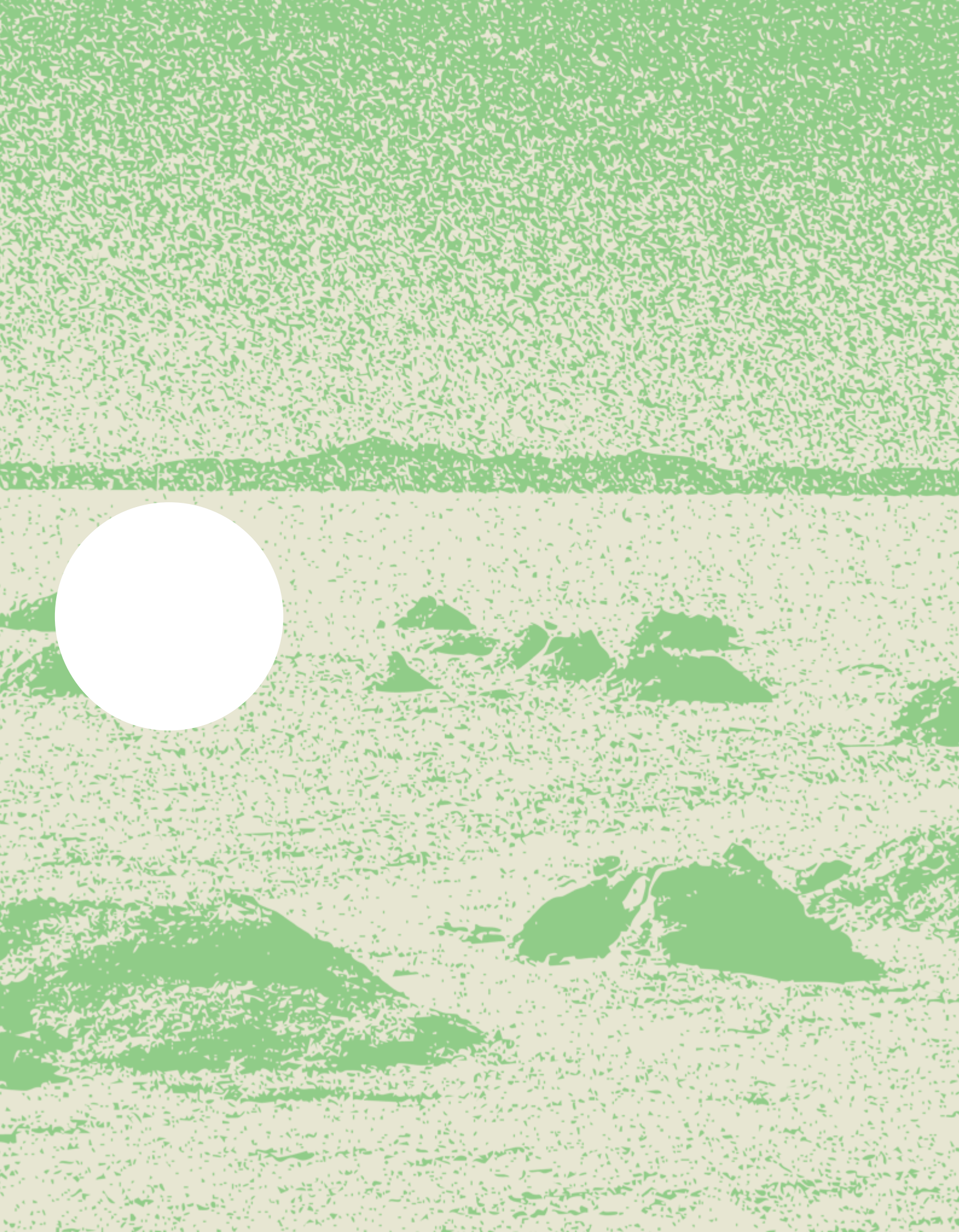
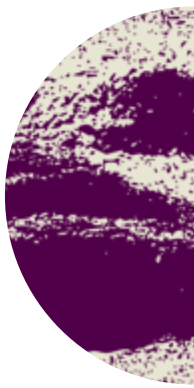




4

**Strategic sectors
for the energy
transition**



Key messages

Rural areas concentrate natural resources—including critical minerals, hydrocarbons, water, land, and renewable energy potential—that the world needs to decarbonize. The global energy transition necessarily runs through the region's rural territories.

