



EL MUNDO EN QUE VIVIMOS

Critical minerals, dependence and global power competition: governance challenges in South America's lithium triangle

Minerales críticos, dependencia y competencia geopolítica: desafíos para la gobernanza en el Triángulo del litio sudamericano

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ABSTRACT *Against the backdrop of ongoing global climate change, the continuous development of electric vehicles and renewable energy storage technologies has made lithium a critical and highly sought-after mineral resource worldwide. Projections indicate that lithium demand could increase up to 40-fold by 2040, with electromobility accounting for 80% of its end use. This rapid growth has intensified global competition for access to critical mineral resources, a race that has been further accelerated by energy disruptions caused by geopolitical conflicts, including the war in Ukraine and instability in the Middle East. Against this backdrop, the Lithium Triangle—comprising Argentina, Bolivia, and Chile—has gained renewed international significance, as it holds approximately 60% of the world's lithium resources and 47% of its reserves, placing South America at the forefront of the global lithium supply chain. This paper focuses on two key dimensions of governance in the Lithium Triangle. The first dimension examines domestic regulatory frameworks in Argentina, Bolivia, and Chile, analyzing their impact on the development of the lithium industry and their integration into global supply chains. The analysis will adopt an International Political Economy approach,*

focusing on the concepts of dependence, primarization, development models linked to industrialization, and regional integration. The central argument is that the absence of robust medium- and long-term policies for resource management, investment regulation, and trade could perpetuate primary-export economic models, reinforcing external dependence.

Keywords: Power competition, energy transition, lithium, South America, dependency

RESUMEN En el contexto del cambio climático global, el desarrollo continuo de los vehículos eléctricos y de las tecnologías de almacenamiento de energías renovables el litio se ha consolidado como un mineral crítico y altamente demandado a nivel mundial. Las proyecciones indican que la demanda de litio podría multiplicarse por 40 hacia 2040, con la electromovilidad representando el 80% de su uso final. Este crecimiento acelerado ha intensificado la competencia global por el acceso a minerales estratégicos, una carrera que se ha visto aún más impulsada por las disrupciones energéticas provocadas por conflictos geopolíticos, como la guerra en Ucrania y la inestabilidad en Medio Oriente. En este escenario, el Triángulo del Litio —integrado por Argentina, Bolivia y Chile— ha adquirido una renovada relevancia internacional, al concentrar aproximadamente el 60% de los recursos mundiales del mineral. Este trabajo se centra en dos dimensiones clave de la gobernanza en el Triángulo del Litio. La primera aborda los marcos regulatorios domésticos en Argentina, Bolivia y Chile, analizando su impacto en el desarrollo de la industria del litio y su inserción en las cadenas globales de valor. El análisis se basa en un enfoque de Economía Política Internacional, haciendo uso de conceptos como dependencia, primarización, modelos de desarrollo vinculados a la industrialización e integración regional. El argumento central sostiene que la ausencia de políticas sólidas de mediano y largo plazo para la gestión de recursos, la regulación de inversiones y el comercio podría perpetuar modelos económicos de tipo primario-exportador, reforzando así la dependencia externa de los países de la región.

Palabras clave: Competencia geopolítica, transición energética, litio, América del Sur, dependencia

INTRODUCTION

In the ever-evolving tapestry of global affairs, the dynamics of energy demand and consumption stand as a pivotal force shaping economies, policies, and the environment. As nations strive for progress and development, the quest for energy sources to fuel industries, power homes, and drive innovation has become increasingly urgent. But the increasing energy demand, mostly as a result of a growing global population, has generated an unprecedented amount of CO₂ emissions in the last two decades. Between 1990 and 2021, total emissions from energy sources increased from 20 billion to 34 billion tons of CO₂. The largest growth in emissions from energy occurred in the first decade of the 2000s, with carbon dioxide emissions increasing by at least 30% by 2010. (International Energy Agency, 2023)

Thus, the transition to a green paradigm became more visible and urgent in the face of the inexorable threat to human survival posed by the current global economic and productive system. Furthermore, recent events contributed to strengthening the conviction of the imminent need to accelerate energy change in general. The pandemic and the war in Ukraine accentuated various shortcomings of the current energy model based on fossil fuel combustion. On the one hand, the consequences of the high dependence on external supplies, as evidenced in the case of Western Europe in relation to gas supplies from Russia. On the other hand, the interrelation between the environmental impacts of global warming and the associated global-scale dangers, including natural disasters, melting ice, pandemics, among others. (Fornillo, 2022)

According to the World Bank (2024), in 2020, the portion of renewable energy in total final energy consumption worldwide was 19.77%. The trend shows an increase in renewable energy consumption since 1999. That year, the global percentage of renewable energy consumption was approximately 17%. Despite the incremental rise in renewable energy sources, fossil fuels continue to dominate, underscoring the ongoing challenge of transitioning to a more sustainable energy system.

