of the Caucharí-Olaroz project despite the potential opportunity for American raw material firms and original equipment manufacturers (OEMs) to have provided financing within the early-stages of the project. Ganfeng Lithium acquired the project in 2017, and simultaneously signed strategic cooperation agreements with OEMs, such as Tesla and BMW, to supply battery-grade lithium for downstream production.[xlix] While American firms perceive the upstream extraction investment as risky, Ganfeng Lithium understands that it will make a profit on guaranteed supply contracts. Even if Argentine firms prefer to work with U.S. companies, Chinese companies are often the only option. Argentina officially joined the Belt and Road Initiative (BRI) on February 6, 2022, with President Alberto Fernández's visit to Beijing, which is a result of China's increasing involvement across Latin America coupled with the country's dire economic situation. **Scott Hynek** of the U.S. Geological Survey claims that "Argentina is by far the best bet from a geopolitical investment, but they are the least effective from keeping China at bay."[l] In this context, the United States needs to increase its involvement in Argentina's lithium industry before China secures an even greater portion of the country's lithium.

Recommendation (1): New Project Financing Opportunities for Production and Processing Operations Abroad

This recommendation falls within the parameters of Model 2, a Chinese State-Backed Strategy, and will be explained in more depth later (see ***Section IV, Policy Recommendation 4***). For countries like Argentina, in which lithium is open to foreign direct investment without any sort of regulation, the United States should create new mechanisms for project financing to give American private sector firms incentives to produce and process lithium in a booming lithium hub. **Accordingly, as part of the Build Back Better World platform, ENR should direct the Development Finance Corporation (DFC) and the Export-Import (EXIM) Bank to allocate capital for public investment in lithium projects in Argentina, as selected by ENR in collaboration with USGS experts.** ENR should advocate for the creation of a fund with specific financing allocated for lithium projects in Argentina (see ***Appendix C*** for project candidates for ally-shoring). Many projects in the feasibility stage under Australian ownership could welcome American investment to produce lithium hydroxide as Australia also seeks to diversify trade away from China and increase its share of lithium processing and refining operations.

Finding (2): Most lithium projects in Argentina have steered clear of adding value to the supply chain in the form of lithium hydroxide.

While Argentina is projected to become a more powerful global lithium supplier in the next decade, most of this output will likely be lithium carbonate, rather than lithium hydroxide. Given the slowly emerging nature of the electric vehicle industry in Argentina and the rest of South America, most

lithium producers do not plan on producing lithium hydroxide, as that output will still need to be exported to China for eventual cathode production. **David Guerrero** explains that "exchange rate controls in Argentina discourage conversion from lithium carbonate to hydroxide. It makes more sense to produce battery-grade lithium carbonate in Argentina and do the conversion to lithium hydroxide in another country." At the company level, **Franco Mignacco** explains that at Caucharí-Olaroz "there have been conversations about producing lithium hydroxide, but lithium carbonate is more convenient to produce."[li] Since lithium offtake will be shipped to China and be converted into lithium hydroxide by companies with a longer track record of expertise for eventual downstream use outside of South America, most companies are not moving forward with lithium hydroxide in the country.

However, there may be an opportunity, to produce lithium hydroxide in the Americas at a more efficient price. **Rene LeBlanc**, Chief Technical Officer at Lithium Americas, explains that "the Chinese have higher structural production costs than the rest of the world. Its backwards from what most people think. For every ton of lithium carbonate produced, they need about seven tons of spodumene concentrate from western Australia, which is currently priced around $2,000 per tonne according to Fastmarkets. This type of production is not cheaper than the production in South America or North America."[lii] Since China must convert spodumene to lithium carbonate and hydroxide at a higher structural cost, lithium carbonate conversion to hydroxide from brine operations should be able to enter the market cost competitively.

Recommendation (2): Incentivize American Firms to Invest in Lithium Hydroxide Production and Processing

ENR should allocate additional financial incentives to American firms to produce lithium hydroxide in Argentina. ENR should encourage firms opening upstream extraction projects to include plans to produce lithium hydroxide to be shipped to the United States by providing direct grants or loan guarantees to assist in the additional cost for a conversion plant. For firms already operating in Argentina, similar incentives should be offered as well as tax credits for taking the step of creating an additional lithium hydroxide conversion plant. For a company like Lilac Solutions, which has already invested in the pilot plant stage at the Kachi project, lithium hydroxide production could take place in a couple of years.

Finding (3): The geographically distant location of Argentina's lithium production in some of the country's poorer northwest provinces makes it difficult for firms to easily produce and transport lithium.

Argentina's northwest lithium-producing provinces –Jujuy, Salta, and Catamarca– are disjointed in their approach to increasing investment in the industry, which makes it difficult to coordinate

on internal country investment on infrastructure and energy improvements to help the overall industry. Highways and roads connecting the provinces to each other and to lithium production sites, for instance are old, unrepaired, windy, and dangerous due to a lack of investment (see ***Illustration 3***). Due to the difficult highway system, lithium production transport from mining sites to ports is sometimes delayed as cargo trucks must make their way across these difficult pathways.

Illustration 3*: View of Highway 52 in Jujuy province, Argentina. This mountainous highway is the only way to reach the Caucharí-Olaroz project.*

Photo Credit: Wolfgang Kaehler, Getty Images[liii]

In addition to highways, the remote location of lithium mines also makes it difficult to provide energy. This concern has become even more of an issue as companies attempt to implement DLE, which according to **Franco Mignacco** "uses at least five times the amount of energy than a traditional lithium evaporation pond."[liv] China's policy banks play a large role in financing new energy projects to address some of these issues. For instance, China's Export-Import Bank provided a $331 million loan for Caucharí-Olaroz's solar parks in 2017.[lv] As the push for using renewable energy at mining sites increases, the United States will need to leverage its strengths to cooperate on clean energy in Argentina.

Recommendation (3): Address Infrastructure and Energy Challenges

ENR should share best practices with their mining counterparts in Argentina to address infrastructure and energy challenges for more efficient lithium production. Cooperation between the United States and Argentina on renewable energy provision at mining sites could be critical to the development of the industry. Helping to establish an equivalent to the Chilean Clean Technologies Institute –an institute dedicated to solar energy, low emission mining, and advanced materials of lithium– in Argentina, or partnering with the Chilean Institute, would be helpful to address some of the challenges Argentina is facing as it attempts to increase production output.[lvi]

Finding (4): Existing U.S. private sector firms require additional diplomatic and trade facilitation assistance from ENR and the U.S. Embassy Buenos Aires economic staff to take full advantage of the opportunities in Argentina.