Critical minerals represent an opportunity to move beyond the traditional extractive model. Countries in the region, already well-positioned in these markets, must advance toward refining, processing, and manufacturing activities associated with these resources.

Low-carbon fuels open a parallel pathway for energy and productive diversification. Hydrogen and its derivatives, together with biofuels, can serve hard-to-abate sectors and give rise to new industrial value chains.

The expansion of distributed generation and renewable technologies facilitates access to electricity in isolated areas and reduces reliance on biomass. This brings direct benefits for health, productivity, and well-being, while also helping to close territorial gaps.

Regulatory instability, socioenvironmental conflicts, institutional weakness, and transparency gaps can deter investment and exacerbate environmental impacts. Governance and sustainability in extractive sectors are closely intertwined and constitute the main challenge for their development.

To seize the window of opportunity created by the energy transition, stable regulatory frameworks, environmental, social, and governance (ESG) standards, revenue-redistribution mechanisms, technological innovation, and cross-country coordination are essential.



Local supplier development, local-content requirements, workforce training, and technological upgrading help ensure that the rents generated by extractive sectors translate into tangible local impacts in rural areas.



Digital tools, electrification, automation, and monitoring systems enable more efficient and safer processes, while also opening space for new types of rural employment. Technology adoption is a key driver of productivity and of the reduction of environmental impacts.

Strategic sectors for the energy transition¹

Introduction

Rural areas in Latin America and the Caribbean (LAC) occupy a strategic position in the current global context, mainly due to two factors: their capacity to supply essential inputs for the energy transition and their potential contribution to achieving the Sustainable Development Goals (SDGs) and international commitments on climate mitigation and adaptation.

Current energy markets are largely dominated by a small group of oil-producing countries. The energy transition—already underway in most economies—is reshaping the relative importance of key energy inputs, replacing oil and coal with solar, wind, hydropower, natural gas, low-carbon fuels (such as biofuels), and, in the medium term, green and blue hydrogen. These technologies rely on two main inputs: (i) renewable natural resources, such as solar irradiation, wind, water, and land; and (ii) critical minerals, among them copper and lithium, used in the production of key components for electricity grids, solar panels, and batteries.

LAC in general, and its rural areas in particular, are endowed with abundant natural resources. In several rural territories, critical minerals essential to the energy transition are especially prevalent. This endowment positions the region as a potential key player in the ongoing reconfiguration of global energy markets. At the same time, technological advances associated with the energy transition offer last-mile solutions for rural households, enabling countries in the region to progressively close gaps in service provision and infrastructure. These advances can improve the quality of life of rural populations while contributing to the achievement of the SDGs.

This chapter makes two key contributions. First, it provides an overview of LAC's current endowment of natural resources that are critical to the energy transition and their geographic distribution, and analyzes the role of extractive sectors in regional economies, identifying the countries where these sectors are most significant. Second, it highlights the main opportunities and challenges facing

¹ This chapter was written by Juan Odriozola with research assistance from Belén Cañuelo, Delfina Silva, and Emilse Vargas.

LAC countries and proposes policy actions to harness these opportunities along two dimensions. On the one hand, it focuses on positioning the region as an indispensable actor in the global energy transition—a process that is essential for

development and that can facilitate greater and more diversified income flows in rural areas. On the other hand, it examines how the energy transition can be leveraged to improve the quality of life of rural populations.

Strategic resources for the energy transition

Climate change and countries' SDG commitments put mining, hydrocarbons, and energy generation in a strategic position for the region. On the one hand, major global economies are advancing toward decarbonization, posing significant challenges for hydrocarbon-producing countries. On the other hand, demand is rising for critical minerals required for clean technologies—such as solar panels and batteries—as well as for lower-emission hydrocarbons, particularly natural gas. Many of these resources are abundant in the region and, by their nature, are located in rural areas. At the same time, growing demand for low-emission energy is increasing interest in energy inputs such as biofuels and low-carbon hydrogen. Hydrogen and its derivatives are particularly versatile, as they can be used as an energy carrier, a transport fuel, and an input for heavy industry, while also offering storage potential. Finally, as countries move away from coal, natural gas is emerging as a key input for the energy transition, given its lower emissions intensity and reduced local pollution compared with coal.

