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Expanding the lithium value chain in Chile

Mining, batteries, and recycling

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EXECUTIVE SUMMARY

Chile's lithium mining industry has grown to supply over one-fifth of the world's lithium demand while providing a less greenhouse gas (GHG)-intensive material than lithium mined from hard-rock sources in other regions. The trajectory of Chile's lithium mining industry is important for both the global battery electric vehicle (BEV) transition and the country's sustainable economic development ambitions.

This report explores the economic potential of lithium mining and estimates the additional revenue and job potential if Chile were to onshore additional parts of the battery production supply chain. The analysis also assesses the GHG emissions intensity, water consumption, and social impacts of lithium mining and battery production in Chile, in addition to opportunities for battery recycling.

Results of this analysis include the following:

Lithium-ion battery demand from BEVs is projected to rise rapidly in Chile. Total battery demand from battery and plug-in hybrid electric vehicles in Chile is estimated to rise from 0.5 GWh in 2024 to 13.0–17.8 GWh in 2030 and to 27.7–38.0 GWh in 2035, depending on the development of average battery sizes of light-duty vehicles. This corresponds to an increase in Chilean lithium demand from vehicles from 44 t in 2024 to 1.1–1.5 kt in 2030 and to 2.3–3.2 kt in 2035.

Lithium production capacity in Chile is expected to increase markedly by the end of the decade. The total announced lithium production capacity in Chile is projected to rise from 42 kt in 2024 to 64 kt in 2030 and 79 kt in 2035. In 2030, 91% of this capacity is projected to correspond to mines already in operation today. In 2024, the gross revenue from Chile's lithium industry was about $2.7 billion. Depending on commodity prices and the realization of announced mining projects, Chile's lithium export revenue is projected to amount to $7.3 billion in 2030 and $8.9 billion in 2035, which correspond to 2.2% and 2.7% of the country's 2024 GDP, respectively.

Expanding Chile's current lithium mining and refining capacities to cathode production can provide considerable revenue and job potential. In 2025, nearly all of the lithium mined in Chile is expected to be refined domestically. The production of cathode material alone could generate up to $1.1 billion in annual revenue in 2030 and $2.2 billion in annual revenue in 2035 when meeting the lithium-iron phosphate (LFP) demand from vehicle batteries in the Latin American market. This would generate about 1.9 times the annual revenue of simply exporting the equivalent amount of lithium carbonate in both years. Furthermore, the onshoring of LFP cathode material production could create 900–1,700 jobs in 2030 and 2,100–3,700 jobs in 2035.

Onshoring battery cell production can provide additional revenue and job potential. Developing each stage of the value chain needed to meet the projected demand for vehicular LFP batteries in Latin America could generate an annual gross product of up to $6.1 billion by 2030 and $12.3 billion by 2035, which correspond to 1.8% and 3.7% of Chile's 2024 GDP, respectively. This could also lead to the creation of 8,600–15,000 direct jobs in the battery value chain in 2030 and 19,000–32,600 jobs by 2035.

Batteries produced in Chile would have a lower life-cycle GHG emission intensity compared with other battery producing regions around the world today. The GHG emission intensity of lithium carbonate from Chilean brine is estimated to be 86% lower than that produced from Australian ore, the other major source of lithium production today, and 67% lower than lithium carbonate produced in the United States. Due to the low GHG emission intensity of sourcing lithium from Chilean brine and the comparatively high share of renewables in the country's electricity mix, the average emission intensity of LFP battery pack production in Chile is estimated to be 35% lower than the average emissions intensity of LFP batteries in China, 16% lower than in the United States, and 9% lower than in Europe.

The lithium mining industry has disrupted communities and raised the cost of living in mining regions, and expanded mining activity could pose environmental risks for local ecosystems. The water consumption of lithium mining from brine in Chile is similar to that of hard-rock mining in other regions but is of higher concern given the aridity of the desert ecosystems where salt flats are located. However, the interconnection between brine extraction and freshwater depletion is not well understood, and further study is needed to understand the long-term impact of lithium production on local ecosystems. Freshwater consumption could be partially mitigated by technological improvements in lithium mines. Furthermore, the government so far has not consistently engaged local communities early in mine consultation processes. International best practices for due diligence requirements and community engagement could provide governance models for the Chilean government to mitigate the social and economic impacts of the lithium mining industry.

Setting up an efficient battery collection and recycling ecosystem in Chile would allow the recovery of valuable minerals and create new jobs. Between 0.5 GWh and 1.2 GWh of vehicle batteries are expected to be retired in Chile in 2040, rising to 6.0–15.1 GWh in 2050. To process this volume of batteries in 2050, between 114 and 317 jobs could be created in a battery recycling industry.

This analysis suggests that implementing various policies could accelerate BEV adoption and increase the benefits of the lithium and battery value chain in Chile. Building upon its adopted vehicle electrification targets, the Chilean government could consider implementing regulations mandating an increase in BEV sales across vehicle segments. This would provide regulatory certainty for automakers, consumers, and charging infrastructure providers that can spur investment in BEV supply. This would have the additional benefit of strengthening a domestic lithium and battery industry.

To expand the domestic lithium value chain, the government could consider implementing targeted incentives for cathode material production, cell manufacturing, and recycling infrastructure. Such incentives could include the expansion of existing provisions in contracts with mining companies to reserve select quotas of lithium at preferential prices for domestic value-adding projects.

The government could also consider mandating reductions in water use and GHG emissions from mines, formalizing its network of protected salt flats, and reforming its mine public consultation process to promote transparency and seek free, prior, and informed consent from affected communities. Such measures would reduce the social and environmental impacts of mines while promoting trust and investor confidence in the Chilean mining industry.

To spur the development of a domestic battery recycling industry, Chile could assign extended producer responsibility for end-of-life vehicle battery collection to vehicle importers and could follow the lead of the European Union in developing an ambitious and comprehensive battery recycling regulation.

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INTRODUCTION

Advances in lithium-ion battery technology alongside a rapid growth of battery and mineral supply chains have enabled the global shift to battery electric vehicles (BEVs). The government of Chile has adopted ambitious vehicle electrification targets to reduce vehicle emissions, mitigate global warming, and enhance the quality of life for Chileans. These targets position Chile as a potential leader of the electric vehicle transition in Latin America.

Chile's lithium mining industry has grown to supply over one-fifth of the world's lithium demand while providing a less greenhouse gas (GHG)-intensive material than lithium mined from hard-rock sources in other regions. The trajectory of Chile's lithium mining industry is thus important for both the global BEV transition and the country's sustainable economic development ambitions.

This report explores how Chile can leverage its vast lithium resources to power the BEV transition, while developing a clean domestic battery supply chain and minimizing the environmental impacts of the mining industry. Further, this study evaluates the benefits of building an efficient battery collection and recycling industry in Chile.

The report is organized as follows. First, we provide background on the policy landscape in Chile and an overview of lithium production and the battery supply chain in the country. We next explore the economic potential from lithium mining and estimate the additional revenue and job potential if Chile were to onshore further parts of the battery production supply chain. We also assess the GHG emission intensity, water consumption, and social impacts of lithium mining and battery production in Chile, in addition to opportunities for battery recycling. We close with policy considerations derived from our analysis.

BACKGROUND

This section provides an overview of transport electrification policies, lithium production, and the battery supply chain in Chile.

VEHICLE ELECTRIFICATION OUTLOOK

Globally, battery electric and plug-in hybrid electric vehicles (PHEVs) made up 17% of all light-duty vehicles (LDVs) sold in the first half of 2024 (Fadhil & Shen, 2024). Chile's light-duty electric vehicle sales share was lower than that in several other emerging vehicle markets in the first half of 2024 (Fadhil & Shen, 2024), with a BEV sales share of 1.3% and a PHEV sales share at 0.3% (ANAC, 2024a, 2024b). Nevertheless, Chile's electric vehicle market is expanding rapidly, with BEV sales growing 133% and PHEV sales growing 99% in the first quarter of 2025 compared with the first quarter of 2024 (ANAC, 2025).

Chile has adopted a BEV policy platform centered around the new vehicle sales targets presented in the National Electromobility Strategy. Adopted in October 2021, the strategy targets that 100% of new sales of light- and medium-duty vehicles and urban buses be zero-emission vehicles, including BEVs and fuel-cell electric vehicles (FCEVs), by 2035 (Pettigrew, 2022). Heavy-duty freight vehicles and interurban buses have a target of 100% zero-emission sales by 2045.

The Chilean government has also adopted several complementary policies to support the transition to electric vehicles. The Energy Efficiency Law (No. 21305) set corporate average fuel economy targets for new vehicles (Pettigrew, 2022). Under this law, the average energy consumption of new vehicles sold by an original equipment manufacturer or importer must comply with standards that gradually increase in stringency. The law includes provisions enabling importers to count sales of BEVs, PHEVs, and FCEVs three times toward their fleet-average efficiency, incentivizing importers to increase their supply. These standards went into effect for light-duty vehicles in 2024 and are slated to go into effect for medium- and heavy-duty vehicles in 2026 and 2028, respectively.[1] The Energy Efficiency Law further empowers the Ministry of Energy to set requirements for charger interoperability and accessibility, which were formalized in regulations in October 2024 (Resolution No. 27547).

The Energy Storage and Electromobility Law (No. 21505), adopted in 2022, exempts owners of new BEVs, FCEVs, and PHEVs from paying annual vehicle registration taxes for 2 years, and partially thereafter for 6 years. This law also facilitates the integration of BEV batteries as energy storage equipment into the electricity grid, enabling BEV owners to generate revenue from vehicle-to-grid services. Further, the Climate Change Framework Law (No. 21455), adopted in 2022, sets a framework for institutional arrangements for long-term climate adaptation and mitigation in line with Chile's Nationally Determined Contribution towards meeting the targets of the Paris Agreement. The Law includes sectoral mitigation plans, including plans for the mining and transport sectors (OECD, 2024).

Chile is one of 31 national governments that have signed the Zero Emission Vehicles Declaration (Accelerating to Zero Coalition, 2023), which aim to allow only the sale of new cars and vans that are zero-emission by 2040. It is also one of 15 initial signatories

1 Notably, different from other regions, Chile defines light-duty vehicles as having a gross vehicle weight of below 2,700 kg, medium-duty vehicles from 2,700 kg to 3,860 kg, and heavy-duty vehicles above 3,860 kg.

of the Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-duty vehicles, which aims to achieve 100% zero-emission vehicle sales for new trucks and buses by 2040 (Global Commercial Vehicle Drive to Zero, 2024). Chile's targets for light- and medium-duty vehicles align with the Zero Emission Vehicles Declaration, and its 100% ZEV target for heavy-duty trucks and interurban buses is 5 years after the Global Memorandum of Understanding target of 2040.

MINERAL RESERVES AND LITHIUM PRODUCTION IN CHILE

The global vehicle electrification trend has been made possible by an improvement in performance and reduction in cost of lithium-ion batteries over the last two decades (BloombergNEF, 2024). Lithium, a central material in this type of battery, enables high energy densities, which allow vehicles to travel several hundred kilometers on a single charge. Today, 53% of global lithium demand comes from BEVs and PHEVs, and this is projected to grow to 73% in 2030 and 83% in 2040 (International Energy Agency [IEA], 2025). The uptake of BEVs and PHEVs is thereby driving an increase in global demand for lithium.

Home to 31% of global lithium reserves (~9.3 million tonnes) and 20% of global production (U.S. Geological Survey, 2025), Chile plays a central role in producing the lithium required for the global electric vehicle battery market. Reserves refer to the estimated resources of a mineral that are considered economically recoverable at the time of classification. Considering estimated global lithium resources—which include all concentrations of materials from which extraction is potentially economically feasible—Chile's relative share is small, at only 10%.

Lithium resources in Chile are primarily located in subsurface brines in the Atacama salt flat. Smaller deposits exist in the form of lithium-containing clays and geothermal deposits. In 2023, nearly all of the lithium mined in Chile was refined domestically; of this, 82% was processed into lithium carbonate, 11% was processed into lithium hydroxide, and the rest was processed into lithium sulfate (Benchmark Mineral Intelligence [BMI], 2024b). Both lithium carbonate and lithium hydroxide refined in Chile are battery-grade and can be directly used in cathode material production.

Lithium production in the Atacama salt flat has steadily increased each year since 2020, with production in 2024 and 2025 projected to reach 252 kt and 282 kt of lithium carbonate equivalent, respectively (BMI, 2024b). Of the lithium carbonate produced in Chile, 86% was exported in 2023, amounting to US$5.4 billion, which corresponded to 1.6% of the country's GDP the same year (COCHILCO, 2024a; International Monetary Fund, 2025). The total value of exports of all lithium products in 2023, which were primarily exported to China and South Korea, amounted to US$7.8 billion (COCHILCO, 2024b).

Home to 19% of global reserves, Chile is also the world's largest copper producer, supplying 23% of the world's copper in 2024 (U.S. Geological Survey, 2025). The copper exported corresponded to 45% of the country's export value in 2023 (COCHILCO, 2024a). Due to its high electrical conductivity, copper is a key component in electric vehicle motors, wiring, inverters, and batteries. However, since BEVs are projected to continue corresponding to a minor share of copper demand—6% of the end uses of copper production globally in 2030 and 12% in 2040 (IEA, 2025)—this study focuses primarily on lithium mining.

EXPANDING THE LITHIUM SUPPLY CHAIN IN CHILE

National Lithium Strategy

In 2023, the Chilean government established a vision for the development of Chilean lithium resources in its National Lithium Strategy (Gobierno de Chile, 2023). This document outlines supply chain development and social, environmental, and fiscal sustainability objectives for the industry. It further defines the role of the government in lithium exploration and mine operations, which are undertaken by two state-owned mining companies—Codelco and Enami—which develop public-private partnerships with private sector companies, and regulatory oversight, which is managed by Chile's State Economic Development Agency (CORFO). The government is also expanding mining data collection and hiring technical experts with the aim of increasing the state's leverage to maximize public revenue in mine contract negotiations and strengthening the government's role in developing industrial policy and social and environmental regulations. The strategy document also establishes the institutional framework for public-private partnerships, regulatory decision-making, and stakeholder engagement, especially regarding indigenous communities living near salt flats.

In addition to the objectives listed above, the National Lithium Strategy aims to foster mining technology development and the diversification of companies operating in the lithium value chain. These goals are intended to promote the growth of domestic industry and generate jobs, while advancing the technologies needed for climate-neutral economies.