Lilac Solutions has had certain issues related to sharing knowledge and training between their engineers in the United States with engineers in Argentina. **Tom Wilson**, the Chief Development Officer at the company, explains that "Chile has a very good reciprocal visa arrangement for engineers that come between the United States and Chile, which means that we can get engineers to come work in Oakland and then go back to Chile. We preferentially hire Chileans for that reason. It might be helpful for Argentina to have a similar visa arrangement program that would allow their engineers to come to the United States to work with us and conversely allow our engineers to go work on projects in Argentina for the benefit of the country"[lvii] In this light, it would be helpful for geological and technology focused firms if they were able to coordinate more effectively with lithium industry experts in Argentina.

In addition to visa arrangements, **Wilson** also commented on Lilac Solutions' shipping difficulties at the port of Buenos Aires: "we are currently shipping a pilot plant to Argentina in five shipping containers, but there may be issues at the port. There is always this risk of hold up of someone saying, 'what are you bringing into the country?' Lilac is a venture backed company without any revenue. Time is basically money, more so than a revenue earning company that can sit back and wait. Every month is a month closer to cash out. If we are held back for two months with shipping containers stuck at a port in Buenos Aires because the head of ports decided to not let the shipment in, then it's a big impact for the company."[lviii] Resolving port disruptions give current supply chain backups is necessary to help speed up lithium production in Argentina.

Recommendation (4): Establish a Visa-Arrangement Program and Fast-Track Critical Mineral Shipments

Embassy Buenos Aires should engage with Argentina's consular service to establish a reciprocal visa arrangement for engineers working on lithium deposits in both the United States and Argentina. ENR should direct U.S. Commercial Service Officers at Embassy Buenos Aires to work with their Argentine counterparts to fast-track research and development trade shipments at ports to ensure that critical mineral containers with lithium production tools are not delayed at port. This provision will be described in greater depth later (see ***Section IV, Policy Recommendation 8***).

Chile: A Consistent Supplier with a New Administration

Chile has the third largest lithium reserves in the world and is the second largest lithium carbonate producer behind Australia, producing and exporting 138,400 metric tons of LCE in 2021.[lix] Given the recent election of President Gabriel Boric and his stated policy preference for creating a national lithium company, there has been an increasing worry in increasing investment into Chile's lithium industry. **However, in the short-term, Chile's lithium industry will continue to be one of the main sources of lithium for the clean energy transition and the United States will need to further incorporate it into its ally-shoring strategy.** The United States currently sources 37 percent of its lithium from Chile.[lx] Chile's historical role as one of the largest lithium suppliers globally and to the United States makes it a clear candidate for increased cooperation.

Lithium Production and Supply Chain Dynamics

Lithium is deemed a strategic resource in Chile, which means the government owns the lithium found in Chile and issues permits to the private sector for production.[lxi] The government agency, CORFO, owns the mining concessions for a large portion of the Salar de Atacama, the largest production center of lithium brine in the world. CORFO oversees contracts with Chile's two major producers, Sociedad Química y Minera (SQM) and Albemarle Corporation, which are set until 2030 and 2043, respectively. The trend of Chinese strategic investment is also true in Chile, with Tianqi Lithium possessing a 24 percent stake in SQM.[lxii] Both SQM and Albemarle operate in a similar fashion. The former sources its lithium from the Salar de Atacama, transports it to its plant at the Salar del Carmen, near Antofagasta, where it is then converted into both lithium carbonate and lithium hydroxide. The latter also sources lithium from the Salar de Atacama, and transports it to La Negra, near Antofagasta, for conversion and shipment overseas. In 2017, Albemarle created the La Negra lithium carbonate II Plant, the most modern lithium carbonate plant in Latin America with the capacity to produce 44,000 metric tons of LCE per year. Albemarle is expanding this plant in a third phase to increase production capacity to 80,000 metric tons of LCE.[lxiii]

In addition to CORFO's concession contracts with SQM and Albemarle, Chile's Ministry of Mining recently held a lithium tender for lithium exploration with the goal of expanding overall production in the country to 380,000 metric tons of LCE per year by 2030.[lxiv] With bids of $61 million and $60 million, respectively, China's BYD Chile SpA and Chile's Servicios y Operaciones Mineras del Norte S.A received contracts to extract up to 80,000 metric tons of LCE each. The companies will have to identify the lithium site to extract and undergo the feasibility studies before coming to market. Overall, this lithium tender gave the two companies

the rights to operate over 160,000 metric tons of LCE, approximately 1.8 percent of Chile's overall lithium reserves.[lxv]

Chile's midstream operations are much more advanced than in Argentina. **Chile currently processes and refines 29 percent of lithium in the world, the second most in the world behind China.**[lxvi] SQM produces lithium hydroxide at Salar del Carmen, near Antofagasta. Albemarle ships their lithium carbonate to the United States for conversion at Kings Mountain, North Carolina. The companies have quite strong shipping infrastructure given their location only a few hours away from the main Chilean ports. Both SQM and Albemarle have their conversion plants within one hour from the Port of Antofagasta, but SQM also uses the Port of Angamos just north of Antofagasta to ship its lithium. **Accordingly, transportation from the Salar de Atacama to the port for overseas shipment is a relatively easier navigation route than in Argentina, which must either cross the Chilean border or travel further distance to Argentine ports.**

Analysis and Policy Recommendations

Chile's categorization of lithium as a strategic resource owned by the government indicates that Model 1 –Incentivizing the Private Sector– is the most appropriate model to pursue. Ally-shoring should be centered on ensuring Chile remains a key player in the supply chain with participation from companies in the United States and incentivizing increased lithium hydroxide production.

Finding (1): President Boric's stated plans to nationalize the lithium industry and create a national lithium company will not subsume the operations of existing private sector firms.

President Boric announced plans to nationalize the lithium industry and create a national lithium company to support the clean energy transition.[lxvii] While these plans may crowd out future private sector investment, existing private sector firms, SQM and Albemarle, will not be subsumed by the national lithium company, but may be subject to more stringent environmental regulations.[lxviii] **Ellen Lenny-Pessagno**, Albemarle's former Chile Country Manager, confirmed that "the administration has made it clear that a national lithium company would enter to compete with the incumbents, not replace the incumbents."[lxix] As such, Albemarle's lithium production contract will continue until at least 2043.

Mario Marcel, Chile's new Minister of Finance, admits that "the business mood is one of wait and see."[lxx] In response to private sector skepticism of potential lithium reforms at the Constitutional Convention, however, Chile's Minister of Mining, Marcela Hernando said that "it is not within our program to nationalize or expropriate mines."[lxxi] Nonetheless, additional private sector investment will likely remain on hold in Chile until the reforms made under the Constitutional Convention are clear.[lxxii]

Recommendation (1): Develop Closer Relationships with the New Administration to Secure Access for American Firms

ENR and U.S. Embassy Santiago should work with the Ministry of Mining and CORFO to guarantee Albemarle's continued operations proceed. Increased support from the U.S. government matters for sustainable increases in lithium production abroad by American firms. With a rather unpredictable new administration, the United States must lobby Chilean government officials to ensure continued access to American private sector firms.