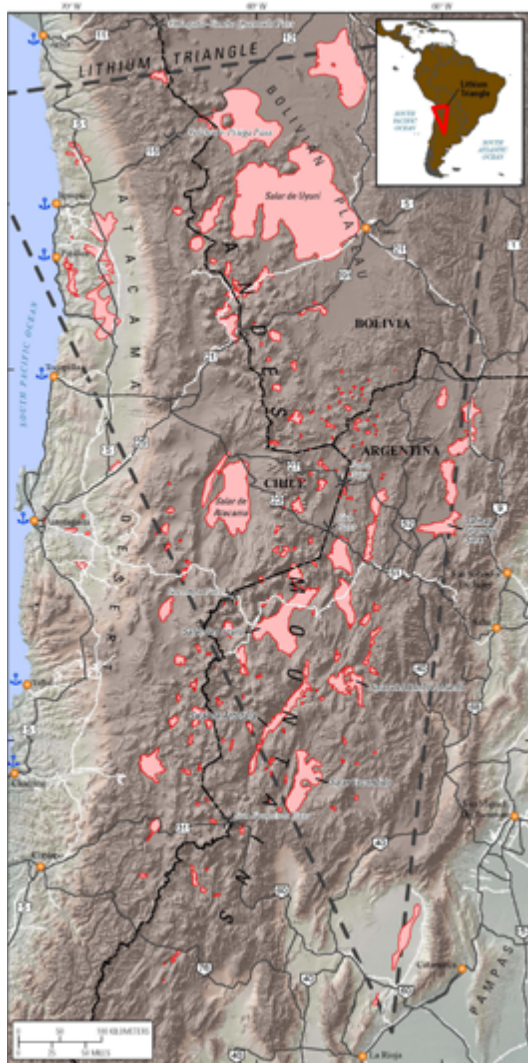


Some LAC countries are global leaders in reserves, extraction, and exports of critical minerals for the energy transition

LAC is a global leader in the extraction, export, and reserves of several critical minerals essential for the energy transition. Chile, Mexico, and Peru together account for around 45% of global copper production, with Chile being the world's leading producer. In addition, the so-called lithium triangle—comprising regions of Argentina, Bolivia, and Chile (Figure 4.1)—concentrates more than 60% of the world's lithium resources (IDB Invest, 2025). This mineral wealth offers a unique opportunity for rural economies to integrate into new global value chains, for example, through lithium refining or component manufacturing.

There are no data that allow for precise identification of the share of mining operations located in rural areas. However, as an activity dependent on natural resource deposits, mining is typically located in remote areas with low population density and therefore tends to have a strong rural presence. In the case of the lithium triangle, reserves are primarily concentrated in salt flats located in arid, high-altitude regions of the three countries.

Figure 4.1
The lithium triangle



Source: Mihalasky et al. (2020).

● ●
Argentina, Bolivia, and Chile form the lithium triangle, which holds the world's largest lithium reserves, while Venezuela has the largest proven oil reserves