Several initiatives announced in the Lithium Strategy have been launched. In 2024, the Ministry for the Environment proposed a network of 27 salt flats and lagoons to be officially protected (Ministerio del Medio Ambiente, 2024). In early 2025, the government launched the National Institute of Lithium and Salt Flats with the mission of generating, applying, and disseminating knowledge and technology related to the sustainable management of lithium production from salt flats (Ministerio de Ciencia, Tecnología, Conocimiento e Innovación, 2025).

The Chilean government has also set several goals for reducing the environmental impact of the lithium mining industry. The Chilean National Mining 2050 Strategy focuses on three key pillars: renewable energy, water management, and carbon neutrality (Ministerio de Minería, 2021). In 2023, 49% of mining energy came from renewables, and a goal is to reach 100% by 2050. The policy also aims to reduce surface water usage to below 10% of water consumption by 2025 and below 5% by 2040. Additionally, the sector has a carbon neutrality target for 2040.

Operational lithium mines and ongoing consultation processes

The world's first and second largest lithium producers, Sociedad Química y Minera de Chile (SQM) and Albemarle Chile, have lease agreements with CORFO to extract lithium in the Atacama salt flat. SQM, whose prior contract was set to expire in 2030, signed a deal in 2024 to grant majority control of its operations to state-owned mining company Codelco in exchange for the rights to increase lithium production in the Atacama salt flat through 2060 (Solomon & Cambero, 2024). Albemarle's current contract runs through 2043, and the company is in discussions with Codelco to negotiate a new contract.

In 2024, the Ministry of Mining solicited interest from private domestic and international companies to develop lithium deposits outside of the Atacama salt flat (Ministerio de

Hacienda, 2024a). After this consultation process, CORFO announced the designation of 12 sites for which a simplified tender and selection process for the assignment of contracts would be initiated in December 2024 and January 2025 to speed up the development of the most promising deposits (Ministerio de Hacienda, 2024b, 2024c). Six of the sites with lithium-containing clays and geothermal sources were prioritized to advance innovative projects using non-traditional brine extraction methods.

THE EMERGING BATTERY SUPPLY CHAIN

As part of its National Lithium Strategy, the Chilean government announced the objective of expanding the types of battery supply chain industry projects that take place in the country. Chile currently has lithium mining and refining operations but does not have cathode and anode production, cell production, battery pack and module assembly, or vehicle production. Broadening its industry to encompass more stages of the battery supply chain would provide Chile the opportunity to increase battery-related economic activity beyond lithium mining and refining.

To attract mid-stream battery investments, CORFO has negotiated a provision, as part of their mine contract with SQM, for the latter to provide preferential lithium access and pricing agreements with companies willing to develop cathode production facilities in Chile. Yongqing Technology Co. Ltd signed an agreement with CORFO in 2023 to develop a lithium-iron phosphate (LFP) cathode plant with production capacity of 120,000 tonnes per year (Benchmark Source, 2023). Although it has since been cancelled (Reuters, 2025), this plant would have received lithium carbonate at preferential prices from SQM until 2030. As of June 2025, there are no battery cell or electric vehicle manufacturing plants announced in Chile.

OVERVIEW OF BATTERY RECYCLING IN CHILE

Collecting and recycling the batteries of end-of-life vehicles helps to avoid environmental contamination from batteries ending up in landfills. Prior to their recycling, a large portion of the batteries collected can be used in second-life applications such as household, industry, or grid storage. Developing battery recycling capacity can recover key battery minerals from end-of-life vehicle batteries for use in new batteries, while also developing jobs and economic activity (Tankou et al., 2023).

As of October 2025, the Chilean government is developing an extended producer responsibility battery regulation (Law 20920) that mandates minimum collection rates for lithium-ion batteries. It is currently unclear whether the burden of responsibility for collecting end-of-life batteries would fall on vehicle importers or the Chilean representatives of vehicle manufacturers. The law is expected to enter into public consultation in January 2026.

ECONOMIC POTENTIAL FROM THE BATTERY SUPPLY CHAIN IN CHILE

BATTERY DEMAND PROJECTION AND ANTICIPATED SUPPLY

Demand projection in Chile, Latin America, and globally

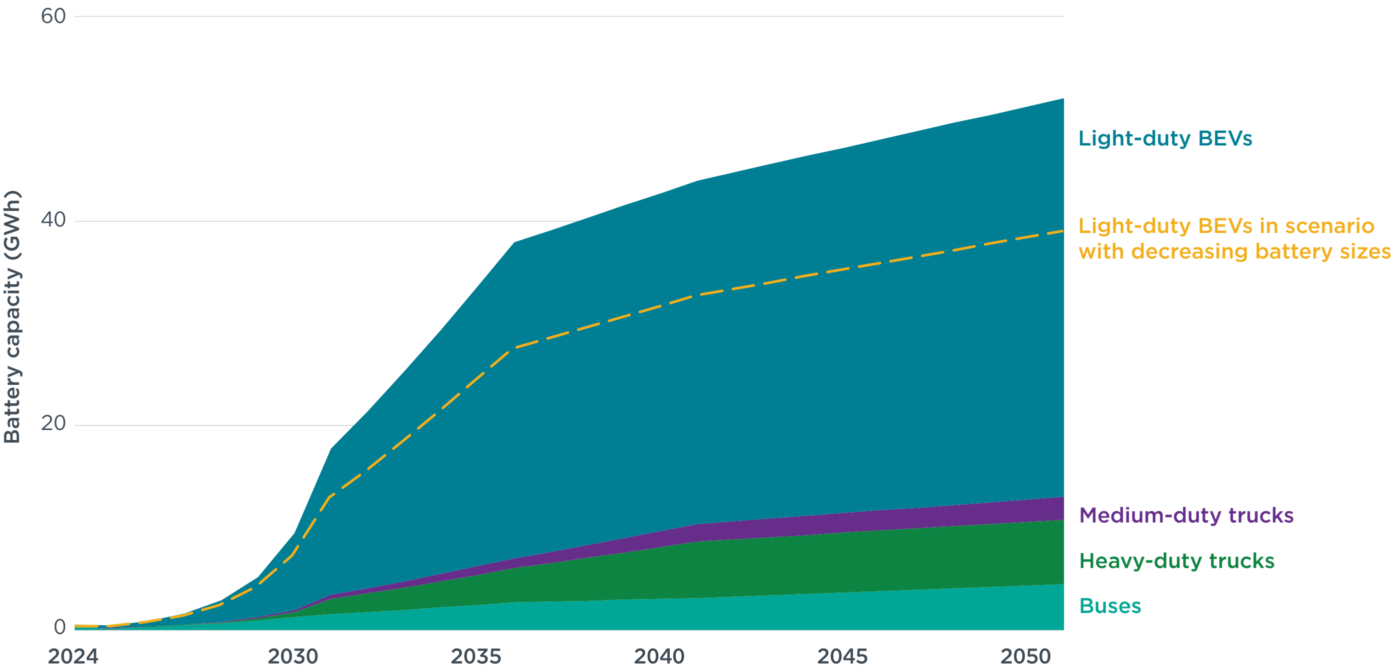
This analysis estimates the demand for batteries and lithium from the implementation of Chile's adopted and announced vehicle electrification policies and targets. Specifically, this analysis evaluates the battery and lithium demand resulting from a pace of BEV and PHEV uptake in line with reaching the 2035 100% ZEV sales targets for LDVs and buses in the National Electromobility Strategy and the energy efficiency targets for passenger cars and light-commercial vehicles in the Energy Efficiency Law. As Chile is a signee of the Global Memorandum of Understanding on HDVs, this analysis also considers a 100% ZEV sales target for new HDVs by 2040 (Global Commercial Vehicle Drive to Zero, 2024).

Because the targets in the National Electromobility Strategy and in the international commitments listed above are non-binding, new regulations mandating an increase in the sale of BEVs would likely be necessary for the targets to be met. The projected rates of BEV adoption corresponding only to the already adopted regulation (the Energy Efficiency law) are listed in Table A3 in the appendix.

The battery and mineral demand projection conducted in this analysis involves a chain of calculation steps equivalent to the methodology used by Li et al. (2024). A detailed explanation of the data sources and methodology used in this analysis can be found in the appendix, including the projected vehicle sales of all powertrain types (Table A1), projected BEV and PHEV shares for different vehicle segments corresponding to adopted and announced vehicle electrification policies and targets (Table A2), average battery capacities for different vehicle segments in 2024 and those assumed for 2030 (Table A4), and the market shares of different battery technologies in BEVs and PHEVs (Figure A1).

Assuming that light-duty BEV battery sizes continue to grow (Li et al., 2024), resulting in an increase in average battery capacities of battery electric LDVs of 20% between 2024 and 2030, this analysis projects that battery demand for all on-road vehicles in Chile will rise from 0.5 GWh in 2024 to 17.8 GWh in 2030 and to 38.0 GWh in 2035. In a scenario in which the battery capacity of battery electric LDVs decreases by 20% between 2024 and 2030, the total battery demand for vehicles would increase to 13.0 GWh in 2030 and 27.7 GWh in 2035. The battery capacity demand for on-road vehicles by segment is shown below in Figure 1.

Figure 1
Annual battery demand for on-road vehicles in Chile by segment



Note: The shares of battery demand from two- and three-wheelers and light-duty PHEVs are negligible and too small to appear in the figure.

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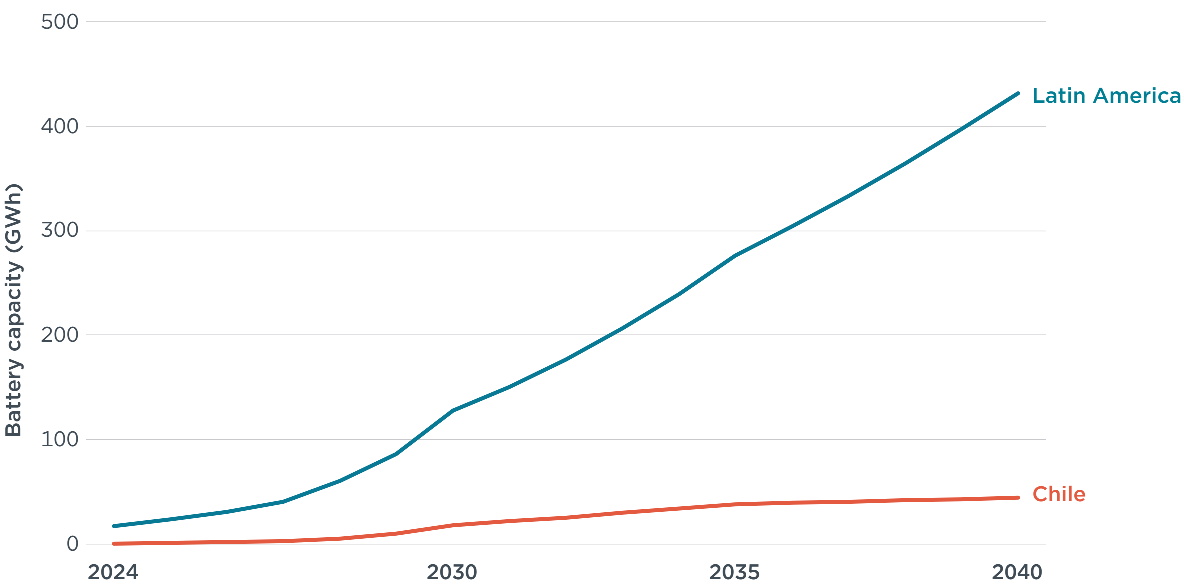
In Chile, the battery demand from plug-in hybrid electric LDVs is projected to be negligible, at 28 MWh in 2024 and 56 MWh in 2030, before PHEV sales are assumed to fall to zero in 2035 to align with the 100% zero-emission sales target. Similarly, the battery demand from electric two- and three-wheelers in Chile is projected to correspond to a minor share of overall vehicular battery demand, rising from 4 MWh in 2024 to 16 MWh in 2030 and 60 MWh in 2040.

For non-vehicular battery demand, this analysis excludes battery energy storage system (BESS) installations in Chile from our demand estimate due to a lack of data on projected future installations. However, data from the Ministry of Energy provide an estimate of the scale of BESS installations in relation to BEV demand (Ministerio de Energía, 2025). As of January 2025, Chile's Ministry of Energy reported 3.3 GWh of operational BESS capacity, which was projected to rise to 4.1 GWh by March 2025. Including projects under construction, in testing, and those that are already operational, the total potential capacity reaches 8.5 GWh. Furthermore, if projects under assessment are considered, the potential capacity would increase by an additional 27.3 GWh (Ministerio de Energía, 2025). In April 2025, the Energy Ministry announced the government is aiming for 6 GW of installed BESS capacity by 2030 (Ruddy, 2025). If realized, this capacity would add a significant amount of battery capacity demand to that from vehicles alone. The battery demand for portable electronics is omitted due to a lack of available Chile-specific data. On a global scale, BMI projects the share of battery demand from portable devices to decline from 5% in 2025 to 3% in 2030 and 1% in 2040 (BMI, 2024c). Their contribution to the total battery demand is thus considered negligible.

Given that the Latin American BEV market could become an export destination for Chilean battery producers or midstream actors in the battery value chain, this analysis projects battery demand for the entire region. In Latin America, battery demand from vehicles is projected to rise from 17.4 GWh in 2024 to 96.6–127.5 GWh in 2030 and to 206.5–275.7 GWh in 2035, depending on the development of the average battery size in battery electric LDVs. Considering only vehicular battery demand, the Chilean market therefore corresponds to 13%–14% of Latin American demand in both 2030 and 2035. The projected battery demand in Chile and Latin America in a scenario in which LDV battery sizes increase between 2024 and 2030 is displayed in Figure 2.

Figure 2

Annual battery demand for on-road vehicles in Chile and Latin America



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Li et al. (2024) projected that the global battery demand from all sectors will rise from 808 GWh in 2023 to 3.8 TWh in 2030 and 5.9 TWh in 2035, assuming an increase in LDV battery sizes. In 2030, the Chilean market alone is projected to correspond to only 0.5% of the global demand.

Battery production in Chile and globally

The onshoring of battery production beyond mining would enable Chile to develop an industry to supply the BEV transition and to reap more economic value out of domestic mineral resources. As of July 2024, however, there have been no announcements of battery production facilities in Chile (BMI, 2024c). Current and announced projects for lithium and cathode active material (CAM) production are described further below.

On a global level, both the total announced cell production capacity and the proportion of this capacity that is considered highly probable are projected to exceed the projected global road transport and non-vehicular battery capacity demand. Even when only considering the capacities of plants already operational in 2024 and those categorized by BMI to be highly probable to reach their listed capacities, the battery cell production capacities are projected to exceed demand by 30% in 2030 (Li et al., 2024). However, producing batteries in Chile has several advantages over production in other regions, including inexpensive lithium production with a low GHG footprint, a comparably high share of renewables in the electricity mix, and existing favorable trade agreements with major vehicle producing countries.