Finding (2): Both SQM and Albemarle have the technological know-how to produce lithium hydroxide at scale and are ramping up production capacity. Albemarle is the United States' biggest player in the lithium industry and has the scale to support a large portion of the clean energy transition in the United States.

One example of SQM's prowess within the lithium industry is the number of resources and knowledge they have invested into the supply chain. **Scott Hynek** from the U.S. Geological Survey (USGS) believes that Chile is well-positioned in the development of lithium hydroxide because of such capabilities. He explains:

> "SQM has a scale that will never be achieved in Argentina. They have analytical laboratories to test the purity of their products and have teams of PhD level chemists working on this. They are the best company in terms of technical expertise and can supply knowledge of these types of systems. They have eight mass spectrometers to measure the purity of their different products, with each spectrometer costing in the range between $500,000 to $1 million. They are spending $20 to 30 million just to set up a lab to ensure the purity of the lithium carbonate to make the lithium hydroxide. Those types of costs can only be borne by an investor with a long-time horizon or a company with a huge amount of revenue."[lxxiii]

Hynek's comment on mass spectrometers –an analytical tool for testing the purity of lithium– demonstrates that Chile is better suited to meet lithium hydroxide needs in the short-term rather than Argentina given the scale of current production efforts.

Recommendation (2): Connect Geological Experts to Increase Lithium Hydroxide Expertise

ENR should connect USGS experts with SQM's experts to develop shared best practices and technical expertise for developing the lithium hydroxide industry. In turn, USGS experts should share this knowledge with American firms in the United States to support the development of

lithium hydroxide domestically. ENR should also work closely with Albemarle to incentivize greater lithium hydroxide production at its facilities in North Carolina, with the aim that increased production capacity is brought to the United States.

Finding (3): Lithium tender processes in countries where lithium is a state-owned resource, like Chile, are important opportunities for companies to invest in production opportunities.

Lithium tender processes provide important opportunities for American investment in countries with state-owned resources; however, it is difficult for American companies to know exactly what to bid on these tender processes, as exemplified by the results of the January 2022 lithium tender in Chile. **Tom Wilson** from Lilac Solutions commented on the recent tender process, explaining that "there is no way that everyone could bid the same amount and we are the ones coming in at something different. We certainly didn't know that everyone was bidding a certain number and it feels like there may be a network we aren't a part of." In this respect, an American company appears to have been at a competitive disadvantage in being selected for a lithium production permit in Chile. Perhaps through local lithium experts or government lobbying, other companies gained a strategic position in the lithium tender process. Moreover, **Ellen Lenny-Pessagno** from Albemarle explained that "the Chinese Ambassador to Chile wrote articles supporting specific companies which could have made a big difference."[lxxiv] China's BYD Chile SpA was awarded one of the two permits in the recent tender process, and the explicit support from China's diplomatic team could have played a part in the results.

Recommendation (3): Provide Lobbying Support for American Companies Prior to and During Lithium Tender Processes

ENR should provide American firms with information on future lithium tender processes and connect them to both internal government officials as well as external lithium experts that can better inform them on these tender processes. U.S. Commercial Service Officers at Embassy Santiago should engage with local government officials to be on top of any lithium tender opportunities initiated by the new administration. They should share this information at the Clean Energy Resources Advisory Committee (CERAC) for timely updates to the private sector.

Mexico: An Emerging Lithium Producer

Mexico possesses the tenth largest lithium reserves in the world but does not yet produce lithium carbonate on the market.[lxxv] **The country's recent discovery of up to 4.5 million metric tons of LCE has brought them into the conversation of contributing to global lithium supply over the next decades.**[lxxvi] However, lithium is a strategic resource in Mexico, which means the federal government owns the resource. President Andrés Manuel López Obrador (AMLO) has claimed he would like to nationalize the lithium industry, which would have a huge impact on the nascent industry in Mexico.[lxxvii] It remains to be seen if AMLO will follow through with these declarations of nationalization; however, lithium development in Mexico will likely occur through government concessions and lithium tender processes. Given Mexico's proximity to the United States, the existing trade relationship and transportation connection between the countries, and its automotive sector strength, Mexico possesses clear strengths as an ally shoring candidate in the lithium industry. As its lithium industry grows, it will be important for the United States to partner with Mexico to increase global production and create a North American value chain.

Lithium Production and Supply Chain Dynamics

The Mexican Geological Survey is currently conducting a full exploration of lithium deposits throughout the country that will be finished in June 2022 (see ***Appendix D*** for current map). According to **Efrain Alva**, the Coordinator General of Extractive Industries at the Ministry of Economy, thus far the Geological Survey has identified "around fifty-seven areas across the country where lithium extraction may exist in quantities that are large enough to be economically exploitable."[lxxviii] **Similar to the United States, Mexico possesses all four of the main lithium deposit types.**

First, there are two to three promising **volcanic-sedimentary clay** lithium deposits in the state of Sonora. Previous administrations allocated Bacanora Lithium a permit for the Sonora Lithium Project, the largest lithium deposit in Mexico. Bacanora was recently taken over by China's Ganfeng Lithium. The project is in the pilot plant stage, in which it operates a lithium carbonate plant in Hermosillo, aiming to begin production by 2023.[lxxix] **Second**, in between Zacatecas and San Luis Potosi, the Geological Survey discovered lithium **brine**, however, Alva explains that "the brine is not very thick, so the deposit does not make sense for extraction on a longer time scale because the investment would not be profitable."[lxxx] **Third**, there is a **geothermal** lithium deposit in Baja California of around 1,200 parts per million. According to Alva, "for a deposit to be economically viable, it would need to be around 4,000 parts per million."[lxxxi] While the deposit does not meet that threshold, Alva explains that the lithium "would not require a difficult separation process. It is practically like a lithium brine as found in the Lithium Triangle. While

there is not much lithium, you would save on a lot of extraction processes and energy use. But the deposit is the territory of a parastatal so you would need to negotiate with Mexico's Federal Electricity Commission for the land."[lxxxii] **Fourth**, a **pegmatite hard-rock** deposit was discovered in Oaxaca and Guerrero but again the investment would not be profitable for the private sector given the limited reserves. **In sum, most of Mexico's lithium deposits would be difficult economic ventures, however, given the status quo, these deposits will be crucial to increase global supply and diversify the supply chain in the longer-term.**

Analysis and Policy Recommendations

Like Chile, Mexico also considers lithium a strategic resource owned by the government, and as such, Model 1 –Incentivizing the Private Sector– is also the appropriate model in this case. Ally-shoring policies in Mexico should focus on government-to-government collaboration to strengthen the North American lithium supply chain, and at the same time, ensure American firms possess a competitive opportunity for future investment.