In this context, critical minerals for the green transition have become crucial. The International Energy agency (2024) has projected that global demand for these minerals will quadruple by 2040. At the forefront are critical minerals such as cobalt, copper, nickel, and lithium. This last one, called the “white gold”, has seen an unprecedented surge in demand in the last ten years, and has fueled a growing interest in resource-rich regions, such as south America. The U.S. Geological Survey (2024) estimates that global lithium resources, excluding the U.S., stands at about 91 million tons. The lithium triangle, conformed by Argentina, Chile and Bolivia salt flats areas, contains roughly 60% of the world's lithium deposits. Within this region, Bolivia holds an estimated 23 million tons, Argentina has 22 million tons, and Chile possesses around 11 million tons, making them the top three countries in terms of resources.

In this paper, we aim to analyze how the increasing demand of lithium as a key mineral to advance energy transition and electromobility is impacting on the Lithium Triangle, particularly from two dimensions. On the one hand, the role of international power competition in the region's dynamics, with a particular focus on global demand trends, foreign investment projects in the region, and bilateral trade flows with major global destinations. On the other hand, we focus on the different domestic regulatory frameworks in Argentina, Bolivia, and Chile, analyzing their impact on the development of the lithium industry and their integration into global supply chains.

The central argument is twofold. Geopolitical competition and the consequent need to secure access

to strategic minerals for the energy transition process is reinforcing South America's reliance on a primary export led economic model. This dynamic is also strengthened by domestic asymmetries between Argentina, Bolivia, and Chile which are obstructing the development of a coordinated regional lithium strategy. These differences not only weaken collective bargaining power with major global players but also hamper efforts to transition toward a value-added production model that could benefit the region's long-term economic development.

The analysis adopts an International Political Economy approach, focusing on the concepts of development model, neo-extractivism and commodities consensus (Svampa, 2019). South America's international trade model has historically been shaped by its abundant natural resources and a reliance on primary commodity exports. This export-led insertion into global markets has defined the region's economic structure, influencing trade policies, regional integration efforts, and development strategies. The academic debate on the articulation between development model and international insertion within Latin America has centered on the region's traditional role as a raw material producer. Some contributions within this discussion reflect what Gudynas (2009) coined as progressive neo-extractivism describing this 21st century phenomenon in South America. From this perspective, a) development is conceived based on extractivist sectors; b) there is a greater presence and active role of the State, which seeks legitimation by means of redistributing the surplus obtained; among other implications.

This entails accepting a subordinate role in global markets, where South American nations act as price takers, relying heavily on international trade intermediaries, brokers, and capital flows. As a result, their domestic decision-making is constrained by commercial opportunities, leading to fierce competition among countries in the region to attract foreign investment. (Gudynas, 2011; Rodil-Marzábal & Sánchez-Carreiras, 2024) Mining gained relevance as an extracting activity throughout South American in the beginning of the

2000s. Lithium industry is among the newest extractive sectors in the region and is contributing to reinforce the abovementioned highly concentration pattern.

The paper adopts a qualitative methodological approach, drawing on official documents and statistical reports as primary sources to reconstruct the regulatory and economic landscape of the lithium industry. It begins by reviewing state-of-the-art debates on the global energy transition, the role of lithium, and South America's position as a leading producer. Subsequent sections explore the external and internal factors shaping the regional lithium industry and their impact on both national and regional policies.

The third section centers on the geopolitical dynamics driving competition for strategic minerals, with a particular focus on lithium. Section four then examines the challenges of regional integration, empha-

sizing how regulatory differences, mineral ownership structures, and political orientations create obstacles to the development of a unified lithium policy. The main conclusions highlight how the extractive model persists due to the interplay of external interests and the lack of a clear, coordinated regional strategy. This dynamic not only reinforces existing challenges but also fuels competition among Lithium Triangle countries, rather than fostering the cooperation necessary to develop a regionally integrated lithium value chain.

DEVELOPMENT

1. Global Energy transition and the role of the lithium industry

Global energy transition, which defines the shift from the current hydrocarbon-based energy mix to a low-carbon one dominated by renewable sour-

Table 1. Total Final Energy Consumption. In percentage. Selected years. World

<u>Year</u>	<u>Coal</u>	<u>Crude Oil</u>	<u>Oil Products</u>	<u>Natural Gas</u>	<u>Wind, solar, etc</u>	<u>Biofuels & waste</u>	<u>Electricity</u>	<u>Heat</u>
2022	8.84	0.07	39.77	16.78	0.68	9.32	20.97	3.57
2021	9.05	0.19	38.75	16.96	0.63	10.37	20.60	3.44
2020	9.56	0.17	38.45	16.80	0.62	10.72	20.45	3.22
2019	9.36	0.16	40.67	16.36	0.55	10.26	19.58	3.06
2018	9.73	0.13	40.85	16.02	0.53	10.21	19.47	3.07
2017	10.35	0.13	41.14	15.54	0.50	10.28	19.08	2.99
2016	10.96	0.14	40.93	15.30	0.47	10.37	18.84	2.99
2015	11.64	0.14	40.83	15.09	0.44	10.47	18.50	2.89
2005	10.51	0.16	43.79	15.19	0.15	10.37	16.53	3.31
2000	7.81	0.20	45.00	16.20	0.13	11.38	15.71	3.59
1995	10.26	0.17	43.36	15.60	0.08	11.55	14.53	4.45
1990	12.16	0.18	42.02	15.29	0.06	11.35	13.50	5.44