LITHIUM DEMAND PROJECTION AND ANTICIPATED SUPPLY

Lithium demand in Chile and globally

The growing demand for electric vehicle batteries entails a significant increase in the demand for battery-grade lithium. In Chile, in a scenario in which recent trends in the market shares of vehicle battery technologies continue, this analysis projects domestic lithium demand from vehicles to rise from 44 t in 2024 to 1.1–1.5 kt in 2030 and to 2.3–3.2 kt in 2035. The range of demand estimates reflects possible increases and decreases in the average battery size of battery electric LDVs. Details on the assumed development of the mix of battery technologies and material intensities are provided in the appendix.

In Latin America, the vehicular demand for lithium for BEV and PHEV batteries is projected to increase from 1.6 kt in 2024 to 8.3–11.0 kt in 2030 and 17.7–23.7 kt in 2035.

On a global level, under a scenario in which announced vehicle electrification targets are met and in which the average capacity of LDV batteries continues to increase, lithium demand from all sectors of road transport, including medium- and heavy-duty trucks, buses, and two- and three-wheelers, is projected to reach 359 kt in 2030 and 534 kt in 2035 (Li et al., 2024). The implementation of ambitious battery recycling policies globally could reduce this lithium raw material demand to 358 kt in 2030 and 527 kt in 2035. Reducing the average size of LDV batteries would result in a lower lithium demand of 257 kt in 2030 and 377 kt in 2035.

In its Announced Pledges scenario, the IEA (2025) projects lithium demand from stationary energy storage to rise to 44 kt in 2030 and demand for other uses to rise to 90 kt. Demand for these sectors is projected to rise to 57 kt and 109 kt in 2035, respectively. Global lithium demand from all sectors is thus projected to rise to 391–493 kt in 2030 and 543–700 kt in 2035.

As evaluated by Li et al. (2024), projected global lithium demand could be significantly altered if lithium-free sodium-ion batteries were to gain a large market share of electric vehicle batteries. Different scenarios for the development of the market shares of lithium-ion battery cathode materials, however, are found to only have a limited impact on lithium demand.

Lithium production capacity in Chile and globally

This report analyzes lithium production capacity data from BMI, which includes mine projects announced as of March 2025 (BMI, 2025b). This analysis considers the potential total capacity of mines operating at full utilization rates and includes reductions due to yield losses and disruptions of 10%–18%. These corrections account for factors such as natural variation in material quality and unforeseen events that influence supply, such as extreme weather. For lithium production projects in Chile, mining and refining plants are typically integrated.

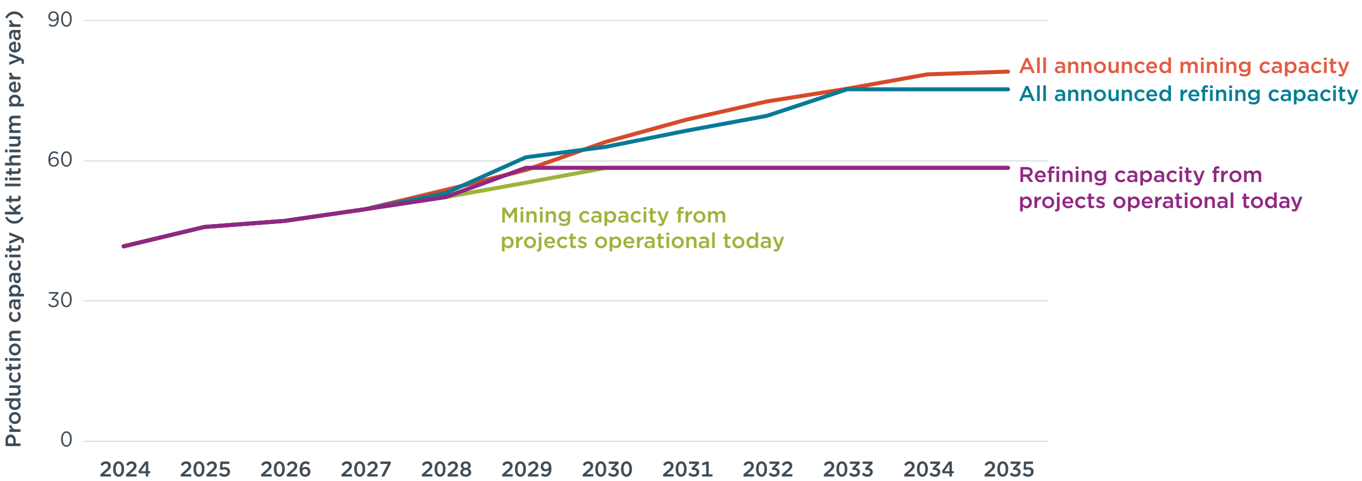
As displayed in Figure 3, the total announced lithium production capacity in Chile rises from 42 kt in 2024 to 64 kt in 2030 and to 79 kt in 2035 (BMI, 2025b). All announced lithium refining capacity in Chile reaches 63 kt in 2030 and 75 kt in 2035, suggesting nearly all lithium mined is expected to be refined domestically. When only considering the mines and refineries that are already in operation, both mining and refining capacity increase from 2024 levels to 58 kt in 2030 and remain roughly constant thereafter. Of all announced production capacity in 2030, 91% comes from mines currently in operation.

Direct lithium extraction (DLE) projects in Chile are expected to start output in 2028, and their announced combined production capacities are projected to make up 18% of all announced lithium production capacity in 2035 (BMI, 2025b).

All the announced lithium mining capacity in Chile could meet 13% of projected global demand in 2030 and 11% in 2035. In contrast, the lithium supply capacities in Chile significantly exceed domestic demand; the domestic demand from vehicles corresponds to approximately 0.1% of all operational production capacity in 2024 and 2.4% in 2030 in the highest demand scenario.

Figure 3

Announced lithium mining and refining capacity in Chile



Data source: BMI (2025b)

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According to BMI, all announced global lithium mining capacity will reach 556 kt in 2030 and 850 kt in 2035 (BMI, 2025b). These mining capacities exceed the projected global lithium demand of up to 493 kt in 2030 and up to 700 kt in 2035 (Li et al., 2024). However, because the capacities of expanding mines that are already operational as of 2024 are projected to only reach 285 kt in 2030, we project that meeting this demand would require additional mines. All announced lithium refining capacity globally is projected to reach 539 kt in 2030 and 767 kt in 2035, also exceeding the projected demand in both years. Considering only the capacities of plants currently in operation and plants classified by BMI to be highly probable, these amount to 299 kt of refining capacity in 2030 and stay roughly constant thereafter. Announced refining capacity is projected to be lower than mine production capacity after 2029. As lithium refineries typically have much shorter lead times than mine projects, with refinery development ranging from 12–24 months (Schmidt, 2022), it is likely that refineries could be built quickly to meet refining demand, if needed.

This analysis indicates that Chile's planned lithium production capacities far exceed domestic lithium demand. The excess production capacity can either be exported or fed into a domestic battery supply chain before being exported. BMI estimated SQM's Atacama salt flat mine and refinery lithium carbonate production costs to be lower than the costs of 79% of lithium carbonate produced globally in 2024 (BMI, 2024e). Given its lower production costs, it is likely that SQM's planned lithium production in the Atacama salt flat will remain competitive and continue to be exported in the future, even in low lithium price scenarios (BMI, 2024e). Albemarle's Atacama salt flat lithium production costs are estimated to be lower than 43% of global lithium production but to remain below average production costs, suggesting they are more sensitive to price declines than those of SQM (BMI, 2024e).

ECONOMIC OPPORTUNITY FROM CREATING DOMESTIC MATERIAL SUPPLY CHAINS AND BUILDING BATTERY MANUFACTURING CAPACITIES

The objectives outlined in the National Lithium Strategy include balancing growing lithium production with social and environmental sustainability and promoting supply chain development to stimulate economic growth beyond mineral production. The growing BEV and PHEV market offers Chile an opportunity not only to leverage its vast mineral reserves but also to grow and diversify its economy and create jobs with the development of downstream battery supply chain activities. These include CAM production, anode production, electrolyte and separator production, battery cell production and pack assembly, and battery collection and recycling.

Building revenue from the battery supply chain

To estimate the economic growth potential for Chile, this analysis first evaluates the potential revenue solely from lithium mining and refining. As displayed in Figure 4, the evaluation distinguishes between two types of lithium export revenue: revenue from expanding production capacity at currently operational mines, and revenue from all announced mines. All values in the figure, and in the remainder of this report, are in U.S. dollars. For both capacities, the figure estimates the revenue based on BMI price forecasts through 2035 and based on 2024 prices, assuming they remain constant.

Building revenue from expanded lithium production

This analysis of the revenue from lithium production uses market prices for lithium carbonate and lithium hydroxide from BMI (2025b). The average price of lithium carbonate in 2024 was about $12,245/t, and the average price of lithium hydroxide was about $12,101/t (BMI, 2024f). Based on BMI data (2025a), this analysis assumes 60% of lithium sulfate and 100% of lithium chloride is converted into lithium hydroxide and sold at lithium hydroxide prices. Chile's 2024 gross revenue from lithium production is estimated to be about $2.7 billion.[2]

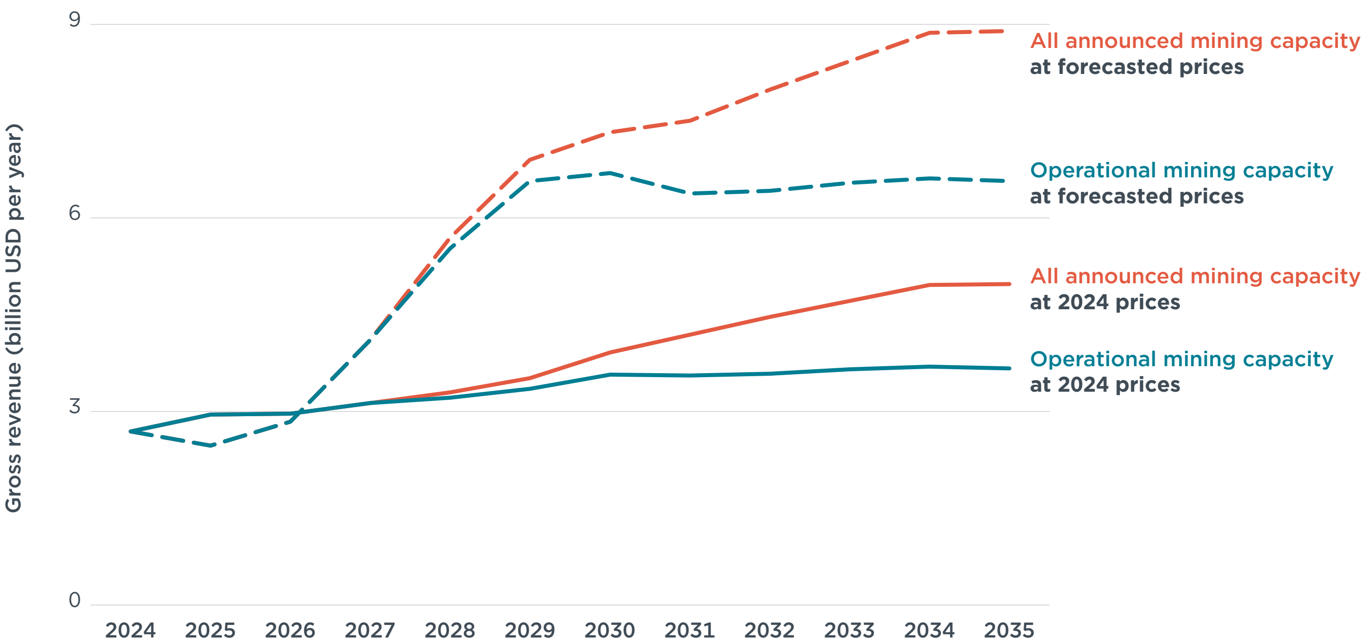
At 2024 global average prices, revenue from all announced mines is projected to rise to $3.9 billion in 2030 and $5.0 billion in 2035. The revenue from the expansion of currently operational mines (at 2024 prices) is projected to rise slightly to $3.6 billion in 2030 and to $3.7 billion in 2035.

2 All revenue projections are in 2025 U.S. dollars and unadjusted for future inflation.

In their lithium price forecast, BMI (2025b) projects that prices will rise sharply in 2027 compared with 2024 prices. Due to projected growing global demand combined with mine curtailments and delayed expansions due to the low-price environment in 2024 and 2025, global lithium markets are projected to shift to a deficit in 2026, which is expected to continue through 2040 (BMI, 2025a). Lithium carbonate and hydroxide prices are projected to remain constant after 2031. This price forecast results in a rise in projected annual lithium export revenue from all announced Chilean mines to $7.3 billion in 2030 and $8.9 billion in 2035. The projected revenue in 2030 and 2035 corresponds to 2.2% and 2.7% of Chile's 2024 GDP, respectively. The revenue from currently operational mines at forecasted prices is projected to rise to $6.7 billion in 2030 and then decrease slightly to $6.6 billion in 2035, due to the projected decline in lithium prices.

Figure 4

Gross revenue from announced lithium production capacities in Chile



Note: Gross revenue is estimated in 2025 U.S. dollars, unadjusted for inflation.
Data source: BMI (2025b)

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This analysis also evaluates the potential for economic growth from developing each additional stage of the LFP battery supply chain to meet the demand for BEV and PHEV batteries in Latin America. Given that most of the value in the battery supply chain is added downstream of material mining and refining, the development of downstream battery supply chain industries in Chile would enable the potential creation of significantly more economic growth per tonne of lithium than the mining and refining activities.