Finding (1): Mexico will not contribute to global supply in the short-term, given domestic challenges surrounding permitting processes and viability of commercial production.

The recent discovery of up to 4.5 million metric tons of LCE presents a unique opportunity for the United States to combine its lithium strategy in conjunction with its regional neighbor. However, permitting processes and viability of production present two major hurdles to beginning production in the short-term. According to **Efrain Alva**, "before any private firm can begin lithium exploration, they must solicit a permit for land use change as well as a manifestation of environmental impact from Mexico's Ministry Secretariat of Environment and Natural Resources."[lxxxiii] Due to the number of permits required, many projects witness delays while awaiting government permits.

With respect to the economic viability of Mexico's volcanic-sedimentary clay lithium deposits, there are a wide range of opinions on how quickly production could begin. **Chris Berry** explains that investors may be wary of clay-based lithium because "there has never been commercial production of lithium from clay, which presents a technology risk. Investors will want to see that a company can produce battery quality material at pilot scale cost competitively before investment occurs."[lxxxiv] However, an opportunity to enter the lithium landscape and revolutionize the industry exists. **Duncan Wood**, Vice President for Strategy and New Initiatives at the Wilson Center, compared clay-based lithium to the revolution of unconventional oil and gas in the United States: "fifteen years ago, shale oil and gas were uncompetitive, but innovation has changed the economics. This could also be true with clay-based lithium because the profits are so great.[lxxxv]

Recommendation (1): Establish a North American Geological Partnership to Share Best Practices

ENR should direct the U.S. Geological Survey to work together with the Mexican Geological Survey to conduct feasibility studies on new lithium deposits in Mexico and develop best practices for clay-based lithium extraction for future opportunities in both countries. Increased cooperation will allow the United States to take advantage of the early opportunities in the lithium industry in Mexico and coordinate general research between similar deposits in both countries.

Finding (2): AMLO's nationalization intentions for lithium are concerning for the prospects of foreign direct investment but could also be an indication that a lithium tender process may occur soon.

If nationalization of the lithium industry moves forward, it could result in a lithium tender process in which American companies could bid for production permits. Lessons from recent lithium tender processes in Bolivia and Chile indicate that the U.S. Embassy will need to support American companies to ensure the possibility of involvement in Mexico's lithium industry at an early stage. Mexico, like Bolivia and Chile, considers lithium as a strategic resource owned by the government and the people of Mexico. As such, Mexico will only allow future lithium production by permit. In this context, it will be important that American companies are up to date with current trends in the industry and any potential lithium tender processes.

Recommendation (2): Provide Lobbying Support for American Companies Prior to and During Lithium Tender Processes

U.S. Embassy Mexico City should inform ENR on current lithium tender discussions to ensure that American companies have a timely update on opportunities in Mexico to be discussed at the Clean Energy Resources Advisory Committee (CERAC). This exact recommendation was written for Chile (for more depth, see ***Chile, Recommendation 3***).

Section IV: Across-Country Ally-Shoring Policy Recommendations

Certain ally-shoring lessons and policies from the cases of Argentina, Chile, and Mexico can be applied across countries through a combination of both Model 1 –Incentivizing the Private Sector– and Model 2 –A Chinese State-Backed Strategy. **This report proposes an ENR-led ally-shoring strategy across all countries with a combination of eight policy recommendations, divided into two sections: (1) financial policies, and (2) diplomatic policies.**

Financial Policies

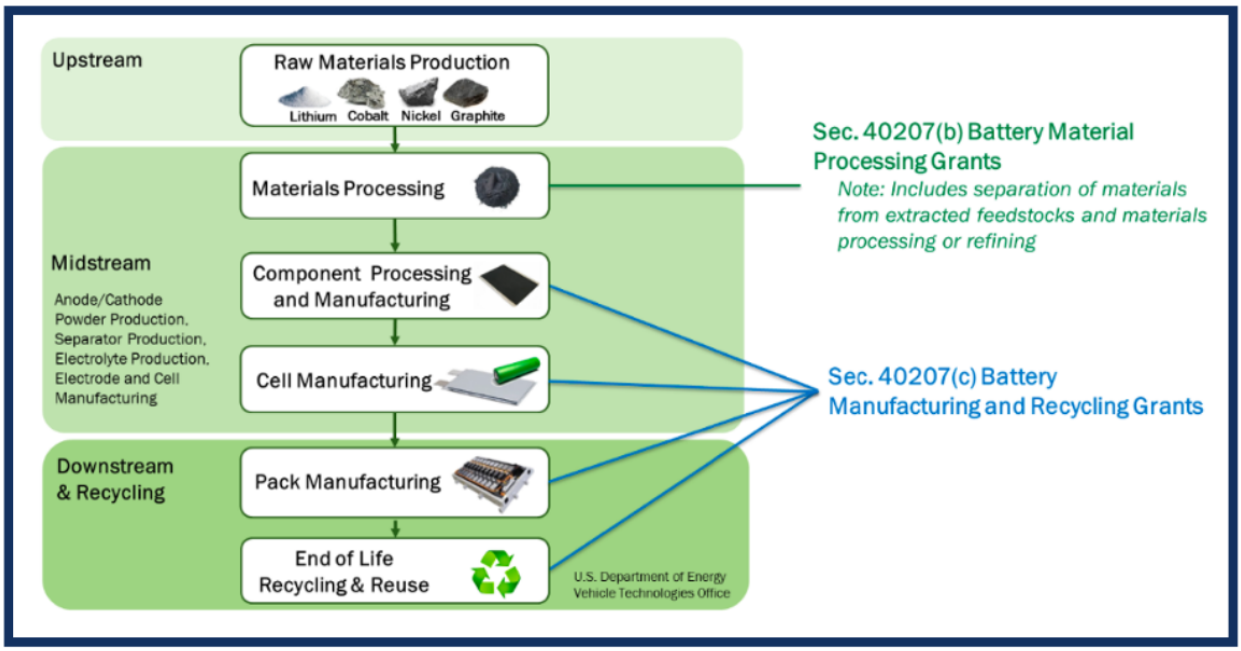
ENR and the rest of the United States government should be taking a stronger industrial approach to address the lithium bottleneck facing the country. The existing state of the lithium supply chain indicates that the private market alone will not reroute supply chains. In this light, additional public sector financing must be allocated to lithium production and processing projects abroad to both increase global supply and the United States' share of lithium. This will require financial policies that de-risk large capital investments and catalyze increased the United States' private sector participation in countries like Argentina, Chile, and Mexico. Increased public sector financial support will help the United States secure lithium production, processing, and offtake agreements abroad. Accordingly, this section provides four policy recommendations that ENR, in collaboration with its partners at the Department of Energy (DOE) and other financing agencies, can take to increase lithium supply.