■ Source: Elaborated by the author with information from the IEA, 2024.

ces, is a pivotal and fundamental process for the planet's long-term survival and human well-being. Environmental imperatives, such as climate change mitigation and improving air quality, underscores the urgency of this transition. Such a transformation is generating unprecedented changes in energy production and consumption worldwide. It signifies a crucial transition away from fossil fuels towards cleaner, more sustainable energy alternatives.

Although several global commitments have been made in the last three decades to reduce carbon emissions, global energy consumption remains highly dependent on fossil fuels and non-renewable sources. As shown in table 1, hydrocarbon sources (coal, oil and its products, and natural gas) account for 65% of total energy consumption in 2022, while this portion represented 67% in 2015, and 69.6% in 1990, according to figures from the International Energy Agency (2025).

Since 1990, energy consumption has multiplied, increasing from 258 million TJ to 422 million TJ in 2022. This rise represents a 64% increase in total global energy consumption. In other words, within the energy mix that makes up global final consumption, renewable and clean energy sources play a greater role due to the exponential growth in global energy demand. As Yergin, Orszag & Arya (2025, p. 106) suggest, given this increase in consumption, "rather than replacing conventional energy sources, the growth of renewables is coming on top of that of conventional sources".

Renewable energy sources, though still a smaller fraction of the total energy consumption, have shown an upward trend. Wind, solar, and other renewables have increased their share in the last two decades. In 2002 they represented 0.13% of total energy consumption, while in 2022 they reached 0.68%, indicating a steady growth in the adoption of renewable energy technologies. Electricity consumption as a percentage of total energy use has been rising, reaching 21% in 2022, up from 15.7% in 2000. This increase reflects the broader trend of

electrification in various sectors, including transportation and heating.

In terms of electric generation, according to the IEA (2024), 30% was generated from renewable and clean sources (hydro, solar, wind and biofuels). Although coal and gas still represent the major portion of electricity generation, 36% and 22% respectively in 2022, renewables and clean sources have gained prominence since the beginning of the century. Hydropower remains the dominant source of renewable energy for electricity generation worldwide, despite having the slowest growth rate among renewable energy sources. In contrast, solar energy production is steadily increasing, driven by continuous advancements in solar technologies that improve energy conversion efficiency.

Regarding transition to renewable energy sources, trends vary significantly across selected countries. For example, Denmark and Brazil have demonstrated a steady increase, exceeding 30% renewable energy consumption by 2020 (World Bank, 2024). In contrast, China's renewable energy consumption stood at 14.90% in 2020, while the United States recorded 11.00%. The European Union, meanwhile, reached an impressive 21.12% in the same year. These figures highlight the differing policy priorities and economic frameworks shaping renewable energy adoption across regions.

Energy transition along with energy security have become policy priorities for most countries. In light of the global impacts of the COVID-19 pandemic, there is a renewed focus on the dynamics of energy transitions. The pandemic has exposed vulnerabilities in energy supply chains and raised questions about long-term strategy adjustments that nations must undertake to meet their climate goals while fostering resilience in their energy systems (Tian et al, 2022). The overarching discourse suggests that adapting policy priorities to reflect the interconnectedness of social equity, economic imperatives, technological capabilities, and political landscapes is pivotal for achieving a successful energy transition.

1.1 Lithium: state of the sector and the Lithium Triangle's role/strategic role

Lithium demand has surged as a consequence of the global process towards a low-carbon based energy mix. Lithium's applications are diverse, but its primary use is in batteries, accounting for an estimated 87% of its consumption in 2023. As a highly reactive metal, lithium is integral to the production of high energy density rechargeable batteries utilized in devices such as smartphones, laptops, electric vehicles (EVs), and energy storage systems (U.S. Geological Survey, 2024). Lithium-ion batteries are particularly advantageous as they can retain their charge longer than traditional batteries and can be recharged upon exposure to electricity. Additionally, lithium is often alloyed with other elements for various functions; for instance, lithium oxide is effective at moisture absorption, while lithium chloride is utilized in industrial drying applications (World Population Review, 2024).

Other applications include ceramics and glass (4%), lubricants (2%), air treatment (1%), and medical uses (1%) (U.S. Geological Survey, 2024). Furthermore, lithium minerals have been directly used as concentrates in ceramics and glass production due to their ability to enhance durability, resistance to corrosion, and thermal stability under extreme conditions. In glass manufacturing, lithium's inherent properties contribute to increased productivity and energy efficiency (Government of Canada, 2024; World Population Review, 2024).