Building revenue by developing a domestic battery supply chain

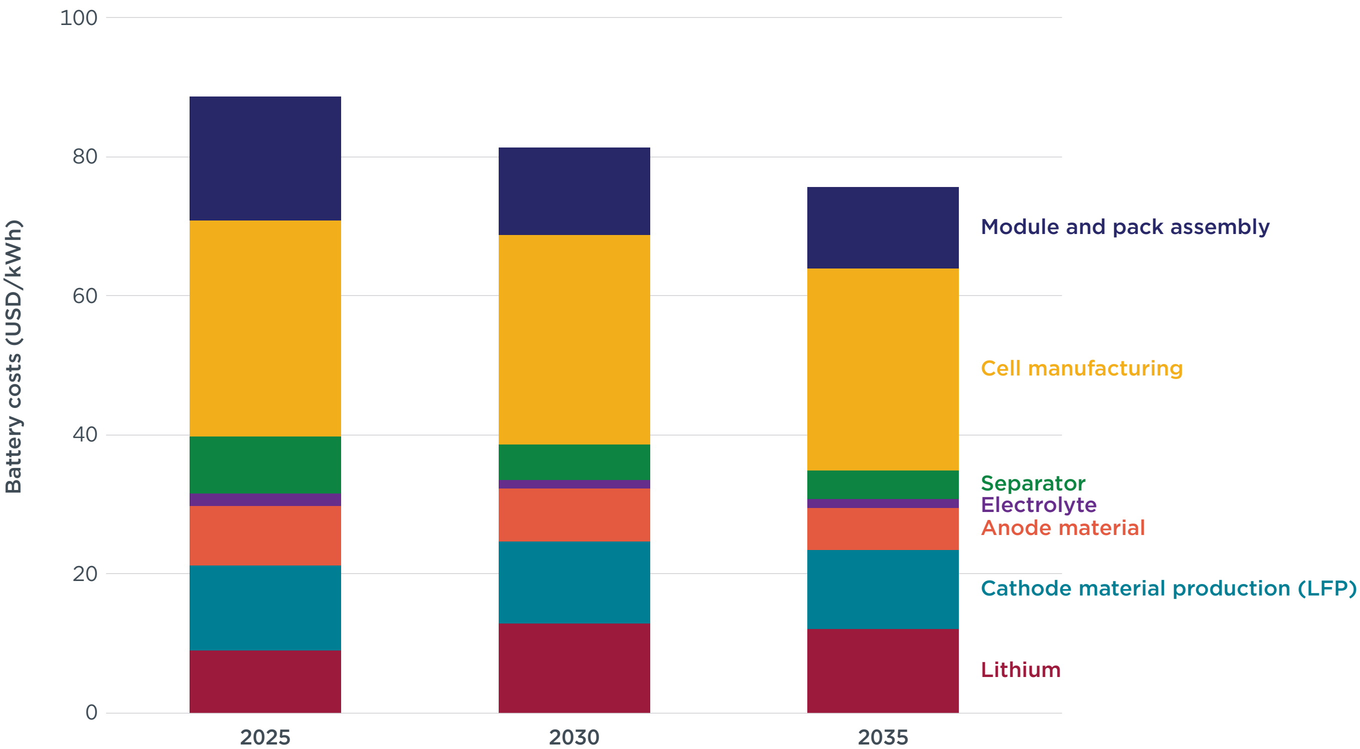
To illustrate the economic potential for Chile, this evaluation estimates the revenue from developing the battery supply chain necessary to meet Latin America's vehicular LFP battery demand. The analysis focuses on the production of LFP batteries because of the ample and low-cost lithium production in Chile, and because of prior announcements of cathode material plant investments targeting LFP production in the country. Because lithium contributes more to LFP battery costs than any other material, Chile's lithium mining industry positions the country well for the production of LFP batteries. While the production of lithium nickel manganese cobalt (NMC) cathodes and other battery technologies is possible, the additional costs of nickel or cobalt, which would mainly need to be imported, make these technologies less attractive for production in Chile.

The vehicle market in most of Latin America is expected to have a growing share of LFP batteries, which currently make up slightly more than half of all vehicular battery capacity demand in the region. Considering the expected growth of electric vehicle sales, the demand for LFP batteries from on-road vehicles in Latin America is projected to grow from 11 GWh in 2024 to 68–89 GWh in 2030 and to 145–193 GWh in 2032. Given LFP battery cells require 0.09 kg of lithium per kWh of battery capacity (Wang et al., 2024) about 8.0 kt of lithium or 13% of Chile's projected total lithium production capacity from all announced mines in 2030 would be needed to meet the demand for LFP batteries in Latin America. In 2035, lithium demand would increase to 15.4 kt, which is equivalent to 22% of Chile's projected lithium production capacity that same year.

The potential revenue from each step in the LFP battery supply chain is estimated based on bottom-up material cost estimates from Shen et al. (2024), updated with mineral commodity prices as of February 2025 (Daily Metal Price, n.d.), future global average lithium cost projections by BMI (2025b), and data on the contribution of cost components from BMI and Fastmarkets (BMI, 2023; Krishna, 2024). This analysis assumes a 3% profit margin for each step in the supply chain and assumes a scrap rate for each manufacturing step of 5% between 2025 and 2027, 4% between 2028 and 2031, and 3% between 2032 and 2035. The lithium materials costs include the processing of lithium carbonate. Warranty, licensing, labor, and administrative costs are incorporated into the cell manufacturing costs step.

As indicated by the cost breakdown by cell component and production step in Figure 5, the cost of producing LFP battery packs in Chile is estimated to be $89 per kWh of battery capacity in 2025, and the cost is projected to decline to $81 per kWh in 2030 and to $76 per kWh in 2035. The reduction in battery manufacturing costs overall results from an assumed reduction in the costs of cathode, anode, and cell manufacturing due to technological improvements and economies of scale in manufacturing processes. The impact of these reductions on the overall manufacturing cost is lessened by an assumed increase in the lithium material cost, which BMI projects to more than double from about 2025 to 2030, not accounting for inflation (BMI, 2025b). If the lithium prices remain at 2025 levels through 2035, the battery manufacturing cost is projected to decrease faster to about $75 per kWh in 2030 and $70 per kWh in 2035.

Figure 5
Projected LFP battery pack production costs in Chile in 2025, 2030, and 2035, by cell component and production step



Note: Cathode material production includes non-lithium material costs. Costs are estimated in 2025 U.S. dollars, unadjusted for inflation.

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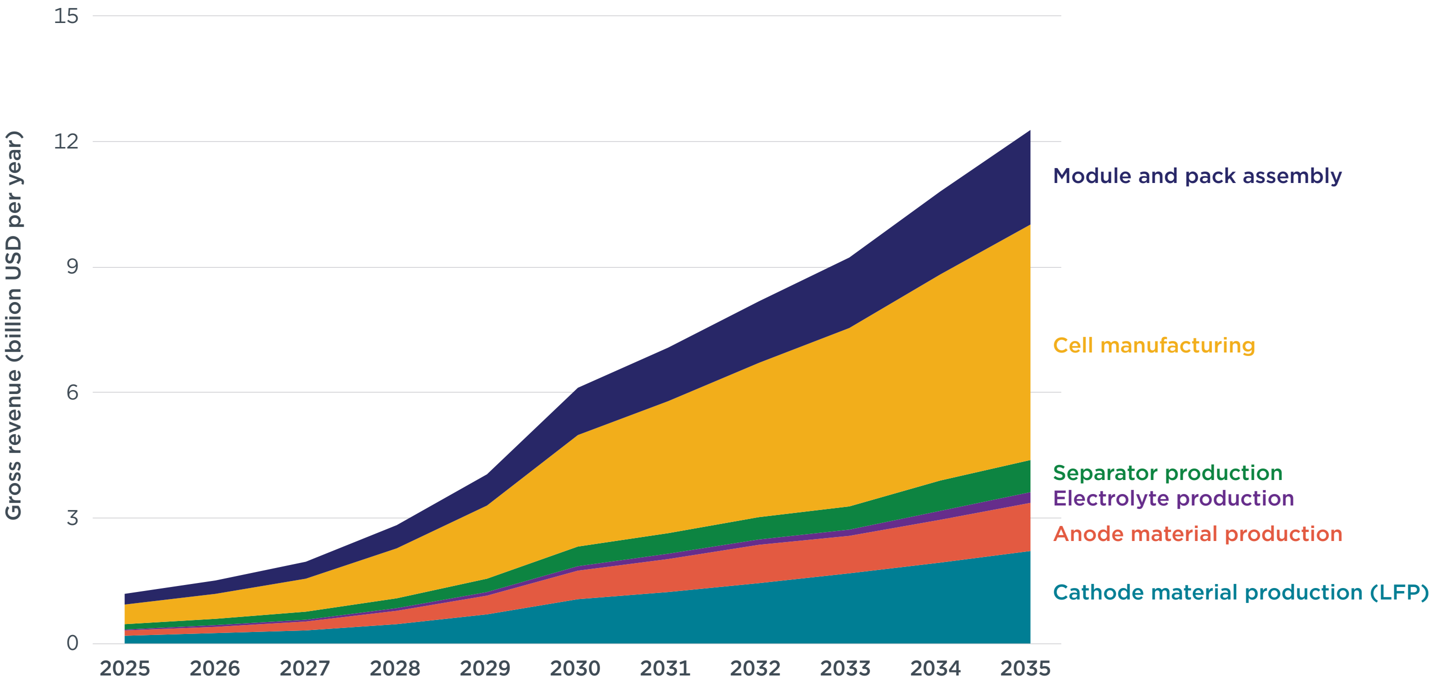
Using this cost data, the analysis estimates potential revenue from LFP battery pack production for the Latin American electric vehicle market to grow from $1.2 billion in 2025 to $6.1 billion in 2030 and $12.3 billion in 2035. The total potential revenue creation from developing each stage of the supply chain is displayed in Figure 6.

Figure 6

Projected gross revenue from the development of battery supply chain industries to meet the demand for LFP batteries in Latin America



Note: Cathode material production includes non-lithium material costs. Costs are estimated in 2025 U.S. dollars, unadjusted for inflation.

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Based on facility announcements, the development of expanded cathode material production is the most likely battery supply chain step to be realized in Chile in the near term. Cathode material production alone is estimated to generate up to $1.1 billion in annual revenue in 2030 and $2.2 billion in 2035. Producing LFP cathode material to meet the Latin American vehicular battery demand would generate about 1.9 times the annual revenue in both 2030 and 2035 of exporting the equivalent amount of lithium carbonate to the global market.

Between 2025 and 2035, cell production is projected to correspond to the largest share of potential revenue at 35%–39%, followed by module and pack production at 15%–20% and cathode material production at 14%–15%.

The projected revenue suggests that the development of LFP battery supply chain industries in Chile would help the country retain a much larger portion of the gross value generated from lithium production. In 2030, the projected gross revenue of onshoring all steps of battery production needed to meet Latin American vehicular LFP battery demand would correspond to 1.8% of Chile’s 2024 GDP (International Monetary Fund, 2025). This value is projected to increase to 3.7% of Chile’s 2024 GDP in 2035.

Creating jobs in the battery supply chain

This analysis evaluates the potential job creation from announced lithium mining and refining projects, as well as from the potential development of industries in the battery supply chain needed to meet Latin American demand for LFP batteries. The potential job growth from developing a domestic battery recycling industry is discussed in the section on battery recycling.

To standardize the labor requirements of different stages of the lithium and battery supply chain, this analysis follows the methodology used in Bui and Slowik (2025), which converts job figures from individual plants into a jobs-per-GWh of battery production ratio. This study uses data from Bui and Slowik and publicly available data on lithium mining facilities, refining facilities, and announced CAM production facilities in Chile and other countries (Albemarle, 2023; CORFO, 2023a, 2023b; Eramet, 2024; SQM, 2023; Standard Lithium, 2024). For the production of battery materials and components, such as lithium products, CAM, and electrolyte material, this ratio is based on the amount of each material required to produce 1 GWh of LFP battery capacity. Similarly, the labor requirements of module and pack assembly plants are represented by the number of jobs necessary to produce the number of modules and packs needed for 1 GWh of battery capacity.

Bui and Slowik (2025) evaluate the battery industry in the United States. We draw on this data while acknowledging the uncertainty inherent in using foreign labor market data. Another limitation of this analysis is that it assumes the job requirements for the battery supply chain will remain constant in the future. Increasing automation and economies of scale in the battery manufacturing industry could decrease worker requirements. However, given the uncertainty in the labor market data used, this report omits the future labor trends.

Lithium mining and refining jobs

Currently, SQM employs 3,492 people in its mining and refining lithium division and Albemarle employs 1,295 people (Albemarle, 2023; SQM, 2023). BMI reported that all announced lithium production capacity in Chile in 2023 totaled 44 kt of lithium, with 32 kt produced by SQM and 12 kt by Albemarle, corresponding to 109 jobs per kt of lithium.

Based on BMI data, SQM is projected to increase production capacity by 22.5 kt between 2023 and 2030, and Albemarle is projected to increase capacity by 8.8 kt between 2023 and 2034. Assuming the jobs-per-kt of lithium production ratio for each company scales proportionally with increased output, the announced production increases would correspond to the creation of approximately 3,417 additional jobs by 2034.

Considering BMI's projected lithium production from all announced mine projects in Chile, this analysis also estimates the potential job creation from future projects. Labor requirements in DLE facilities are estimated based on job numbers from company announcements. Approximately 12 jobs are required to produce 1 kt of lithium in Standard Lithium's Arkansas DLE facility in the United States (Standard Lithium, 2024), and approximately 78 jobs per kt of lithium are required in the Eramet Centenario DLE plant in Argentina (Eramet, 2024). Given that such projects are in early stages, there is uncertainty regarding the labor requirements of DLE facilities, and the two examples cited here may not be representative of future DLE plants in Chile. The job estimates for the four lithium mining and refining projects referenced in this section are listed in Table 1. Realizing the total lithium production capacity announced by

BMI in Chile corresponds to the creation of an estimated 3,000 to 3,900 new jobs by 2035. Depending on the labor requirements of DLE projects, they could correspond to between 6% and 28% of job creation in the lithium industry.

Table 1

Jobs reported for lithium mining and refining projects

Company	Project	Project type	Planned production	Jobs	Annual lithium production capacity in 2023 or in first year of planned production (kt)	Jobs/kt of lithium production
SQM	Atacama salt flat, Chile	Lithium brine evaporation	Operating	3,492	32	109
Albemarle	Atacama salt flat, Chile	Lithium brine evaporation	Operating	1,295	12	108
Standard Lithium	Southwest Arkansas, United States	Lithium DLE	2027	100	8	12
Eramet	Centenario plant, Salta Province, Argentina	Lithium DLE	2024	350	5	78

Cathode material production

In 2023, CORFO announced the development of two CAM production facilities. Both companies have since announced the withdrawal of these investments (Zhang, 2025), but the labor requirements of their project announcements are assumed to reflect those of typical CAM plants and are thus used in this analysis. One plant announced by BYD was slated to create 500 local jobs (CORFO, 2023a). The second facility was being developed by Yongqing Technology and when operating at nameplate capacity was projected to provide 668 local jobs (CORFO, 2023b). The announced capacity of the BYD plant was 50 kt, and the capacity of the Yongqing Technology plant was 120 kt. These job requirements translate into 19 and 11 jobs-per-GWh of LFP battery capacity for BYD and Yongqing, respectively. The job requirements for these facilities are listed in Table 2.