Recommendation (1): Expand Eligibility of Federal Grants to Projects Abroad

ENR should provide financial incentives to lithium private sector firms, in the form of direct federal grants, to incentivize investment in early-stage lithium extraction projects and midstream processing operations in non-U.S. lithium markets. To implement this recommendation, ENR should advocate for an expansion of the newly created Battery Material Processing Grant program under Section 40207(b) of the Bipartisan Infrastructure Law to make U.S. companies operating abroad eligible to receive grants (see ***Figure 4***).[lxxxvi] Under section 40207(b), direct grants from the DOE for new processing facilities are only eligible for facilities built in the United States, with grants of at least $50 million for updating existing projects and at least $100 million for new projects.[lxxxvii] To successfully ally-shore lithium, however, this funding will be necessary for projects in foreign countries. For this reason, ENR should work with the DOE to make these grants

eligible to American companies seeking to construct processing facilities abroad, thereby incentivizing U.S. investment in upstream extraction and midstream processing and refining operations in resource-rich countries.

Figure 4: Bipartisan Infrastructure Law, Section 40207 Battery Processing and Manufacturing



Source: U.S. Department of Energy[lxxxviii]

In addition to expanding eligibility for these grants, the grant program must grow to support the critical mineral industry more effectively. The Bipartisan Infrastructure Law authorized nearly $7 billion in funding for the Department of Energy (DOE) to issue through new loan and grant programs for battery material processing, manufacturing, and recycling over the next five years.[lxxxix] While this investment is necessary, it will likely not be sufficient. Albemarle's **Ellen Lenny-Pessagno** explains that "$7 billion in grants is nothing given it will cost at least $1.2 billion to build a single 50,000 Mt LCE lithium conversion plant, well over two times the cost to build a similar plant in China."[xc] This is a great start, but it is clear that to garner a greater share of the lithium supply chain, a more expansive federal grant and loan guarantee program will need to be created. **Chris Berry** also comments that "political will is what has been lacking, but I do think the policy tools, whether that is low interest loans or tax abatements would help."[xci] Implementation of these policies will be crucial to meeting the soaring demand for lithium and experts across the field agree that financial incentives are a necessary step towards a stronger critical mineral industrial policy.

Recommendation (2): Create a Critical Mineral Investment Platform

ENR and the DOE should create a Critical Mineral Investment Platform within NAATBatt International (the National Alliance for Advanced Transportation Batteries) to be jointly monitored by the two respective agencies that is modeled off the European Raw Materials Alliance's (ERMA), RawMaterials Investment Platform (RMIP). ERMA evaluates and selects investment projects, matches investors with projects according to their strengths, and offers a variety of financing options (grants, equity, and loans) and execution monitoring support through RMIP. With this context, the DOE should take lead on domestic project grants and ENR should take lead on project grants in foreign countries. This platform should serve as a coordinating mechanism to facilitate private sector investment into lithium and other critical mineral projects both domestically and abroad. With the growing trend of original equipment manufacturers (OEMs), such as Tesla and Ford, securing critical minerals in the upstream, it would be important to bring them into this new platform.

This platform would de-risk critical mineral projects by bringing together private sector finance and capacity with public sector knowledge on specific lithium deposits. In the European Union, the European Investment Bank (EIB) adopted a new energy lending policy to support ERMA's RMIP platform for projects related to the supply of critical raw materials.[xcii] In doing so, the platform can shield investors from financial and political risk in foreign countries.[xciii]

Recommendation (3): Institute a Tax Credit for Direct Lithium Extraction (DLE)

The United States' clear advantage in technological progress on DLE should be prioritized as a mechanism to accelerate U.S. competition abroad. ENR should advocate for a tax credit for companies that successfully implement DLE on a lithium production site in an allied country at least in the pilot plant stage, such as Lilac Solutions at the Kachi lithium brine project in Argentina and EnergyX with its recent lithium tender approval in Bolivia. EnergyX recently suggested that government investment in DLE would be helpful to drive the industry forward.[xciv] Additionally, **Chris Berry** notes that "the DLE value proposition is that there are no evaporation ponds, lithium can be produced in a matter of hours rather than the traditional 18 months, and the recovery rate is in the 80% to 90% range. But the problem is that DLE is not yet widely commercialized. I do think DLE will play a role going forward but will be additive to projects rather than redefining the cost curve. For example, Livent, which operates a traditional lithium brine operation in Argentina, uses DLE to augment its traditional lithium brine operation." [xcv] Tax credits would encourage innovation and catalyze these companies through the beginning stages of DLE projects.

Implementation of this recommendation can build on the Energy Sector Innovation Credit Act of 2021 that was introduced in the Senate in July 2021. This bill currently resides in the Senate Committee on Finance and would create tax credits to encourage investment and innovation in the clean energy sector, with the DOE recommending which technologies are eligible to receive the financial assistance.[xcvi] Using this bill as a base, ENR should work with the DOE to lobby for the passage of this bill. Successful DLE projects would significantly reduce the environmental impact of lithium mining and make future extraction more responsible.

Recommendation (4): New Project Financing Opportunities for Critical Mineral Production and Processing Operations Abroad

Within the framework of a Chinese state-backed financing strategy, ENR should implement two separate tools for new project financing opportunities abroad: a new loan guarantee program and a critical mineral subset of project financing through Build Back Better World. Early-stage financing through a new loan guarantee program and project financing through other U.S. government agencies will enable private sector firms to enter lithium offtake agreements and secure increased lithium production. While policymakers might be concerned about legislating grants and loan guarantees to projects in foreign countries as the government would be taking on a larger share of risk, this will help secure necessary lithium supply for the United States and incentivize further American involvement within the supply chain.