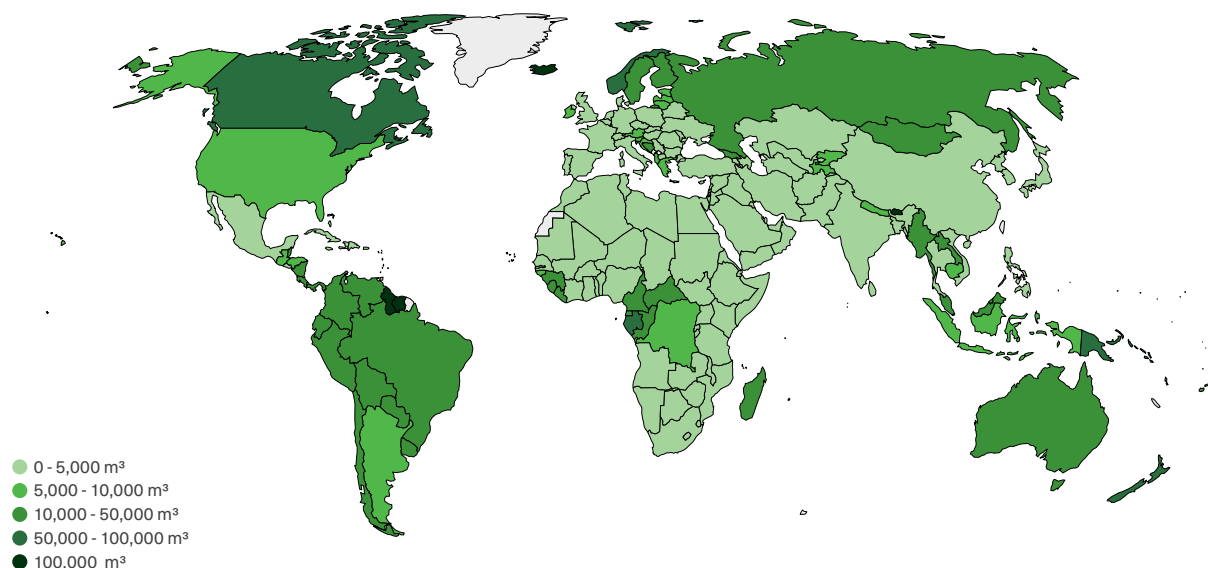
LAC accounts for more than 18% of the world's proven oil reserves and over 4% of global natural gas reserves. Within the region, close to 90% of oil reserves and 70% of gas reserves are located in Venezuela (Olade, 2024). Venezuela holds the world's largest proven crude oil reserves, representing approximately 17% of the global total (IEA, 2024). The transition toward a new economic configuration, characterized by rising demand for electricity generated from renewable sources, introduces considerable uncertainty regarding medium- and long-term demand for fossil fuels. These shifts are already becoming visible in LAC, through growing investment in non-conventional renewable energy (NCRE), public transport electrification, low-carbon hydrogen production, and changes in extraction plans by large mining companies seeking to reduce their carbon footprint (Allub et al., 2024). Natural gas can act as an ally for the region in the energy transition, as it has a lower emissions factor than oil and coal and produces fewer local pollutants than coal. In addition, natural gas is the main input for the production of blue hydrogen, and its reservoirs can be used for storing carbon dioxide (CO₂) captured during the hydrogen production process.

Biofuels stand out as key pillars of the energy transition in transport, particularly in hard-to-abate sectors such as aviation, maritime transport, and heavy-duty road freight (IEA, 2024). Biofuels require organic inputs with high energy density, most commonly sugarcane, maize, sorghum, residues, and organic waste. Their production generally competes with agriculture for land use, and their emissions-mitigation efficiency depends on the feedstock used: waste-based biofuels are the most carbon-efficient, while palm oil and soy are among the least efficient (Brassiolo et al., 2023). A particularly attractive feature for LAC is that biofuels can be produced from organic waste, which is abundant in the region due to the widespread presence of agriculture.

Low-carbon hydrogen is emerging as a medium-term solution for decarbonizing transport and other sectors. Efficient production of green hydrogen requires abundant resources, particularly water, and the capacity to generate renewable energy at low cost and with high reliability. The region has

ample renewable freshwater resources (Figure 4.2) and enormous potential for solar and wind energy generation (see Chapter 1). For blue hydrogen, in addition to access to freshwater, natural gas reserves are required—an input that, as noted above, is abundant in the region.

Figure 4.2
Renewable freshwater sources, 2021



Source: Author based on the FAO (2025o).