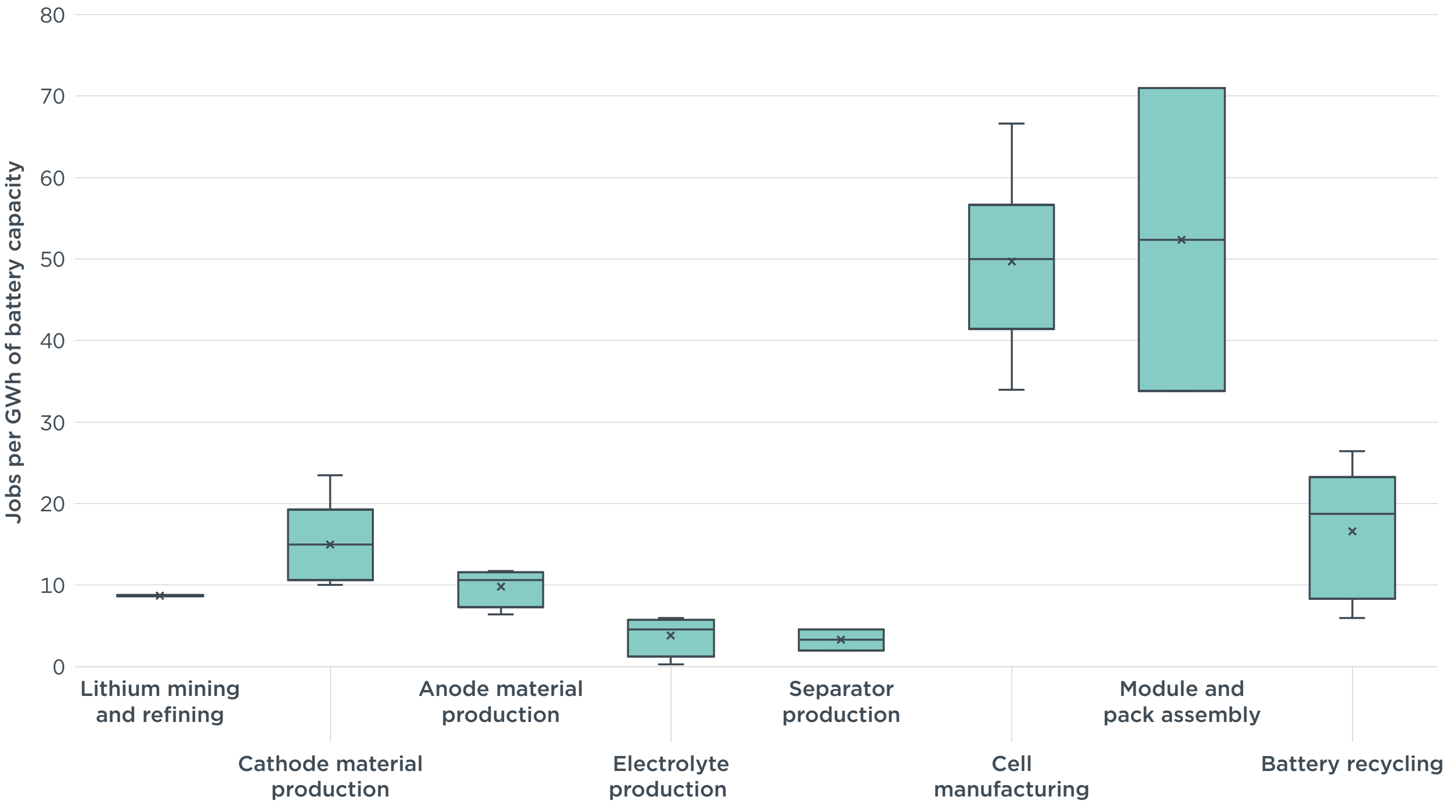
Table 2

Jobs reported for announced cathode active material facilities in Chile

Company	Project	Project type	Planned production	Total jobs	Annual CAM production capacity (kt)	Jobs/GWh of LFP battery pack
Yongqing Technology	Antofagasta Global Green Lithium Eco Industrial Park	LFP cathode material	2025 (cancelled)	668	120	11
BYD	Antofagasta CAM plant	LFP cathode material	2025 (cancelled)	500	50	19

Figure 7 below summarizes the jobs-per-gigawatt-hour ratios for the different steps of the supply chain compiled for this analysis based on project announcements in Chile and from Bui and Slowik (2025). The job requirements for each of these steps of the battery supply chain are listed in Table A5 in the appendix.

Figure 7
Job intensity for each step in the battery supply chain



Note: The horizontal line within each bar indicates the median value from multiple studies while the x represents the average. Half of all values fall between the top of the bar (75th percentile) and bottom of the bar (25th percentile). The vertical lines above and below each bar represent maximum and minimum values. The lithium mining and refining jobs listed here only show the jobs for brine evaporation projects which correspond to the majority of planned lithium production. The job requirements for DLE projects have considerable uncertainty and are thus excluded from the figure.

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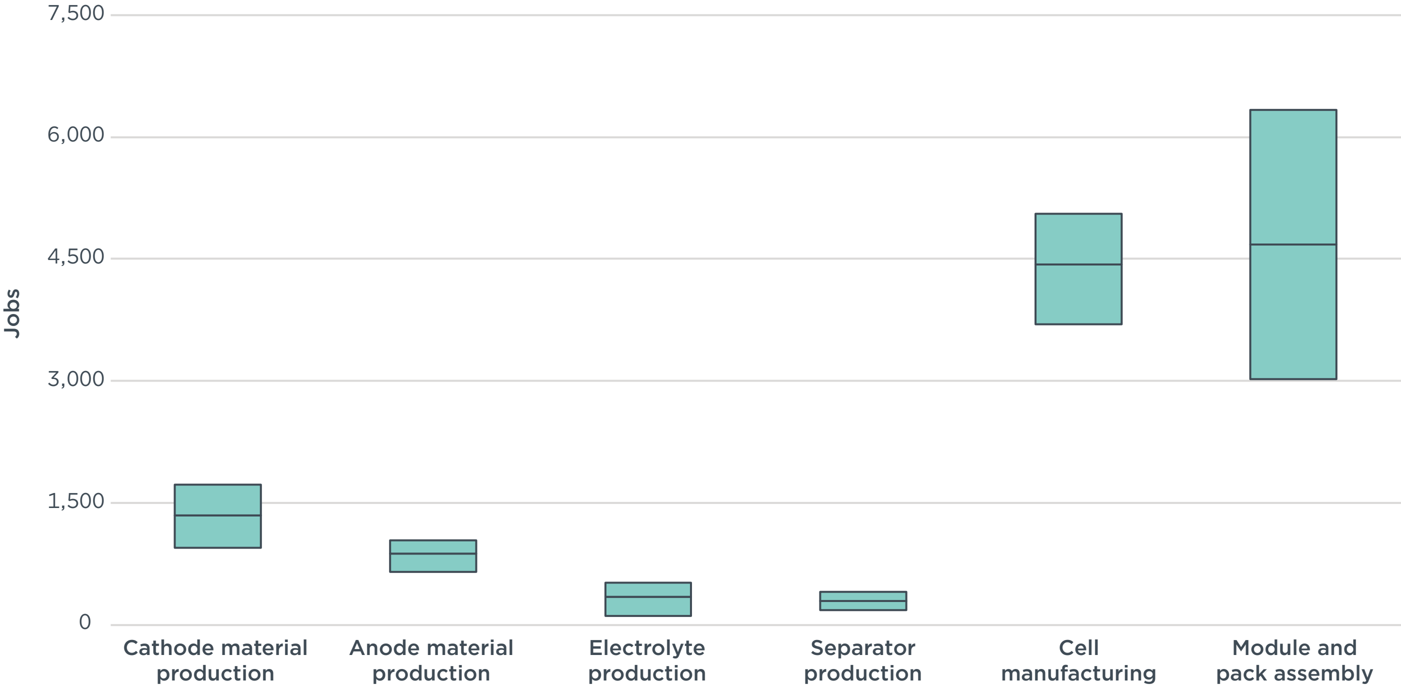
This analysis projects that 8,600–15,000 direct jobs would be created in the battery supply chain in Chile by 2030 and 19,000–32,600 direct jobs would be created by 2035 to meet the projected growth in LFP demand driven by BEV and PHEV uptake in Latin America. This projection excludes job creation from lithium mining and refining, which is projected to grow at a scale larger than that required to supply just the Latin American vehicular LFP demand.

Cathode material production alone is estimated to generate 900–1,700 jobs in 2030 and 2,100–3,700 jobs in 2035. For comparison, about 58,000 workers were directly employed in the large-scale mining industry in Chile in 2023 (CCM & Eleva, 2023). A detailed assessment of the potential ranges of job creation from the development of an LFP battery supply chain is displayed in Figure 8. The ranges in job creation potential account for the range of jobs-per-GWh ratios displayed in Figure 7. The ranges correspond to the 1st and 3rd quartile of the jobs-per-GWh data for each step of the supply chain.

Figure 8

Projected job creation in 2030 from the development of each stage of the battery supply chain, excluding lithium mining and refining, needed to meet the annual demand for LFP batteries in Latin America



Note: The horizontal line within each bar indicates the mean value of multiple industry facility announcements. Half of all values fall between the top of the bar (75th percentile) and bottom of the bar (25th percentile).

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As shown in Figure 8, based on the mean labor requirement data for each supply chain step, cell production and module and pack assembly correspond to 37% and 39% of projected job creation, respectively, in 2030. Cathode material production is projected to create the third largest number of jobs in 2030, making up 11% of all jobs.

Challenges and advantages to developing a domestic battery supply chain

There are several advantages to developing a domestic battery supply chain in Chile. The first is the ample, inexpensive, and comparatively low-GHG lithium concentrate production. Lithium production is already being leveraged by the Chilean government in contracts with mining companies to supply lithium at favorable prices to companies investing in domestic value adding industries. Furthermore, Chile has favorable trade agreements with major vehicle producing regions, including free trade agreements with the United States and China, an interim trade agreement with the European Union, and trade agreements with other Latin American countries through Mercosur and the Pacific Alliance. Chile could likely export battery supply chain products to these BEV producing trade partners.

However, each of the stages of the battery supply chain face specific challenges, including related to workforce training and talent acquisition, machining and production line development, and attracting investment (Bui & Slowik, 2025). Programs such as SQM Aprende and a lithium value chain certificate program offered by the Universidad de Antofagasta could help address workforce development needs by offering skill development and technical training (SQM, n.d.; Universidad de Antofagasta, 2023).

Another challenge to developing battery cell production in Chile is the high electricity cost for industry of around $0.156/kWh (measured in 2024 U.S. dollars), which could be mitigated if separate renewable energy sources are utilized (GlobalPetrolPrices.com, n.d.).

A CLEAN AND RESPONSIBLE BATTERY SUPPLY CHAIN IN CHILE

The characteristics of Chile's lithium deposits and electricity generation mix could contribute to a battery supply chain with a relatively low GHG emission footprint compared with other regions. However, high levels of water consumption from lithium extraction in water-sensitive regions where salt flats are located highlight the need to monitor and limit water use in Chilean lithium production. This section examines the GHG emission intensity and water consumption of lithium production and the GHG emission intensity of potential future battery cell production in Chile and compares these with the environmental footprints of other major lithium and battery cell producing regions around the world.

GREENHOUSE GAS EMISSIONS OF LITHIUM CARBONATE PRODUCTION

Due to the relatively high concentration of lithium in the Atacama salt flats, the mining and refining of lithium from brine evaporation in the Atacama have some of the lowest GHG emissions intensities compared with other major lithium mining sites around the world. The Argonne National Laboratory's 2024 R&D GREET model estimates GHG emissions from the production of lithium carbonate from Chilean brine to be 86% lower than that produced from Australian ore, the other major source of lithium production today, and 67% lower than lithium carbonate produced in the United States (Wang et al., 2024).

A 2024 comparative study of the GHG emissions intensity of lithium carbonate production in the Atacama salt flat in Chile and from other sources, including Australian spodumene mining operations and Argentinian salt flats, also indicates that lithium production from the Atacama salt flat exhibits some of the lowest emissions intensity globally (Lagos et al., 2024). Lagos et al. (2024) cite an emissions intensity for Atacama lithium carbonate production of 3,696–4,063 kg carbon dioxide equivalent (CO_2e) per tonne (excluding the emissions from transport after production). In contrast, lithium carbonate production from Argentinian brine record a wider range of emissions, ranging from 3,370 kg CO2e/t (Allkem, 2022) to 7,388 kg CO_2e/t (Schenker et al., 2022), while Australian spodumene mining operations report the highest emissions, ranging from 15,690 kg CO_2e/t to 20,400 kg CO_2eq/t (Jiang et al., 2020; Kelly et al., 2021). Values for GHG emission intensity from lithium carbonate production in different regions from R&D GREET 2024, and the data compiled in Lagos et al. (2024), are displayed in Table 3.

Table 3

Greenhouse gas emission intensity of lithium carbonate production in different deposits (kg CO_2e/t)

	Chile (Atacama)	Chile (Salar Blanco, Maricunga)	Australia (ore)	Argentina (brine)	United States (brine)
R&D GREET 2024 (Wang et al., 2024)	2,806	-	20,186	-	8,404
Lagos et al. (2024)	3,696 - 4,063	-	-	-	-
Schenker et al. (2022)	-	-	-	7,388 - 7,939	-
Chordia et al. (2022)	3,762	9,340	-	8,222	-
Allkem (2022)	-	-	-	3,370	-
Kelly et al. (2021)	2,900	-	20,400	-	-
Jiang et al. (2020)	-	-	15,690	-	-

Examining the relative contributions of each process to the GHG emissions intensity of producing lithium carbonate from brine, Lagos et al. (2024) provide a detailed breakdown of the emission sources. The authors estimate the primary contributor to emissions to be the production of soda ash for use in the chemical plant, responsible for 2,546 kg CO_2e/t, which correspond to 69% of emissions, followed by electricity consumption and the use of process fuels, which collectively account for 978 kg CO_2e/t, or 26% of total emissions. Out of the emissions from energy consumption, 34% are attributed to electricity and diesel consumption for brine extraction, pumping, and harvesting brine from the mines, while 66% are attributed to electricity, natural gas, and diesel consumption for chemical plant operations.