In 2023, global lithium production, excluding figures from the United States, saw a significant rise of 23%, reaching a total of 180,000 tons (0.96 Mt lithium carbonate equivalent) compared to 146,000 tons in 2022. (U.S. Geological Survey, 2024; IRENA, 2023) This rapid global increase in production is driven by the surging demand for electric vehicles, which is expected to grow at an annual rate of 26% through 2030 (Bibienne et al., 2020).

Regarding resources, the U.S. Geological Survey (2024) estimates that global lithium resources total

about 105 million tonnes. Lithium deposits fall into three main types (Fig. 1): (a) salar deposits, formed from lithium-bearing continental brines; (b) hard-rock deposits, mainly from Li-rich pegmatites; and (c) (volcano)-sedimentary clay-hosted deposits (Bowell et al. 2020). The first two types have provided the vast majority of lithium supply to date. (Gardiner, Jowitt & Sykes, 2024)

The lithium triangle, spanning an area of 400,000 km², contains roughly 60% of the world's lithium deposits. Within this region, Bolivia holds an estimated 23 million tons, Argentina has 22 million tons, and Chile possesses around 11 million tons, making them the top three countries in terms of resources. In the case of lithium reserves Chile possesses the largest reserves globally, followed by Australia in second place and Argentina in third place. Although Bolivia has the most significant lithium resources worldwide, it lacks reserves for two main reasons: first, its high magnesium concentration prevents it from utilizing the same extraction methods as Argentina and Chile; second, the government has classified lithium as a fiscal reserve, limiting private companies from exploiting it (Rizzo, 2024).

In South America, natural deposits of lithium are found underneath the expansive salt flats so its extraction predominantly occurs through evaporation methods. The traditional method employed is solar evaporation, which is economically favorable due to lower operational costs compared to hard rock mining. However, this method is criticized for its high-water consumption, accounting for approximately 65% of the region's freshwater usage, which raises concerns about ecological sustainability and local water resources (Vera et al., 2023).

Chile is the continent's leading producer, and the second-largest lithium producer globally. The country has effectively transformed most of its lithium resources into economically viable reserves suitable for commercial extraction. Meanwhile, Argentina is gaining attention with a robust array of brine extraction initiatives. Although Bolivia possesses

substantial lithium resources, it lacks major projects. Recently, the Bolivian government has entered into multiple agreements to develop its lithium assets and has initiated an international tender for lithium extraction, despite facing considerable challenges, such as critical geographical conditions (IEA, 2024).

In terms of production, Chile's output increased to 44,000 tons –234,000 tons lithium carbonate equivalent (LCE)- in 2023. Argentina also saw a significant production boost to 9,600 tons –51,000 tons LCE- from just 6,590 tons in 2022. In terms of market share for global production, Chile accounted for 23.9% while Argentina represented 7.2% (Pistilli, 2024; Rizzo, 2024). Conversely, Bolivia's situation is distinct; despite having the largest deposits, its production was only about 617 tons in 2022 with no substantial output reported for 2023. But Yacimientos de Litio Bolivianos (YLB) reported that it has increased lithium carbonate production from 3 to 13 metric tons per day by 20224 (The Logistics World, 2024).

Regarding projects, Argentina shows the highest development and diversification of projects in the region. The main lithium carbonate producing provinces are Jujuy, Salta and Catamarca, located in the northwest of the country. The region is currently home to 50 projects in different stages of development, with the Fénix, Olaroz and Cauchari-Olaroz projects standing out in production. In 2023, lithium production in the country grew by 45.67%, consolidating its role as a key player in the global market. Companies with Canadian, US, Chinese, Korean and Australian capital have landed in the area with large-scale projects. The lithium exploration budget recorded a year-on-year growth of 93.5%, reflecting a strategic focus on this metal. According to the Secretary of Mining, once the ten most advanced projects come into production, lithium exports are expected to increase from US\$200 million in 2022 to US\$4 billion per year in 2027.

Cauchari Olaroz, controlled by Ganfeng Lithium (44.66%), Lithium Americas (44.84%), and Jujuy Energía y Minería (8.5%), began operations in 2023,

joining Fénix and Olaroz as the leading production projects in the country. (Juste & Rubiolo, 2023; Ministry of Economy, 2024) More recently, after 12 years of work and with an investment of more than u\$s800 million, the fourth project was inaugurated in Salta province. This is the Centenario-Ratones project, in charge of Eramine Sudamericana. The project is the first one in that province, with a production potential of 24,000 tons of lithium carbonate equivalent (LCE) per year in the first stage. For the first time in the country, the innovative Direct Lithium Extraction process will be used, thus reducing the environmental impact. (El Tribuno, 2024)

In the Plurinational State of Bolivia, the most advanced project to produce lithium compounds is led by the State-owned YLB, in Salar de Uyuni. This project has a pilot plant, while the construction of an industrial plant with a production capacity of 15,000 tons of LCE per year is also under way. In 2021, YLB launched an international tender for direct lithium extraction for the Uyuni, Coipasa and Pastos Grandes salt flats. Bolivia has included the use of DLE process in recent deals signed with the Chinese consortium CBC and the Russian Group Uranium One in 2023 (The Logistics World, 2024).