First, ENR should establish a new loan guarantee program for critical mineral production and processing facilities abroad. ENR can implement such a program by working with the DOE to expand the Loan Programs Office (LPO) current purview. Currently, only projects in the United States are eligible, but program eligibility should be expanded to U.S. companies seeking loans for projects in allied countries. The LPO can help make innovative and challenging lithium projects a success by providing the necessary assistance private sector firms need during the initial stages of a new project. **By providing access to debt capital, flexible financing, and government partnership, private sector firms will see a clear policy drive from the government that lines up with their investment in lithium production abroad.** These loan guarantees are crucial to overcome delays in production and cost overruns that are common with many projects in early stages. While there is certainly a risk that lithium production loan guarantees "takes the form of taxpayer-funded handouts to multinational corporations," as Thea Riofrancos states, the LPO's lending approach aims to protect the taxpayer by working with projects to ensure success and a benefit for the American people.[xcvii]

Second, ENR should leverage the financing of the Build Back Better World partnership to create new project financing opportunities for critical mineral projects. Developing "a full spectrum of financial tools to counter the PRC" is necessary, even if the United States continues

to depend to a larger degree on diplomatic tools.[xcviii] ENR should work with U.S. project financing agencies –including the Development Finance Corporation (DFC) and the Export-Import (EXIM) Bank– to help finance critical mineral production and processing projects abroad. In a similar manner, project financing opportunities through Build Back Better World can be crucial to increasing lithium production abroad. **Duncan Wood** from the Wilson Center identified investment in lithium and other critical minerals as "an opportunity to combine the supply chain for critical minerals with the infrastructure investment conversation about Build Back Better World."[xcix] Through this framing, the U.S. government can raise awareness around lithium and other critical minerals as a strategic space that must be invested in both domestically and abroad. ENR's primary focus should be on creating project financing opportunities with both the DFC and the EXIM Bank, but it should also leverage its relationships with the Inter-American Development Bank and the World Bank as part of Build Back Better World.

Diplomatic Policies

To complement these new financial policies, ENR must also strengthen diplomatic policies as part of its new ally-shoring strategy for lithium in the Americas. The United States' strategy requires diplomacy through government-to-government coordination, geological partnerships, and trade facilitation. This section provides four additional policy recommendations that ENR should pursue in conjunction with its partners at U.S. Embassies, the U.S. Geological Survey (USGS) and the U.S. Trade and Development Agency (USTDA).

Recommendation (5): Create Regional Lithium Partnerships within ERGI

ENR should create regional lithium partnerships in Latin America within the Energy Resource Governance Initiative (ERGI). Strategic partnerships can strengthen cooperation across countries to increase security of lithium supply, enhance collaboration on emerging technologies, and promote environmental, social, and governance (ESG) standards. While ERGI already collaborates with other countries, creating regional partnerships can facilitate coordination between countries with similar lithium deposits in developing more targeted policies and best practices. As such, ENR should create three separate regional partnerships for the United States to engage with each based upon the type of lithium deposits in each country. **The three partnerships should include a lithium brine partnership with the Lithium Triangle countries of Argentina, Bolivia, and Chile; a hard rock partnership with Peru and Brazil; and a clay-based/geothermal partnership with Mexico.** Through these partnerships, ENR should coordinate with the respective Mining Ministries in countries like Argentina and Chile to strengthen clean energy cooperation and security of supply.

These partnerships can be modeled off the EU-Canada strategic partnership that was recently created in June 2021.[c] Another goal of these partnerships should be to create a trade and investment environment in which private sector companies can operate more freely between countries, which might involve diplomatic work to fast-track permitting processes for certain lithium deposits. Accordingly, these partnerships should involve collaboration with private sector firms operating in their respective region and ensure that ESG standards are established and followed across the supply chain. For instance, environmental stressors from lithium brine operations in the Lithium Triangle countries, such as water usage, should be tackled together by countries facing the same issues to share best practices for specific lithium deposits. Partnerships to establish ESG standards will also help private sector OEMs that want to ensure the entire supply of lithium is produced in a sustainable and responsible manner. **Chris Berry** explains this growing trend:

> "OEMs are increasingly concerned about raw material supply and getting eyes on their entire supply chain. They do not want to rely on traditional suppliers such as battery manufacturers and are instead going to directly to the mine site to lock up supply. Companies such as Tesla and BMW are two examples. However, producing these battery materials comes at a cost and it's not just a financial cost, but a CO2 cost. OEMs are going to have to rely on lower-grade materials in more challenging parts of the world, or think about water usage, and permitting in countries like Chile or Indonesia."[ci]

With the growing trend of OEM involvement in upstream extraction, ENR should step in to support the evolution of ESG standards across the industry so that American OEMs have more lithium project options in different countries to secure downstream supply. Ultimately, establishing ESG standards together with our allies and partners will help create more opportunities for American firms operating under higher environmental and mining standards than Chinese firms.

Recommendation (6): Expand Geological Partnerships in Allied Countries

ENR should direct the U.S. Geological Survey to increase geological partnerships with allied countries to coordinate lithium deposit mapping and secure more expertise on the grade of lithium deposits around the world. Under Section 40201 and 40204 of the Bipartisan Infrastructure Law, the U.S. Geological Survey is allocated resources to expand the Earth Mapping Resources Initiative to collect critical mineral resource location data and tasked with the creation of a USGS Energy and Minerals Research Facility.[cii] This domestic effort must be paired with cooperative agreements with foreign geological surveys to co-locate lithium resources in different countries and compare the relative quality of resources in allied countries. These partnerships can help contribute to ENR's effort to highlight lithium projects abroad for private sector firms.

Recommendation (7): Improve Knowledge-Sharing with the Private Sector

ENR must improve knowledge-sharing efforts with the private sector in collaboration with U.S. Embassies, and the U.S. Geological Survey. **ENR should expand the recently created Clean Energy Resources Advisory Committee (CERAC)**, a new private sector advisory group that will advise ENR on strategies, programs, and policies related to clean energy mineral supply chains.[ciii] CERAC should serve as a method to communicate broad policy changes with the private sector and share ideas for production and processing opportunities abroad. In addition, **U.S. Embassy officials must prioritize American lithium companies abroad by connecting firms with relevant local parties, keeping them updated on lithium tender processes, and providing a roadmap for how to navigate permitting processes in foreign countries.**

Duncan Wood explains that "because of the new focus on this sector, you will see more capital flowing into it from markets as they see the opportunity. Raising awareness of the opportunity is a key thing in driving capital availability and investment for US mining firms to be more active internationally." By improving knowledge-sharing and raising awareness of the opportunities, the private sector will be catalyzed to seize these opportunities. Lastly, **U.S. Geological Survey experts should share lithium deposit technical expertise and knowledge with interested private sector firms through NAATBatt International to assess the grade of different lithium deposit projects.** Firms face a lack of knowledge on specific lithium deposits given the incomplete mapping of lithium resources in some countries. In providing more elaborate technical expertise through geological partnerships, USGS will help to reduce geological uncertainty.