In addition to the emissions from the lithium carbonate production itself, Lagos et al. (2024) further estimate that the emissions from diesel vehicles used for personnel transport, for loading and transporting salt within the mines, and for transporting salt to the chemical plants and ports account for an additional 190 kg CO_2e/t. Lagos et al. (2024) also estimate that the emissions associated with shipping lithium from Chile to China, where most Chilean lithium is exported today, account for an additional 137 kg CO_2e/t. The development of a domestic battery supply chain in Chile could limit the emissions (and costs) from shipping lithium products to China and from shipping finished lithium-ion batteries back to Chile or Latin America.

Lagos et al. (2024) estimate that using soda ash produced by the trona process drawing on concentrated solar power (CSP), in addition to replacing natural gas used as process fuel in the chemical plant with green hydrogen produced with CSP electricity, could reduce total emissions (excluding transport) by 71% to 1,064 kg CO_2e/t. Lagos et al. (2024) further found that replacing diesel pumps with electric pumps powered by CSP electricity could reduce emissions by an additional 5% from the baseline, to 877 kg CO_2e/t. Using BEVs powered by CSP instead of diesel-powered vehicles in the mines and for travel to chemical plants and ports could reduce emissions by 127 kg CO_2e/t, which corresponds to 66% of land transport emissions.

Additional alternatives to reduce the emissions impacts of lithium carbonate production from brine sources were described but not evaluated by Lagos et al. (2024). These include methods to increase the percentage of lithium recovered from brine such as DLE, and the use of CO_2 instead of soda ash to precipitate lithium in brine. This novel method could use captured CO_2 to further reduce GHG emissions (Kim et al., 2024).

POTENTIAL OF DIRECT LITHIUM EXTRACTION TO REDUCE EMISSIONS FROM LITHIUM CARBONATE PRODUCTION

Direct lithium extraction is an emerging technology that uses electro-chemical processes to increase the proportion of lithium recovered from brine up to 90%, which could enable lithium extraction from brines with lower lithium concentrations. In 2025, there are a handful of projects operating at small scales, and many more pilot projects planning to scale operations in the late 2020s.

The 2024 R&D GREET model estimates the GHG emissions of two U.S.-based DLE projects at 10.4 kg CO_2e/t and 8.7 kg CO_2e/t, which are considerably higher than the range of emissions estimated for brine evaporation in the Atacama salt flats. In theory, using renewable electricity to replace fossil fuels in DLE processes could significantly reduce emissions (Systemiq, 2024). This analysis does not assess the costs of converting DLE processes to use electricity.

Given the high solar irradiance in the Atacama region, many mining projects are investing in renewable energy plants to meet their energy demands (Ministerio de Minería, 2022). Moreover, Chile is among the countries with the highest levels of electricity curtailment relative to its total renewable energy capacity (IEA, 2023), suggesting low-cost renewable electricity could be available for future DLE projects if they are operated at times when electricity from renewable sources would otherwise be curtailed. Considering the potential improvements in lithium recovery from brine with DLE technology, the emissions intensity of future DLE projects could be monitored to limit their global warming impacts.

GREENHOUSE GAS EMISSIONS OF BATTERY MANUFACTURING

In addition to lower global warming impacts of lithium production from brine, Chilean battery production could have a relatively low emissions footprint compared to other major battery producing regions, largely due to the relatively high share of renewable electricity generation supplying Chile's grid.

Using the 2024 Argonne National Laboratory R&D GREET model (Wang et al., 2024), this analysis modeled the emissions intensity of Chilean battery production. By changing the lithium and copper sources to Chile, and adjusting the electricity mix used in LFP CAM production, battery management system production, and battery assembly to the Chilean mix as of 2023 (IEA, 2024a), this analysis estimated a life-cycle GHG emissions intensity of 39 kg CO_2e/kWh of battery capacity. The adjustments made to the default GREET values are described in the appendix.

For comparison, based on the 2024 version of the R&D GREET tool and adjusting the above factors as described in Kelly et al. (2019), the emission intensity of producing LFP batteries in Europe, the United States, and China are estimated to be 43 kg CO_2e/kWh, 46 kg CO_2e/kWh, and 60 kg CO_2e/kWh, respectively. The emissions intensity of LFP battery pack production in Chile is thus estimated to be 35% lower than the average of LFP battery production in China, where the majority of LFP packs are produced today. Wang et al. (2023) estimate the life-cycle CO_2 emissions of LFP batteries produced in China to be about 65 kg CO_2 e/kWh in 2020 and around 38 kg CO_2 e/kWh in 2030. Chilean LFP production would also have 9% and 15% lower emissions than LFP production in the European Union and the United States, respectively. Given Chile's targets to increase the share of renewable electricity generation on its grid, the GHG intensity of Chilean battery production is expected to decrease further.

Table 4
Greenhouse gas emissions intensity of producing battery packs with LFP via solid state synthesis in Chile compared with other major battery producing regions

Production region	Greenhouse gas emissions (kg CO_2e/kWh)
Chile	39.0
Chile (recycled lithium)	38.4
Chile (100% renewable electricity)	30.9
China	60.0
European Union	42.9
United States	46.1

Source: Wang et al. (2024)

The adoption of battery recycling and lithium recovery in Chile can help to reduce the emissions intensity further. When using 80% recycled lithium, the emissions intensity would decrease to 38 CO_2e/kWh. Assuming that only renewable energies would be used for the electricity consumption in the steps mentioned above, the emissions intensity of battery production in Chile could be reduced to 31 kg CO_2e/kWh, which is 35% lower than with the 2023 electricity mix.

These scenarios underscore the potential for Chile to produce lithium-ion batteries with a lower GHG emissions footprint than other major battery producing regions. With the achievement of Chile's 100% renewable electricity target by 2050, emissions could be further reduced. Considering the planned adoption of carbon footprint requirements in the EU Battery Regulation, the relatively low projected GHG emissions intensity of Chilean battery manufacturing could grant batteries produced in Chile a competitive advantage when sold to European BEV manufacturers.

WATER CONSUMPTION OF LITHIUM CARBONATE PRODUCTION

The water consumption of lithium production sites in Chile is of concern given the high levels of water scarcity in the desert regions where lithium brine deposits are located. The water consumption for lithium carbonate production from brine evaporation varies depending on the concentration of lithium in brine, ranging from 0.17 m^3 per kg of lithium carbonate in higher-grade brines to 7.66 m^3 per kg in lower-grade brines (Mas-Fons et al., 2024). This estimate includes water consumption measurements in which brine depletion is conservatively assumed to be equivalent to the volume of freshwater consumption, due to freshwater sources being absorbed into brine aquifers after brine is pumped to the surface for lithium production. This uncertain process is referred to as freshwater transfer (Vera et al., 2023). Several mines employ saline wedge systems to limit freshwater transfer into underground brine aquifers. Although preliminary engineering models show potential, the complexity of in-situ hydrogeological processes makes the actual efficiency of these saline interfaces difficult to quantify (Ford et al., 2024).

Water scarcity in the Atacama salt flat region highlights the need for measures to continue monitoring and pursuing efforts to mitigate water consumption from brine evaporation processes to limit the impacts of lithium production on surrounding communities and ecosystems. Direct lithium extraction is touted as a method to recover lithium from brine deposits with lower water use than evaporation methods due to an increased lithium recovery rate (Vera et al., 2023). There is limited data on the water usage of large-scale operational DLE projects, and available data indicates a wide range of water consumption levels, including some projects that have higher water consumption than brine evaporation projects, limiting their suitability in water-scarce salt flat regions (Vera et al., 2023). Additionally, the reinjection of lithium-depleted water poses another challenge, as certain chemical processes used in DLE may introduce contaminants that prevent safe reinjection, potentially causing environmental harm (Gallegos et al., 2025).

OVERVIEW OF SOCIAL IMPACTS OF MINING IN CHILE

Mining activities in Chile, particularly in the Antofagasta region, have been linked to numerous social impacts, including increased living costs, altered traditional and agricultural practices due to changing ecosystems, and governance challenges involving competing visions for the management of natural resources.

Environmental stressors

In the desert ecosystem where the Atacama salt flat is located, the water consumption of expanding lithium mining operations has raised concern among local communities. Antofagasta, located in the driest nonpolar zone globally, faces significant water scarcity challenges. Approximately 42% of its rural population lacks formal access to drinking water, further complicated by low rainfall and high arsenic concentrations in freshwater sources (Ruffino et al., 2022). In recent years, residents have reported less forage available for their livestock herds and water shortages affecting their ability to grow crops (Beiser, 2024, Chapter 6).

While studies have noted diminishing water in local ecosystems over the last two decades (Liu et al., 2019), attributing these changes to the lithium mining activities has proven more difficult. Scientists have been unable to precisely untangle lithium mining's impacts on the local ecosystem's water cycle from the impacts of copper mines and the longer-term impacts of climate change (Beiser, 2024, Chapter 6).

Studies have linked lithium extraction to other forms of ecological and biodiversity degradation, notably to the subsidence of the Atacama salt flat at a rate of 1 cm per year (Delgado et al., 2024) and to a decline in the population of threatened flamingo species (Gutiérrez et al., 2022). The Atacama salt flats are also home to rare communities of microorganisms capable of living in high-saline brines (Cubillos et al., 2018). In addition, lithium evaporation ponds have a pronounced effect on local fauna. Notably, there have been 45 recorded incidents of local birds interacting with SQM-refining ponds, a disruption attributed to the absence of noise alarms. These alarms were mandated by the Environmental Ministry under the Environmental Qualification Resolution but have yet to be installed (Superintendencia del Medio Ambiente, 2024).

Economic impacts

Mining in Chile has considerable economic benefits, notably contributing 72% of Antofagasta's GDP, 39.4% of Chile's exports, and 13.6% of the national GDP (OECD Rural Studies, 2023; International Trade Administration, 2023). Mining companies like

Codelco and SQM have funded community development initiatives, such as Codelco paying tuition fees for employees' children, under corporate social responsibility programs. High wages in the mining industry, however, have inflationary effects on local economies: Relatively high incomes in the mining industry drive up the costs of goods and services, increasing living expenses for residents who do not work in the mining sector. For example, housing prices in Antofagasta increased from 90% of Santiago's prices in 2000 to 160% in 2013 (Atienza et al., 2021).

Governance challenges

Numerous indigenous communities reside in the Antofagasta region, with 18 collectively represented by the Consejo de Pueblos Atacameños (CPA; Ministerio de Educación, 2022). These communities have engaged in negotiations with mining companies, resulting in agreements like Albemarle's 2016 commitment to share 3.5% of its gross revenues with the CPA (CORFO, 2024). In 2018, SQM pledged $15 million annually for community projects but faced opposition from key indigenous groups (SQM, 2018), leading to partial rejection of the proposal (Brion Cea, 2018). Despite this, SQM reportedly maintains confidential agreements with four out of five communities near the Atacama salt flat (Initiative for Responsible Mining Assurance, 2023b).

Mining operation relations with local communities also have historical complexities. SQM's privatization in 1988 occurred without consultation or consent from indigenous communities (Poveda Bonilla, 2020). In 2008, Chile ratified the International Labour Organization's 1989 Indigenous and Tribal Peoples Convention 169 (International Work Group for Indigenous Affairs, 2023) after SQM's privatization. More recently, the mining industry has faced various legal disputes and criticism over its approach to public consultation. CORFO sued SQM in 2016 over alleged contractual breaches and tax fraud, which were resolved in 2018 (SQM, 2018). Similarly, Albemarle faced arbitration initiated by CORFO in 2021 for underreporting lithium sales, culminating in a 2024 settlement (CORFO, 2024; Pizzoleo, 2024). In 2024, Chile published a list of protected and exploitable salt flats, reportedly only including indigenous consultation processes late in the site selection process (Andean Wetlands Alliance, 2024; Johns, 2025). Currently, several indigenous consultation processes regarding proposed lithium mines are underway, guided by Law 21600 (Ministerio de Hacienda, 2024c). Issues surrounding the balance of ecological preservation and extractive priorities, adequate public participation, and information transparency have been raised by the Andean Wetlands Alliance, a coalition of local communities, civil society organizations, and advocates for salt flat preservation (Andean Wetlands Alliance, 2024).

Topics under discussion include the mining companies reducing freshwater usage, transitioning to renewable energy sources, and ensuring compliance with standards like the Initiative for Responsible Mining Assurance (IRMA). Albemarle and SQM in 2024 achieved IRMA compliance scores of 50% and 75%, respectively (IRMA, 2023a, 2023b). These scores benchmark how these mining companies are currently operating and reveal areas that may need further development.

The IRMA standard focuses on site-specific dynamics and does not capture the complexities of the Atacama salt flat, an area where two copper and two lithium mines operate concurrently (Johns, 2025). Furthermore, both lithium producers in the region have faced litigation following observations of a significant drop in brine levels at a monitoring station, raising concerns about the environmental sustainability of their operations (Fundación Terram, 2024).

Policies addressing the social impact of lithium mining

CORFO's 2024 contract negotiations with Albemarle, SQM, and Codelco led to the establishment of more rigorous frameworks for new projects intended to ensure stricter environmental standards and a more sustainable extraction process (Codelco & SQM, 2024; CORFO, 2024). These efforts will be supported by regulations in vehicle-producing regions designed to mitigate risks in battery mineral supply chains.

Slated to go into effect in August 2027, the EU Battery Regulation due diligence standards aim to enhance mineral traceability and redress social and environmental malpractices in mineral supply chains (European Parliament, 2024). These frameworks are designed to make manufacturers evaluate whether the minerals in their supply chains are sourced in an environmentally and socially responsible manner and to work to mitigate problems that arise. Chilean mining companies intending to supply lithium to European EV manufacturers will need to set up documentation processes to adhere to the European Union's due diligence requirements.