In Chile, the primary players lithium industry are SQM, accounting for approximately 65% of production, and Albemarle, holding 35%. Both companies operate in the Salar de Atacama, where they control 34% of the world's lithium supply, equivalent to approximately 44000 tons. (Gutiérrez & Ruiz-Leon, 2024). The government has established a National Lithium Company (ENL) as part of its lithium mining development policy. This seeks to lead the exploration and exploitation of lithium projects with private participation, but under State control; and in the near future it could expand the portfolio of projects in operation and production in Chile. (ECLAC, 2023)

This state-of-the-sector analysis shows lithium's critical role as a primary resource towards the energy transition process globally, and also, South America's strategic position as a producer and supplier for

this mineral. As mentioned in the introduction, the three countries are consolidating their global role as raw materials suppliers with this relatively new export item. External and internal conditions are operating to strengthen this process, many times referred to as reprimarization. The two following sections analyze two of these conditions: the international power competition as a major external factor influencing the Lithium Triangle's landscape, and the national regulatory frameworks that operate as limitations to an articulated regional lithium policy.

2. International power competition and impact in the region's dynamics

The geopolitical context surrounding the competition for strategic minerals, especially lithium, is increasingly pivotal in shaping international relations and energy security. The growing competition over these minerals became a game changer in the last decade. Although they had already become indispensable years ago, these minerals had maintained a low profile outside of the mining and technology sectors. (Kalantzakos, 2020)

Among the external conditions affecting the energy landscape, the competition between China and the United States has significant implications influencing trade dynamics, technological advancements, and environmental policies. This ongoing rivalry has spurred both nations to enhance their renewable energy policies and investments. As highlighted by Mohamad et al. (2023), both China and the U.S. are making concerted efforts to transition to renewable energy sources to mitigate environmental degradation. This transition is crucial for addressing climate change and serves as a strategic move to reduce reliance on fossil fuels and enhance energy security. The rivalry has thus catalyzed advancements in clean energy technologies, with both countries investing heavily in research and development to gain a competitive edge in the global market.

Particularly evident in the clean energy sector, the competition has also motivated both nations to strive for

securing stable access to strategic minerals, which are essential for technologies such as solar panels, wind turbines, and, particularly, electric vehicle batteries. Although lithium is primarily found in peripheral countries within the international system, the production of lithium-ion batteries is concentrated in developed nations, predominantly in Asia, with growing advancements in Western Europe and the United States.

As the world's largest consumer of lithium, China accounted for approximately 50-60 percent of global lithium consumption over the past five years, with its refining capacity reaching about 80 percent of the global total (Riofrancos, 2023). It is important to notice that besides Beijing's international quest for lithium providers, the country's lithium resources are also substantial. In 2024, China's proven lithium reserves accounted for 6.8 million tons, representing approximately 6 percent of world total reserves (U.S. Geological Survey, 2024). In January 2025, China's breakthrough in lithium exploration boosted its global share of lithium reserves from 6 to 16.5 percent, raising its global ranking from sixth to second according to a China Geological Survey report. These developments are anticipated to alleviate domestic supply constraints and enhance China's position in the global lithium market. (Global Times, 2025)

Besides these recent developments, Chinese batteries and EV industries are highly dependent on lithium imports to meet the growing domestic needs. With the continued expansion of the country's renewable energy industry, the import of lithium carbonate has surged annually. In 2023, the country imported 158 thousand metric tons of the compound, with a value of 4.35 billion U.S. dollars. As shown in figure 1, South Korea and Japan follow as major importers, with shares of 22.4 percent (2.4 billion USD) and 9.6 percent (1.05 billion USD), respectively, reflecting their advanced tech and automotive industries. The European Union and the United States contribute modestly, representing 2.75 and 2.28 percent, while countries such as the Netherlands,

United Kingdom, Germany, and France hold even smaller shares. This distribution highlights China's central role in the lithium supply chain, emphasizing its reliance on imports to sustain its renewable energy ambitions.

Fig. 1 Lithium carbonate main import countries, 2023 (in percentage)

■ *Source: Elaborated by the author with information from World Bank, 2025.*

In 2023, Argentina and Chile were China's primary lithium suppliers, accounting for a combined \$4.28 billion—98% of China's total lithium carbonate imports. Argentina, in particular, has emerged as one of the fastest-growing import markets (OEC, 2024), reflecting the surge in mining investments and projects outlined in the previous section. As part of its global strategy to secure critical raw materials, China has invested \$11 billion in lithium extraction across Latin America since 2018.