Recommendation (8): Negotiate a Fast-Track Trade Provision for Critical Minerals

ENR should work with the U.S. Trade and Development Agency (USTDA) to negotiate a new international trade provision between the United States and other lithium-producing countries to fast-track critical mineral related cargo shipments. Lithium related technology and production tools exported from the United States to countries in Latin America categorized as 'research and development' shipments require additional port assistance to avoid delays in upscaling lithium production abroad. Implementation of this new trade provision will require both high-level trade negotiation as well coordination with U.S. Customs and Border Protection (CBP) Officers located at the various ports across Latin America. CBP Officers provide crucial support to facilitate trade for American businesses abroad and their role in coordinating with local port officials will be crucial in implementing this fast-track provision effectively. Tom Wilson from Lilac Solutions expressed that this type of trade provision "would be a game changer for his company."[civ]

Conclusion

Over the past year, the U.S. government has taken swift action to address the critical mineral bottleneck that it will face in the next decades beginning with Executive Order 14017 on America's supply chains. President Biden's recent announcement to invoke the Defense Production Act for the purpose of spurring domestic output of critical minerals furthered the administration's action.[cv] **This report aims to supplement recent government action on critical minerals by providing an ally-shoring strategy that complements existing policy and recommends additional action in collaboration with America's allies and partners.**

Ally-shoring the lithium supply chain presents several uncertainties given the changing dynamics of critical minerals and the clean energy transition. The price of lithium, for instance, could continue to skyrocket due to the mismatch between supply and demand. Policymakers could also be concerned about the possibility of a new battery chemistry becoming commercialized that does not require lithium. Companies are already testing new battery technologies that would forgo the use of cobalt.[cvi] Another technological uncertainty is the extent to which DLE technology will solve environmental issues within the lithium industry. Lastly, ally-shoring depends on the political climate of our allies and partners across the world and in the Americas, which can at times be uncertain as witnessed during the pandemic.

Despite these uncertainties, however, lithium and other critical minerals are critical for the clean energy transition and working with our allies will be necessary to address the incoming industry bottleneck. This report takes the lithium supply chain as a case study and provides policy recommendations that the United States should pursue to initiate the supply chain shift. **While policies differ depending on the country context in which they are pursued, the lessons learned in Argentina, Chile, and Mexico with respect to lithium are equally relevant to other countries with similar policy aspirations to increase critical mineral production.**

In this light, these policies set a precedent for how ENR and the rest of the United States government should pursue ally-shoring policies to reroute critical supply chains. As the United States builds out resilient supply chains together with its allies and partners, it will face numerous challenges in shifting away from the globalization of the last decades. **While ally-shoring will not be an easy solution to diversify and strengthen critical mineral supply chains, it is a necessary step towards protecting the United States' economic and national security interests to make the clean energy transition a reality.**

Appendices

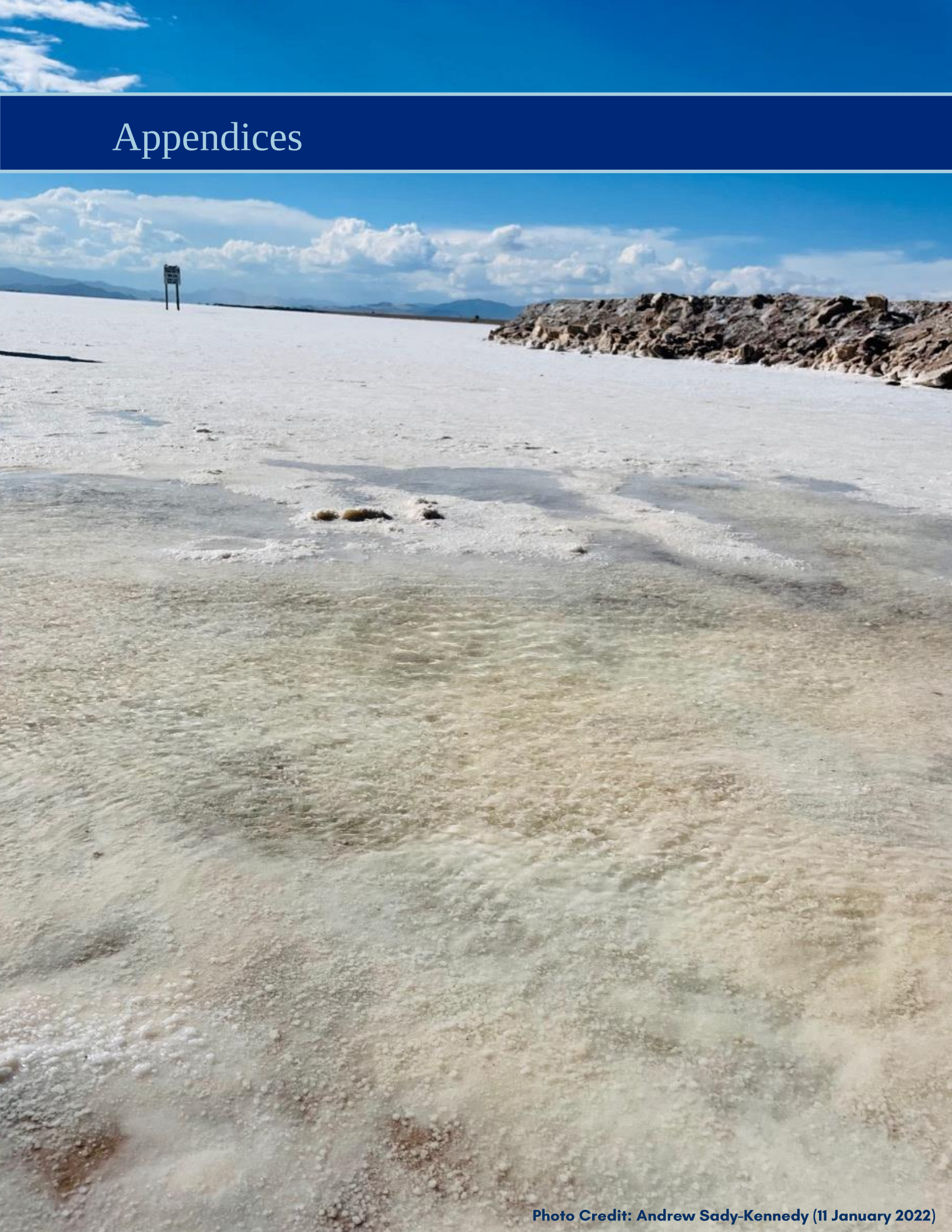


Photo Credit: Andrew Sady-Kennedy (11 January 2022)