ECONOMIC AND ENVIRONMENTAL BENEFITS OF BATTERY REUSE AND RECYCLING

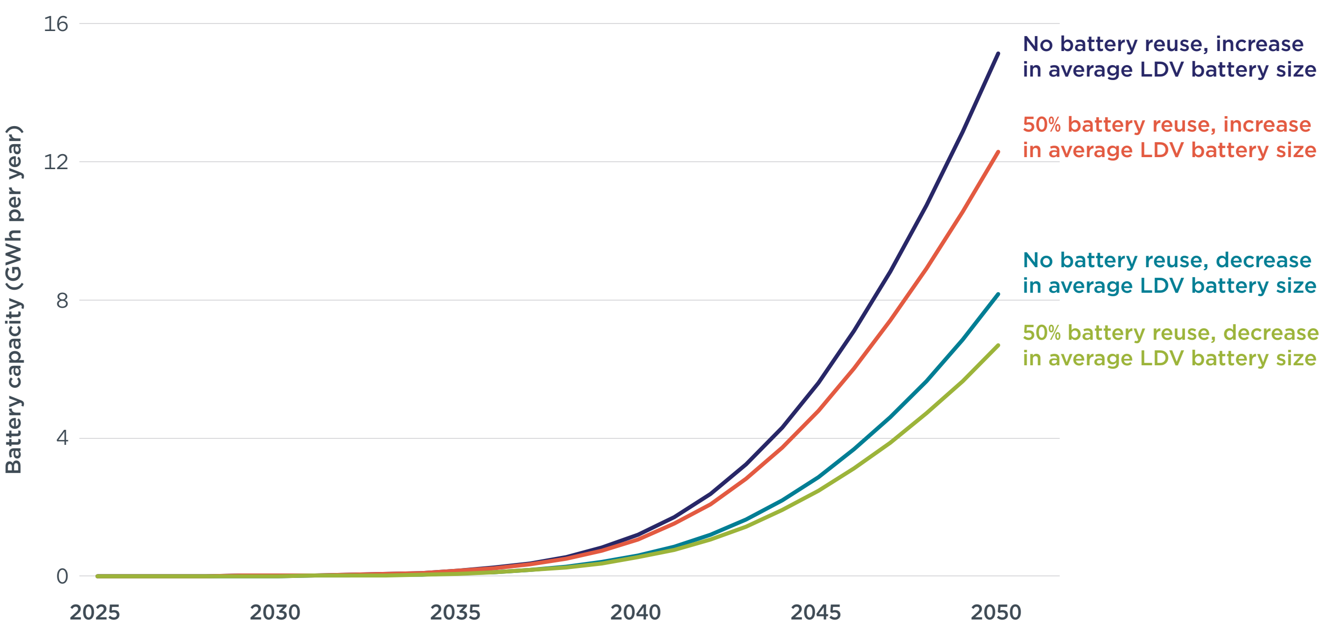
FUTURE DEMAND IN BATTERY REUSE AND RECYCLING CAPACITIES

As the uptake of BEVs and PHEVs accelerates around the world, the volume of vehicle battery retirements at the end of their useful life is projected to rise rapidly. If lithium-ion batteries end up in a landfill, they can leach heavy metals (nickel and cobalt) and other toxins into the soil and groundwater, create a fire risk that can result in toxic air emissions, and pose serious health risks to waste treatment workers.

Figure 9 below shows the volume of vehicle battery capacity projected to be retired in Chile. Given the natural delay between a vehicle's initial sale and its end-of-life, the volume of batteries projected to be retired is expected to only ramp up starting around 2037.[3] However, due to the projected rapid adoption of BEVs in 2025, the volume of end-of-life vehicle batteries is projected to grow exponentially after 2040; between 0.5 GWh and 1.2 GWh are expected to be retired in 2040, rising to 6.7 GWh–15.1 GWh in 2050, depending on the trend in passenger vehicle battery sizes and the rate of battery reuse.

Figure 9

Projected end-of-life battery retirements with different levels of battery reuse



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Battery recycling can divert batteries from ending up in landfills and recover their constituent materials. Prior to recycling, it is possible that a substantial portion of vehicle batteries could be reused in a secondary application after ending their useful

3 This analysis assumes that half of passenger cars will be retired 24 years after their initial sale. The model assumes half of buses, light-commercial vehicles, medium-duty trucks, and heavy-duty trucks are retired 16 years, 20 years, 20 years, and 14 years after their initial sale, respectively. Data sources for vehicle lifetimes are shared in the appendix.

life in a vehicle. However, there is considerable uncertainty regarding end-of-life vehicle battery collection rates and rates of battery reuse in secondary applications. This analysis employs the methodology used in Li et al. (2024) and assumes a 90% collection rate for end-of-life batteries and that 10% of retired vehicles are either not collected or are exported outside of Chile.

The feasibility and likelihood of battery reuse depend on several factors, including the ease of collecting, inspecting, and reconfiguring batteries for secondary use and the economics favoring the reuse of a battery instead of recycling it and recovering its constituent materials (Tankou et al., 2023). To account for the uncertainty in the amount of battery reuse, this analysis evaluates a scenario in which 50% of batteries are reused for 10 years before they are retired and a scenario in which no battery reuse occurs.

The benefits of developing a battery recycling ecosystem in Chile are many. If Chile were to develop a domestic recycling industry, it could help avoid the disposal of batteries in landfills as well as the growth of informal recycling activities, which can pose worker safety and environmental risks (Beiser, 2024, Chapter 9). On the other hand, lithium could be recovered from the recycling process, and in the case of NMC batteries, also nickel and cobalt, which are currently not mined at scale in Chile. The potential to grow a secondary supply of such minerals could help offset parts of the amount of raw mineral mining in Chile, thereby helping to lower the environmental impacts of mining operations. Developing efficient battery collection and processing infrastructure could help divert end-of-life vehicle batteries for use in BESS to provide grid stabilization services.

When compared with the recycling of NMC batteries, including a recovery of the relatively expensive materials of nickel and cobalt, the recycling of LFP batteries that do not contain these minerals is less profitable. In fact, it remains uncertain if solely the recovery of copper and lithium from LFP batteries offsets the recycling costs (Tankou et al., 2023). Thus, to avoid the disposal and waste of LFP batteries, a recycling regulation with element-specific recovery targets would be necessary.

This analysis modeled battery recycling conditions similar to those used in Li et al. (2024), which assumes battery recycling operations globally could achieve material recovery rates equivalent to those mandated by the EU Battery Regulation starting in 2027. Assuming a 90% collection rate of end-of-life vehicle batteries, under a scenario in which no battery reuse occurs, the supply of lithium from end-of-life vehicle batteries could reach 74 t in 2040 and 941 t in 2050. Under a scenario in which half of collected batteries are recycled, and half are reused in a non-vehicular application for a period of 10 years before entering the recycling stream, the supply of lithium from end-of-life vehicle batteries could reach 38 t in 2040 and 508 t in 2050. These scenarios model battery recycling assuming an increasing average battery capacity for passenger BEVs. If passenger car battery sizes were to decrease instead, the recovered lithium from both the reuse and no reuse scenarios would be slightly lower than in the increased average battery size scenario.

Battery recycling could also create a domestic source of nickel and cobalt. In 2040, 93–205 t of nickel and 6–13 t of cobalt could be recovered from end-of-life batteries in Chile. These volumes rise to between 1.2 kt and 2.6 kt of nickel and 65 t and 148 t of cobalt in 2050.

JOB POTENTIAL OF RECYCLING

Bui and Slowik (2025) estimated an average of 17 jobs are required per GWh of battery capacity that is recycled, with a 25th percentile of 8 jobs per GWh and a 75th percentile of 23 jobs per GWh. Assuming these labor requirements apply to a future battery recycling system in Chile, between 8 and 18 full-time jobs would be required to recycle the projected volume of retired battery capacity in 2040, rising to between 114 and 317 jobs in 2050. These projections only include jobs in battery recycling facilities (Bui & Slowik, 2025). Jobs in end-of-life battery collection and distribution are excluded from this projection.

CONCLUSION

Chile's plans to develop its lithium mining industry have the potential to position the country as a key player in the global lithium-ion battery supply chain. Although Chile's transition to BEVs and the growth of its lithium industry are still in their early stages, additional policy actions can help to expand their economic benefits while minimizing harmful social and environmental impacts. This paper evaluates how Chile can leverage its lithium resources to expand long-term economic growth from manufacturing technologies needed for climate-neutral economies. The analysis results in the following conclusions:

Lithium-ion battery demand from BEVs is projected to rise rapidly in Chile. Total battery demand from BEVs and PHEVs in Chile is estimated to rise from 0.5 GWh in 2024 to 13.0–17.8 GWh in 2030 and to 27.7–38.0 GWh in 2035, depending on the development of the average battery sizes in light-duty BEVs. This corresponds to an increase in Chilean lithium demand, rising from 44 t in 2024 to 1.1–1.5 kt in 2030 and to 2.3–3.2 kt in 2035.

Lithium production capacities in Chile are expected to increase markedly by the end of the decade. The total announced lithium production capacity in Chile is projected to rise from 42 kt in 2024 to 64 kt in 2030 and 79 kt in 2035. In 2030, 91% of this announced capacity corresponds to mines already in operation today. In 2024, the gross revenue from Chile's lithium industry is estimated to be about $2.7 billion. Depending on the development of lithium commodity prices and on the realization of announced mining projects, Chile's lithium exports could generate $7.3 billion in 2030 and $8.9 billion in 2035, which correspond to 2.2% to 2.7% of its 2024 GDP, respectively.

Expanding Chile's current lithium mining and refining capacities to cathode production can provide substantial revenue and job potential. In 2025, nearly all the lithium mined in Chile is expected to be refined domestically. Cathode material production in Chile alone could generate up to $1.1 billion in annual revenue in 2030 and $2.2 billion in 2035 when meeting the LFP demand from vehicle batteries in the Latin American market. This would generate about 1.9 times the annual revenue of exporting the equivalent amount of lithium carbonate in both years. Furthermore, the onshoring of LFP cathode material production could create between 900 and 1,700 jobs in 2030 and between 2,100 and 3,700 jobs in 2035.

Onshoring battery cell production and all intermediate steps in the value chain of battery production can provide additional revenue and job potential. Going beyond lithium mining and refining and cathode material production and developing each stage of the value chain needed to meet the projected demand in vehicular LFP batteries in Latin America could generate an annual gross product of up to $6.1 billion by 2030 and $12.3 billion by 2035, which correspond to 1.8% and 3.7% of Chile's 2024 GDP, respectively. This buildout of a battery supply chain in Chile could also lead to the creation of between 8,600 and 15,000 direct jobs in the battery value chain by 2030 and between 19,000 and 32,600 jobs by 2035. For comparison, about 58,000 workers were directly employed in the large-scale mining industry in Chile in 2023 (CCM & Eleva, 2023).

Batteries produced in Chile would have some of the lowest life-cycle GHG emission intensity compared with other major battery-producing regions around the world today. The Argonne National Laboratory's 2024 R&D GREET model estimates GHG emissions from the production of lithium carbonate from Chilean brine to be 86% lower than that produced from Australian ore, the other major source of lithium production today, and 67% lower than lithium carbonate produced in the United States (Wang et al., 2024). Due to the low GHG emission intensity of sourcing lithium from Chilean brine and the comparatively high share of renewables in the country's electricity mix, LFP battery pack production in Chile would be 35% lower than the average emissions intensity of LFP batteries in China and 16% and 9% lower than in the United States and Europe, respectively. With an increasing number of countries developing carbon pricing mechanisms, and with the EU Battery Regulation introducing maximum production emissions thresholds for batteries, the projected low life-cycle GHG footprint of Chilean-made batteries could result in a competitive advantage for the country.

Expanded lithium mining in Chile could pose risks of adverse environmental and social impacts. The water consumption of lithium mining from brine in Chile is similar to that of hard-rock mining in other regions but is of higher concern given the aridity of the desert ecosystems where salt flats are located. However, the interconnection between brine extraction and freshwater depletion is not well understood, and further study is needed to understand lithium production's long-term impact on local ecosystems. This freshwater consumption can be partially mitigated by technological improvements in lithium mines. International best practices of due diligence requirements and community engagement provide governance models for the Chilean government to mitigate the harmful social and economic impacts of the lithium mining industry.

Setting up an efficient battery collection and recycling infrastructure in Chile could allow the recovery of valuable minerals, create new jobs, and prevent the risk of BEV batteries ending up in landfills. Between 0.5 GWh and 1.2 GWh of vehicular batteries are expected to be retired in Chile in 2040, rising to between 6.7 GWh and 15.1 GWh in 2050. The establishment of an efficient battery collection and recycling infrastructure to address the increase of BEV and PHEV retirements would also avoid batteries ending up in landfills, contaminating water and soil, and posing a health hazard to waste disposal workers.

POLICY CONSIDERATIONS

As of mid-2025, it is expected that an increasing number of BEVs will be adopted in Chile in the coming decade. At the same time, Chile is poised to benefit from expanding its lithium mining industry to meet a large share of the global vehicular demand for lithium-ion batteries. This analysis finds that with additional policy initiatives the Chilean government could encourage faster uptake of BEVs in line with its ZEV targets. Other policies can spur the development of a clean domestic lithium-ion battery industry to increase economic growth, public revenue, and job creation while minimizing the social and environmental impacts of the mining industry. Taking some or all of these steps would signal Chile's strategic orientation towards both leading the BEV transition in Latin America and building the foundations for a Chilean lithium-ion battery industry.

VEHICLE ELECTRIFICATION

Building upon its adopted vehicle electrification targets, the Chilean government could consider implementing regulations mandating an increase in BEV sales across vehicle segments to ensure the targets will be met. Specifically, the government could finalize its announced HDV fuel economy standards and consider making its current ZEV targets legally binding and enforceable. The government could also consider increasing the stringency of its light- and medium-duty fuel economy standards or adopting ZEV sales requirements. Either of these policies would provide regulatory certainty for automakers and importers, consumers, and charging infrastructure providers and spur investment in BEV supply and charging infrastructure.

UPSCALING THE DOMESTIC LITHIUM VALUE CHAIN

To expand the domestic lithium value chain, the government could consider implementing targeted incentives for cathode material production, cell manufacturing, and recycling infrastructure, such as the expansion of existing provisions in contract agreements to reserve select quotas of lithium at preferential prices for domestic value-adding projects. Battery supply chain incentives could include ones similar to the production-linked incentives for domestic battery manufacturing in the United States' Inflation Reduction Act. Public expenditures to encourage the development of technical workforce training programs, particularly in regions near mining projects, can help equitably prepare the domestic workforce needed for a successful battery industry.

SOCIALLY AND ENVIRONMENTALLY RESPONSIBLE DEVELOPMENT OF MINING

To lower the environmental impacts of lithium mining as production increases, the government can consider making the targets in its National Mining 2050 Strategy mandatory, such as lowering freshwater use to less than 5% of total consumption and achieving carbon neutrality by 2040. The government could also request increased benefits sharing, local hire policies, and workforce training programs in their negotiations with mining companies to promote more cohesion with local communities in mining regions. The government could also consider improving existing consultation processes to align with the UN Declaration on the Rights of Indigenous Peoples, with the goal of obtaining groups' free, prior, and informed consent for any mining project that may affect them (United Nations, 2007).

The adoption of binding mining standards that provide for transparency and data sharing at the national level could also promote more domestic and international trust in the governance of the Chilean mining industry and mitigate the risk of local opposition. The government could also consider adopting due diligence requirements similar to those in the EU Battery Regulation, which are designed to make battery manufacturers evaluate whether the minerals in their supply chains are sourced in an environmentally and socially responsible manner and to work to mitigate problems that arise, either by working with mineral producers or simply by changing suppliers (European Parliament, 2024).