Although the United States has expressed concerns over Beijing's growing influence in South America's mining industry, its role in the region's trade and investment trends remains less significant. In 2023, the U.S. imported \$246 million in lithium carbonate, with the majority coming from China (\$154 million) and Argentina (\$84.8 million), which together accounted for 97% of total U.S. imports (OEC, 2024). Meanwhile, Chile has emerged as the fastest-growing supplier, highlighting the key role of Albemarle, one of the leading mining companies in the country's lithium sector.

Within the competition scenario, Europe has also become a key player, albeit with a less prominent role. European energy dependence has increased in recent decades, particularly on fossil fuels. A recent report shows that, "in 2022 the EU's energy demand was highest for oil and petroleum products reaching 21.532 petajoules (PJ), of which 97.7% was imported. For natural gas, the demand in 2022 stood at 12.324 PJ, with 97.6% of it covered by imports"

(Eurostat, 2024). This heavy reliance on energy imports underscores the EU's delicate position between two energy security paradigms—still dependent on fossil fuels for short-term stability while facing increasing challenges in securing access to critical materials for its long-term transition. In this context, non-fossil energy sources play a crucial role in the EU's strategy to decarbonize its economy by 2050 (Defard, 2023).

Since 2011, the European Commission has published a triennial list of critical raw materials (CRM), identifying minerals essential to the EU's economy and subject to high supply risks due to geopolitical, geographical, and geological factors (IEA, 2022). The most recent list, released in 2023, includes 34 elements, with copper and nickel newly added. Latin America plays a crucial role in this supply chain, as 25 of the 34 critical raw materials on the EU's list are extracted in the region. While Brazil stands out as the leading supplier of critical raw materials from Latin America to the EU, Chile dominates lithium refining, providing 79% of the EU's supply. (Jütten, 2024) The Anglo-Australian Rio Tinto and the French Eramine are the two leading European mining companies operating in the Lithium Triangle, with a strong focus on Argentina. As discussed in the following section, Argentina's more open investment policies for lithium extraction have fostered a more diversified portfolio of international stakeholders.

South America has increasingly become a contested region in the global race to secure stable and reliable access to strategic minerals essential for the energy transition. While China remains the dominant partner for the Lithium Triangle countries, both the United States and the European Union have stepped up efforts to strengthen their presence, reflecting growing concerns over Beijing's expanding influence in the region.

Lithium raises critical questions about how the energy transition -driven primarily by the Global North and China- impacts extractive regions in the Global

South, where natural resource exploitation for export remains a key economic activity (Bos & Forget, 2021). This dynamic is reshaping global geopolitics, as state actors and transnational corporations renegotiate access to these vital resources. Once again, the strategic competition for territorially concentrated resources in the Global South underscores the broader struggle for control over the foundations of the energy transition.

3. Domestic regulatory frameworks in Argentina, Bolivia, and Chile: impacts on regional integration and development

Efforts to foster deeper cooperation or forge a productive alliance between Argentina, Bolivia, and Chile in lithium exploitation face significant institutional challenges stemming from disparities in their legal systems. In Bolivia, the pathway to cooperation may be comparatively straightforward, as the state exercises comprehensive control over lithium ownership, access, exploitation, extraction, and production. In Chile, although the state retains considerable ownership of lithium concessions, a legal framework allows for contracts with private companies. In contrast, in Argentina, lithium is exploited through concessions held by private enterprises, often involving international capital, while the provinces maintain original ownership of natural resources within their territories, as stipulated by Article 124 of the 1994 National Constitution. (Rubiolo & Fiore Viani, 2024)

Unlike Chile and Bolivia, both unitary states, Argentina's federal structure grants provinces exclusive, non-delegable powers alongside shared competencies with the federal government. Article 75, Clause 12 of Argentina's National Constitution authorizes Congress to enact foundational legislation, such as the Mining Code, while preserving local jurisdictions. Provinces retain authority to regulate procedural aspects of resource management.

Argentina's Mining Code, established by Law 1919, outlines the rights, obligations, and procedures for

acquiring, exploiting, and utilizing mineral resources. The Code treats mines as distinct legal entities, with metallic minerals exploitable only under concessions granted to individuals or entities by the relevant authorities. These concessions define terms such as duration, guarantees, royalties, and compliance with technical and environmental standards. Furthermore, Law 24.196 on Mining Investments offers incentives for exploration and exploitation, including a 30-year tax stability period for new or expanded projects and exemptions from customs duties on imported equipment. While these measures have attracted foreign investment, they have been criticized for being overly favorable to companies, with calls for greater contributions to national economic and social development (Moscheni & de la Torre, 2017).