Appendix A: Interview List

Name	Organization and Role
Efrain Alva	Mexican Ministry of Economy, Coordinator General of Extractive Industries
Daniel Amaya	INVAP, Project Manager
Cecilia Aversa	Integra Lithium, Non-Executive Director
Chris Berry	House Mountain Partners, Lithium-Ion Battery Minerals Consultant
Ernesto Calvo	Argentina's Institute of Physical Chemistry of Materials, Environment, & Energy (INQUIMAE), Director of Research
Benjamin Gedan	Wilson Center, Deputy Director of the Latin American Program
David Guerrero	Independent Lithium Consultant
Scott Hynek	U.S. Geological Survey, Hydrologist
Agustina Jefremov	U.S. Embassy Buenos Aires, Economic Officer
Craig Kim	U.S. Embassy Santiago, Economic Officer
Rene LeBlanc	Lithium Americas, Chief Technical Officer
Ellen Lenny-Pessagno	Albemarle Corporation, Global Vice President of Government & Community Affairs
Ignacio Martínez	Chilean Ministry of Mining, Advisor to the Minister
Lori Michaelson	U.S. Department of State, Mexico Desk Officer
Franco Mignacco	Minera Exar, President
Thea Riofrancos	Providence College, Lithium Supply Chain Researcher
Leah Severino	U.S. Embassy Buenos Aires, Economic Officer
Leonardo Valenzuela	Chile's Production Development Corporation (CORFO), Director of Lithium Unit
Patricia Vásquez	Wilson Center, Lithium Triangle Project Fellow
Arnaldo Visintín	Argentina's National Scientific & Technical Research Council (CONICET), Lithium-Ion Battery Researcher
Martin Walter	Inter-American Development Bank, Mining and Energy Sector Specialist
Tom Wilson	Lilac Solutions, Chief Development Officer
Andrew Winkelman	U.S. Embassy Mexico City, Economic Officer
Duncan Wood	Wilson Center, Vice President for Strategy & New Initiatives

Appendix B: Global Lithium Deposits Map

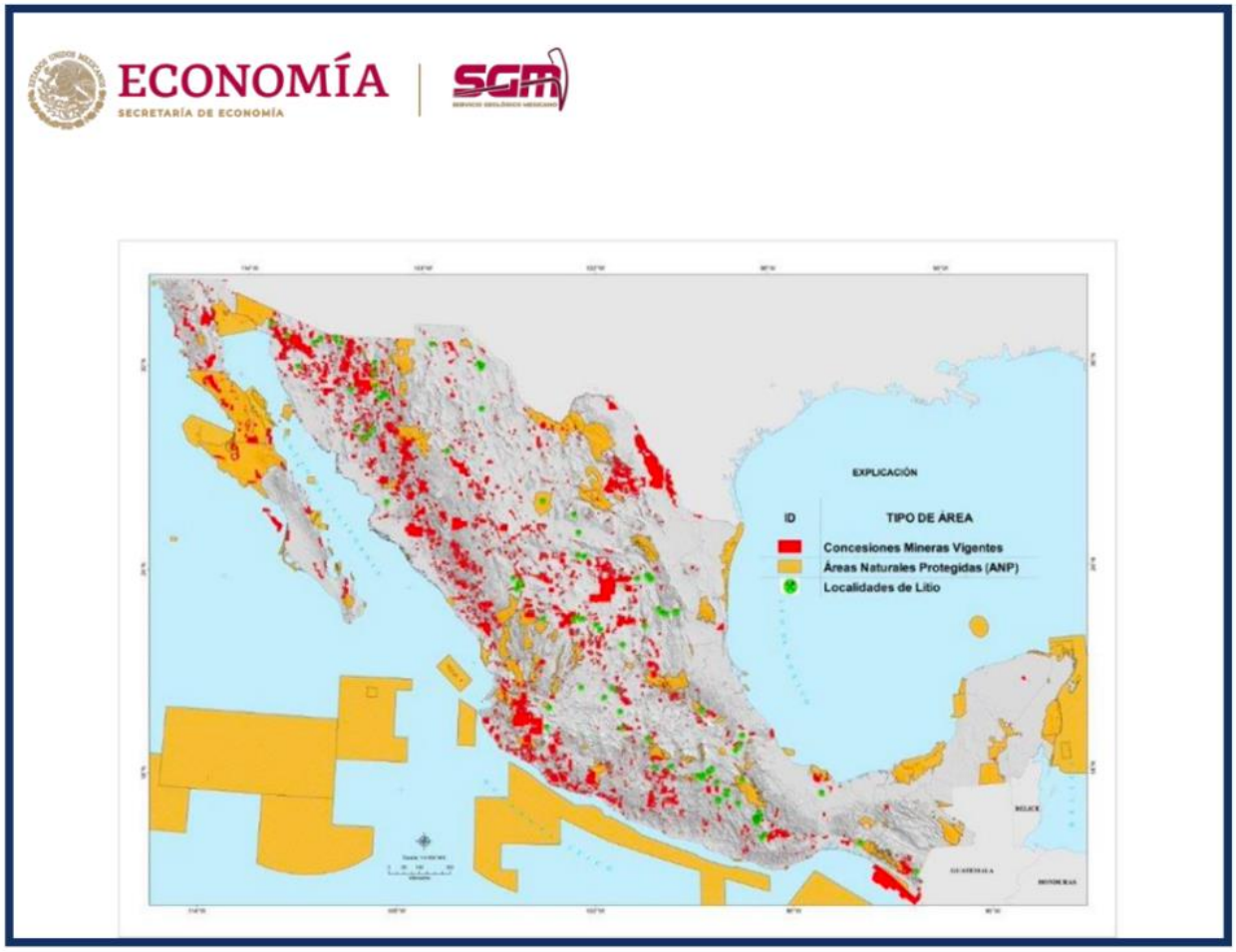
Source: British Geological Survey[cvii]

Appendix C: Argentine Lithium Project Candidates for Ally-Shoring

Project	Ownership	Province	Stage	Production Capacity
Mina Fenix	Livent Corporation (USA)	Catamarca	Production & Expansion	Production: 20,000 LCE Expansion: 60,000 LCE
Salar de Olaroz	Allkem Limited (Australia) Toyota Tsusho (Japan) JEMSE (Argentina)	Jujuy	Production & Expansion	Production: 25,000 LCE Expansion: 50,000 LCE
Pastos Grandes	Millenial Lithium Corp. (Canada)	Salta	Feasibility Study Completed (2019) Pilot Plant under Operation Construction for Production (Projected 2024)	24,000 LCE
Sal de Vida	Allkem Limited (Australia)	Catamarca	Feasibility Study Completed (2021)	32,000 LCE
Caucharí	Allkem Limited (Australia)	Jujuy	Pre-Feasibility Completed (2019)	25,000 LCE
Kachi	Lake Resources (Australia) Lilac Solutions (USA)	Catamarca	Pre-Feasibility (2020)	25,000 LCE

Source: Prepared by the author based on public reports from companies operating the projects.

Appendix D: Mexican Lithium Deposit Map



Source: Mexican Geological Survey[cviii]

This Mexican Lithium Deposit Map shows current lithium mapping efforts conducted by the Mexican Geological Survey. The key explains each of the areas by color:

- ⇒ Red: Current Mining Concessions
- ⇒ Yellow: Protected Natural Areas
- ⇒ Green: Lithium Localities

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