BATTERY REUSE AND RECYCLING

To spur the development of a domestic battery recycling industry, Chile can follow the lead of the European Union in developing a comprehensive battery recycling regulation. The EU Battery Regulation includes mandatory mineral recovery rates and provisions requiring a minimum share of recycled content in new batteries. The regulation also includes mandatory data sharing provisions, which would ensure data on battery characteristics, including chemical composition and state of health, are readily available to those processing end-of-life batteries. Making information on chemistry and state of health readily available can reduce costs associated with testing and sorting end-of-life batteries, thus facilitating battery reuse and recycling processes.

In the absence of a domestic battery recycling industry, the government could consider including battery collection in Chile's extended producer responsibility law (Law 20920). The government could simultaneously consider setting social and environmental standards for the battery recycling industry to ensure that it does not pose a risk of harming its workers or local communities.

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APPENDIX: METHODS AND ASSUMPTIONS

VEHICLE SALES

The growth in sales of BEVs and PHEVs modeled in this analysis was estimated based on projected sales of vehicles of all powertrain types multiplied by the BEV and PHEV sales shares that correspond to policy targets. The projected vehicle sales are based on estimates of passenger and freight activity projections in the IEA's Mobility Model under the Stated Policy Scenario (STEPS; 2024c). The vehicle types modeled in the roadmap correspond to the following weight classes: passenger cars (GVW < 3.5 tonnes), light-commercial vehicles (GVW < 3.5 tonnes), urban and coach buses (GVW ≥ 3.5 tonnes), medium-duty trucks (GVW 3.5–15 tonnes), and heavy-duty trucks (GVW > 15 tonnes). Notably, these vehicle categories do not match up identically with the weight classes for vehicles considered in ANAC data, nor in Chile's Energy Efficiency Law. The total vehicle sales of all powertrains in different segments are displayed in Table A1.

Table A1
Projected vehicle sales of all powertrains by segment in Chile

Vehicle segment	2024	2030	2035	2040
Passenger car	213,917	235,460	253,412	271,365
Light commercial vehicle	106,782	126,235	142,447	158,659
Two- and three-wheeler	24,107	27,031	29,467	31,904
Bus	2,999	5,680	7,913	10,146
Medium-duty truck	4,868	6,882	8,561	10,239
Heavy-duty truck	7,439	8,213	8,859	9,503

The projected total sales of different vehicle segments are based on total passenger and freight activity projections for different vehicle types (ICCT, 2024).

The modeled BEV and PHEV shares correspond to those that would occur with the implementation of the LDV energy efficiency standards and the achievement of the goals outlined in the National Electromobility Strategy (Pettigrew, 2022), the Global Memorandum of Understanding on HDVs (Global Commercial Vehicle Drive to Zero, n.d.), and the Global ZEV Declaration (Accelerating to Zero Coalition, 2023). The national electromobility strategy targets a 100% ZEV sales share for new LDVs and public transit buses by 2035. The LDV energy efficiency standards target improvements in fleet efficiency by 2030, which are assumed to translate to a 50% BEV share in 2030. The Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles targets a 100% ZEV share for MDVs and HDVs in 2040, with an intermittent target of 30% of new vehicle sales in 2030. The modeled BEV shares for different vehicle segments are displayed in Table A2.

Table A2

BEV and PHEV sales shares for different vehicle segments in Chile corresponding to adopted and announced vehicle electrification policies and targets

Vehicle segment	2024	2030	2035	2040
Passenger car (BEV)	1%	50%	100%	100%
Passenger car (PHEV)	0%	1%	0%	0%
Light commercial vehicle (BEV)	1%	50%	100%	100%
Light commercial vehicle (PHEV)	0%	1%	0%	0%
Two- and three-wheeler	15%	26%	41%	61%
Bus	10%	75%	100%	100%
Medium-duty truck	2%	35%	68%	100%
Heavy-duty truck	0%	30%	65%	100%

The projected rates of BEV adoption corresponding only to the adopted energy efficiency regulations for light- and medium-duty vehicles are listed in Table A3.

Table A3

BEV and PHEV sales shares for different vehicle segments in Chile corresponding to adopted vehicle electrification policies

Vehicle segment	2024	2030	2035	2040
Passenger car (BEV)	1%	42%	45%	47%
Passenger car (PHEV)	0%	1%	0%	0%
Light commercial vehicle (BEV)	0%	24%	27%	30%
Light commercial vehicle (PHEV)	0%	1%	0%	0%
Two- and three-wheeler	15%	24%	44%	60%
Bus	10%	27%	37%	47%
Medium-duty truck	2%	2%	4%	7%
Heavy-duty truck	0%	2%	4%	7%

The PHEV sales shares correspond to a negligible share of LDVs, which include passenger cars and light-commercial vehicles. In line with the assumptions used in Li et al. (2024), this study assumed that all zero-emission HDVs are battery electric, rather than a mix of hydrogen fuel-cell electric and battery electric vehicles. This assumption is based on the current dominance of battery electric over fuel-cell electric HDVs (Mao et al., 2023; Mulholland et al., 2024) and the projected total cost of ownership advantage of battery electric trucks over other HDV technologies in major markets (Basma et al., 2023; Basma & Rodríguez, 2023; Mao et al., 2021). Since BEVs typically have larger batteries than fuel-cell electric vehicles for a vehicle with equivalent range, this analysis thus provides a conservative upper bound for battery demand by assuming 100% of zero-emission HDVs are BEVs.

Vehicle lifetimes were calculated in the ICCT Roadmap model based on ICCT expert insight (ICCT, 2024). For passenger cars, the assumed lifetime of 24 years compares to statistical evidence of an average vehicle lifetime of 22 years in Brazil (Mera et al., 2023) and between 19 and 24 years in EU Member States (Negri and Bieker, 2025). This analysis assumes battery electric vehicles in all segments will not require battery replacements during their lifetimes, based on analysis of battery cycle life and vehicle lifetime mileage data in Li et al. (2024).

BATTERY CAPACITY

This analysis assumed a continuation of trends in the Chilean and global BEV markets over the last 5 years. These include a steady increase in the average battery size of light-duty BEVs, which include both passenger cars and light commercial vehicles. Mirroring the global market trend, the average battery size of light-duty vehicles in Chile has grown by 14% over the last 5 years, from 56 kWh in 2019 to 63 kWh in 2024 (EV Volumes, n.d.; Li et al., 2024). Similar increases in battery size have occurred for passenger PHEVs and for both battery electric and plug-in hybrid light commercial vehicles.

Given this trend, and the growing sales shares of larger vehicles such as SUVs in Chile, the baseline scenario of this analysis assumed light-duty BEV and PHEV battery sizes will increase by 20% between 2024 and 2030. As a sensitivity analysis, this study modeled the battery capacity demand in a scenario in which the average battery size of light-duty BEVs would decrease by 20% between 2024 and 2030, which could occur as a result of advances in battery technology and vehicle energy efficiency, in addition to shifting consumer preferences. The increased availability of smaller segment BEVs in emerging markets where few passenger BEV models are available could also lead to a declining average battery size. In this scenario, the average battery size of LDVs reaches 50 kWh in 2030. After 2030, the average battery size of LDVs is assumed to remain constant in both scenarios.

The battery sizes for medium- and heavy-duty trucks and buses were based on data from EV Volumes (n.d.) and their future development was based on Li et al. (2024) and on ICCT expert analysis of trends in the Chilean public transit bus fleet (Rebouças & Cieplinski, 2024). The average battery size of different vehicle segments in 2024 and in 2030 is displayed in Table 4.

Table A4
Modeled average battery size of different vehicle segments in Chile in 2024 and 2030

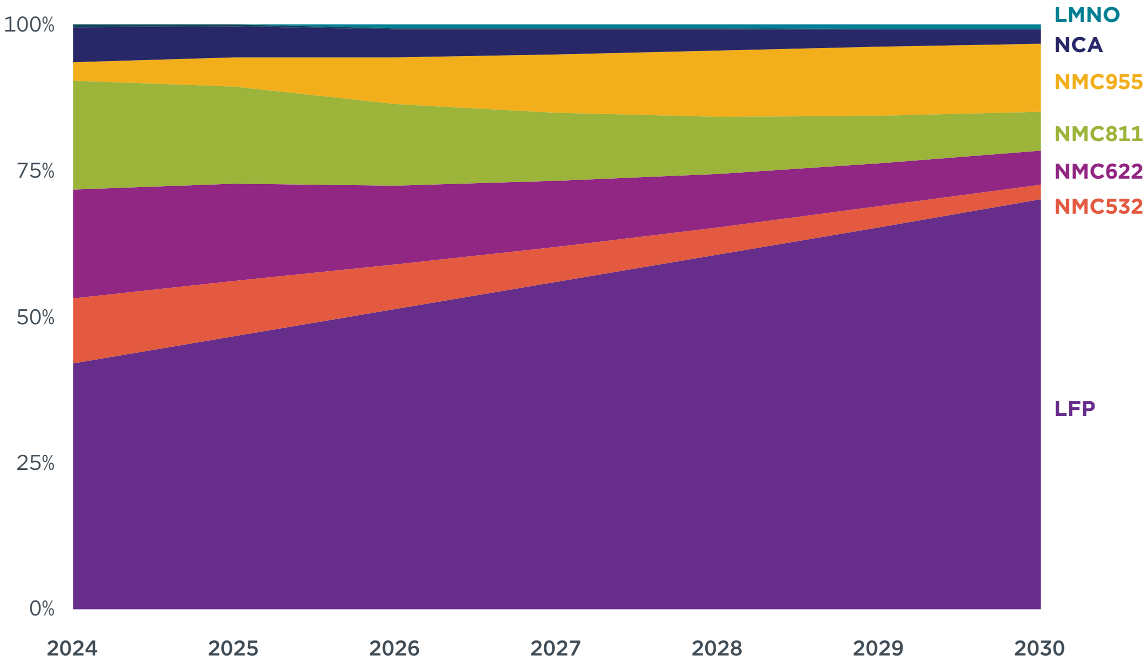
Vehicle segment	2024 Battery size (kWh)	2030 Battery size (kWh)
LDV (BEV)	63	76
LDV (PHEV)	23	28
Medium-duty truck	145	161
Heavy-duty truck	386	564
Bus	356	356
Two- and three-wheeler	3	3

MARKET SHARES OF BATTERY TECHNOLOGIES

For the battery technology market shares, this analysis assumed a continued increase in the share of LFP batteries within the light-duty vehicle segment and a shift within the NMC battery variants to technologies with higher nickel and lower cobalt content. EV

Volumes (n.d.) reported an LFP share of 39.4% and 99.8% for battery-electric light and heavy-duty vehicles, respectively, in 2024. Given the ratio of battery capacity demand from light- and heavy-duty vehicles, and ongoing trends in the global vehicular battery technology mix, this analysis projects an LFP market share for the overall Chilean vehicle fleet of 42% in 2024, increasing to 70% in 2030, and remaining constant thereafter. The market shares of battery technologies are shown in Figure A1.

Figure A1
Market shares of battery technologies as a share of vehicle battery capacity demand in Chile



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MATERIAL INTENSITY

The material content of different battery technologies is based on those used in Table A4 in Li et al. (2024).

BATTERY MANUFACTURING COST ESTIMATE

For the battery manufacturing costs estimate, this analysis assumed a 3% profit margin for each step in the supply chain and assumed a scrap rate for each manufacturing step of 5% between 2025 and 2027, 4% between 2028 and 2031, and 3% between 2032 and 2035. The lithium materials costs step includes the processing of lithium carbonate. Warranty, licensing, labor, and administrative costs were incorporated into the cell manufacturing costs step.

JOB CREATION PROJECTION

Table A5

Job requirements for different steps of the battery supply chain

Industry	Jobs per GWh of battery pack capacity			Source
	25th percentile	Average	75th percentile	
Lithium mining and refining (brine evaporation)	8.6	8.7	8.8	SQM (2023); Albemarle (2023)
Lithium mining and refining (DLE)	0.9	3.6	6.2	Standard Lithium (2024); Eramet (2024)
Cathode material production	10.3	15.0	19.8	CORFO (2023a; 2023b); Bui & Slowik (2025)
Anode material production	7.3	9.9	11.6	Bui and Slowik (2025)
Electrolyte production	1.3	3.9	5.8	Bui and Slowik (2025)
Separator production	2.0	3.3	4.6	Bui and Slowik (2025)
Cell manufacturing	41.5	49.7	56.7	Bui and Slowik (2025)
Modules and pack assembly	33.8	52.4	71.0	Bui and Slowik (2025)
Battery recycling	8.4	16.6	23.3	Bui and Slowik (2025)

GREET MODEL METHODOLOGY

To estimate the GHG footprint and water consumption of battery production in Chile, this analysis employed the following steps in the R&D GREET 2024 model, as based on the methodology used in Kelly et al. (2019) with additional steps to account for the latest electricity grid mix in Chile. The share of process fuels in the mineral refining and battery material production processes are not modified.

1. The "Fuel-Cycle Energy Use and Emissions of Electric Generation: Btu or Grams per mmBtu of Electricity Available at User Sites (wall outlets)" for stationary use and for the Chilean Generation Mix in the Greet1_Import_Export sheet were changed to reflect the environmental impacts of Chile's 2023 electricity generation mix as sourced from IEA (2024a), imported from the 2024 R&D GREET1 model.
   - These changes were reflected in the emissions intensity of electricity consumption in LFP cathode material production in the Other_Cathodes sheet, in battery assembly processes in the Battery_Assembly sheet, in BMS production in the Battery_Materials sheet, and in copper production in the Copper sheet.
2. The source of lithium carbonate and lithium hydroxide were changed to Chile in the Li_Chemicals sheet.
3. The copper source was changed to Chile in the Copper sheet.

These changes are assumed to reflect the life-cycle environmental impacts battery pack production in Chile as of 2023.

To evaluate the impact of recycling batteries and recovering lithium material on a battery's life-cycle environmental impacts, the share of lithium carbonate from hydrometallurgical processing in the Battery_recycling sheet was increased to 80% to reflect a lithium recovery rate in Chile similar to that mandated under the EU Battery Regulation.

To evaluate the impact of increasing the share of renewables in the electricity generation mix to 100%, with increased shares of wind and solar generation and the share of hydrothermal generation assumed to remain constant, the grid mix in the stationary use and Chilean Generation Mix in the Greet1_Import_Export sheet was updated with values reflecting the 100% renewable generation mix in the 2024 R&D GREET1 model.

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