In Bolivia, lithium exploitation is governed by Law No. 535 (Ministry of Mining and Metallurgy, 2014), commonly known as the "Lithium Law," which designates lithium and other evaporitic resources as strategic assets and state patrimony. This law permits private sector participation only through joint ventures with public enterprises. Additionally, Law 928 established Yacimientos de Litio Bolivianos (YLB), a state-owned company tasked with overseeing lithium production (FAO, 2019). Bolivia's legal framework mandates that exploration, exploitation, industrialization, and commercialization of these resources be conducted by the state, either directly or through public entities under the supervision of the Ministry of Energy. Furthermore, the legislation emphasizes environmental protection and community rights, ensuring that local populations benefit from lithium-related activities.

In the case of Chile, as stated in the National Lithium strategy launched in April 2023, the legal status of this mineral is an exception in the country's mining concession system. The main legal background is based on Law Decree No. 2,886 of 1979, through which Chilean legislation reserved lithium for the State, rendering lithium reserves non-concessionable. This regulation is also enshrined in Law No.

18,097 of 1982 and the Mining Code of 1983. Minerals that cannot be concessioned can only be explored or extracted through one of the mechanisms established by Chile's Constitution in article 19, No. 24, section 10. (Government of Chile, 2023)

As Perotti & Coviello (2015) point out, the new Organic Constitutional Law established that lithium is a state-owned resource in Chile and explicitly stipulated that the exploration or exploitation of non-concessible substances, such as lithium, could only be carried out directly by the Chilean State, its entities, or through administrative concessions and special operation contracts, subject to the specific requirements and conditions set by the President of Chile. Additionally, the law assigned regulatory oversight of the mineral to the Chilean Nuclear Energy Commission.

Lithium was originally granted this unique status in Chilean legislation due to its role in nuclear energy generation, as established by Law No. 16.319. Furthermore, as highlighted in the 2015 report by Chile's National Lithium Commission, lithium plays a crucial role in the ongoing global energy transition, which relies on non-conventional renewable energy sources, electric energy storage solutions, and electromobility. More recently, and as part of the National Lithium strategy under Gabriel Boric's presidency, the government has defined that state-owned entities will play a major role in the entire production cycle of lithium and proposed the creation of a National Lithium Company to coordinate future public-private partnerships. (Government of Chile, 2023)

Regarding fiscal frameworks governing lithium extraction in Argentina, Bolivia, and Chile, there are key differences that shape regional policies and investment dynamics in the lithium sector. Argentina maintains a relatively moderate taxation structure, with a 3% provincial royalty on the mine-mouth value (equivalent to 1.6% of sales revenue) and export duties set at 4.5% of the free-on-board (FOB) value since 2021. Additionally, financial transactions

are subject to an ITF tax of 0.6%, while distributed dividends incur a 7% tax. Bolivia, in contrast, imposes a more complex and heavier fiscal burden, including an additional 25% rate after deducting 33% of accumulated investments and 45% of net income, plus a surcharge of 12.5% (yet to be specified for lithium), alongside a 3% mining royalty on export value.

Chile stands out for its progressive royalty system, where rates range from 6.8% to 40% depending on lithium carbonate prices, and a Specific Mining Tax (IEAM) that varies between 4.8% and 12.3% based on operational margins. Additionally, Chile requires a 1% regional development contribution on investments during the first five years. (ECLAC, 2023) These variations in taxation and royalties influence each country's attractiveness to investors, shape national strategies for lithium governance, and impact broader regional discussions on balancing economic benefits with resource sovereignty.

In summary, the three Lithium Triangle countries differ significantly in their mineral ownership structures and regulatory frameworks for exploration, extraction, and export. These differences complicate efforts to establish a unified regional lithium policy while simultaneously fueling intra-regional competition as countries seek foreign investment and infrastructure to develop their industries. This dynamic further reinforces the asymmetric relationship between South American lithium producers and their external partners.

Proposals have emerged, particularly from academic circles in South America, to create a lithium-exporting organization modeled after OPEC (Zicari & Fornillo, 2017). However, such an initiative faces significant challenges, including regulatory disparities, the diverse political orientations of member states, and, in Argentina's case, the provincial control over lithium resources, which contrasts with Bolivia and Chile's more centralized approaches. These factors present major obstacles to deeper regional integration in the lithium sector.

Despite these challenges, Chile and Argentina have taken initial steps towards cooperation. In June 2022, both countries established a Binational Working Group on Lithium and Salt Flats (Argentinian Ministry of Foreign Relations and Trade, 2022). According to the Memorandum signed in November 2023 to formalize the initiative, the group aims to: 1. Enhance the value of lithium extraction by improving purity levels and promoting the use of more sustainable production technologies and, 2. Integrate into global value chains by advancing participation in industrial production processes (Chilean Ministry of Foreign Relations, 2023). While not a fully regional initiative, if sustained, this collaboration could mark an important step toward strengthening South America's position in the global lithium market.

4. Prospective scenarios and policy recommendations

Lithium will remain central as a critical energy mineral in the coming years, driven by the growing demand associated with the energy transition and the intensifying global race for access to strategic resources. While currently the lithium market remains in surplus, in part as the result of an oversupply driven by the maturation of several major lithium projects in Australia and Zimbabwe among other countries, lower-than-expected electric vehicle sales, and China's economic slowdown, structural and longer-term trends continue to make the lithium market an attractive one. (Argentinian Secretary of Mining, 2025)

Regarding the global competition for critical minerals, particularly between China and the United States and the EU, it will continue to show a strong impact on South America. This dynamic delineates a scenario that reinforces the role of the countries in the Lithium triangle as mere exporters of raw materials, hindering local industrialization and keeping them in the least developed segments of the lithium value chain.

Regional cooperation is considered one of the main tools to face these competitive dynamics and to

expand the room for maneuver of South American states in international negotiations. But several conditions hinder this path. On the one side, institutional factors further complicate regional cooperation. Differences in legal frameworks and political organization across the three countries influence how lithium is treated as a strategic resource and result in varying degrees of authority between national and subnational governments. Additionally, the three countries follow different trajectories of international economic integration and adopt distinct development models. While Chile and Bolivia have economies heavily reliant on raw material exports, Argentina has a more diversified productive structure, with a moderately developed industrial sector focused largely on the regional market. These structural and political asymmetries limit the possibility of coordinated strategies for lithium industrial development.

To address these challenges, three lines of action are proposed to strengthen regional cooperation. First, declaring lithium a strategic resource in Argentina would enable the national government to play a stronger role in its regulation and open the door to more effective coordination with Bolivia and Chile, without infringing upon the constitutional rights of the provinces.

Second, the creation of a permanent dialogue platform, bringing together regional and extra-regional stakeholders involved in the lithium industry. Such a space would foster sustained multi-level and multi-actor communication, encourage knowledge sharing, define joint development agendas that integrate economic, social, and environmental dimensions, and produce regular technical reports on the lithium value chain as part of a shared regional agenda.

Finally, promote regionally coordinated projects that link the lithium industry with strategic sectors such as electromobility and battery production. Initiatives like Argentina's proposed Sustainable Mobility Law, which includes incentives for the production and purchase of electric vehicles, could be

aligned with the region's existing automotive infrastructure to add value to lithium, boost high-tech exports, and attract new investments to expand the region's productive capacities. In this context, the already strong cooperation between Argentina and Brazil could serve as a strategic bridge connecting the Lithium Triangle countries with Brazil's growing lithium battery sector. (De Tomi et al, 2024).

CONCLUSIONS

From a development perspective, the lithium boom is often framed as an opportunity for economic growth and modernization in South America. However, the dependency framework introduces caution, emphasizing the historical context of resource exploitation in the region. As discussed earlier, dependence on lithium extraction risks perpetuating a neocolonial dynamic with global markets, especially as a few key Asian countries dominate the supply chain, concentrating the bulk of battery production. This dependency can limit local autonomy and reinforce unequal economic power dynamics.

Svampa (2019) introduced the concept of the "commodities consensus" to describe the large-scale export of primary goods, economic growth, and increased consumption driven by neo-extractivism. She argued that the rising prices and demand for commodities gave rise to another phenomenon: the "developmentalist illusion." According to Svampa, both progressive and conservative regional governments believed that these economic opportunities could help bridge the gap with industrialized nations and achieve development. However, the substantial revenues generated by these exports have, in practice, further discouraged the growth of national industries and reinforced an unfavorable trade dynamic for South America (Slipak, 2012). Industrial policy remains largely absent across most countries in the region, and where it does exist, it is primarily defensive, limiting the ability to adapt to new technological models (ECLAC, 2016).

Without medium- and long-term policies oriented towards industrialization or value-added processes

of lithium, the already consolidated extractive dynamics will further reinforce South America's dependent international insertion. Even though the prospects for lithium demand are expanding, intensifying the concentration on commodity production and export also raises the state's vulnerability to external changes many times and, at the same time, decreases its margin of economic, commercial and political autonomy. Furthermore, following Dussel Peters & Armony (2018), this insertion model strengthens the foreign direct investment (FDI) presence which focuses on the extraction of natural resources or their basic processing, reinforcing the specialization pattern of the region and making the development of low technological content activities stronger.

Finally, only a regionally coordinated policy, one that balances domestic capacities and legal frameworks while identifying shared needs and opportunities, can enable the Lithium Triangle to break away from the extractive patterns that have historically constrained its economic development and global integration. A regional lithium value chain, integrating Argentina, Bolivia, and Chile with Brazil's emerging EV industry, represents a viable path forward.

Achieving this requires institutional harmonization among Lithium Triangle countries and the establishment of a regional collaboration platform centered on three key pillars: technological, productive, and financial cooperation. In this evolving landscape, China's recent involvement has shown a positive impact on industrialization, driven by the complexity of its engagement and the nature of its latest investment projects.

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