The importance of extractive and energy sectors for LAC economies

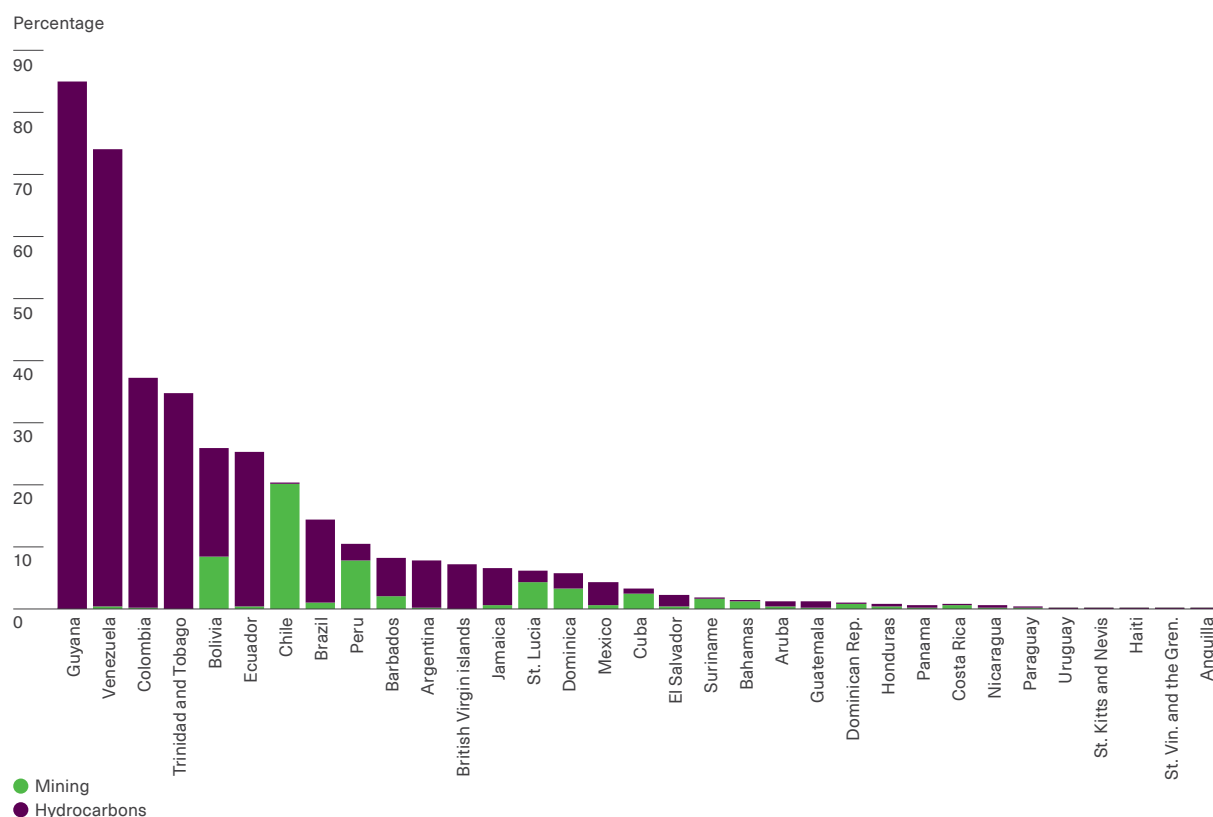
Extractive and energy sectors play a strategic role in several economies in the region, particularly in rural areas, where many of these resources are located. Taken together, the extractive sector (mining and hydrocarbons) accounts for approximately 4% of regional GDP, a share slightly below the average contribution of agriculture at the regional level

(Milano, 2018). Unlike agriculture, whose economic weight is significant in most countries in the region (see Chapter 2), the importance of these subsectors is unevenly distributed across groups of countries. Graph 4.1 shows the share of mining and hydrocarbons in exports across LAC countries. It clearly highlights the export role of mining in Bolivia,

Peru, and especially Chile, where mining exports accounted for 20% of total national exports in 2023. In the case of hydrocarbons, countries in northern South America stand out, particularly Guyana and Venezuela, where hydrocarbons represent close to 85% and 73% of exports, respectively.

In Central America and the Caribbean, although reserves and production are not on the scale observed in Andean countries, valuable mineral resources are nevertheless present. Table 4.1 presents the main exported mineral resources, together with other mined resources, in six countries with available data.

Graph 4.1
Share of mining and hydrocarbons in exports, 2023



Source: Author based on UNCTAD (2025b).

Table 4.1
Main mineral resources in selected Central American and Caribbean countries

Country	Main exported resources	Other important mineral resources
Jamaica	Aluminum oxide	Bauxite, alumina, gypsum, limestone, copper, gold
Nicaragua	Gold	Silver, copper
Panama	Copper ore	Copper, gold, iron
Dominican Republic	Gold	Nickel, silver, copper
Suriname	Gold, bauxite	Alumina

Source: Stancu et al. (2025) and USGS (2024b).

Despite favorable natural conditions and the potential to use agricultural residues, biofuel production is not widespread in LAC, with the notable exception of Brazil. This South American country is the region’s leading producer and the second largest globally, accounting for close to 20% of global production. Moreover, the sector has expanded significantly in the country, growing by 41% over the past decade (Torroba & Chiara, 2024). Brazil also exhibits biofuel use well above the global average: approximately 80% of new vehicles operate on gasoline blended with high proportions of ethanol (Sousa et al., 2023), reflecting mandatory ethanol-blending policies.

● ●

Brazil is the world’s second-largest producer of biofuels, accounting for 20% of global production

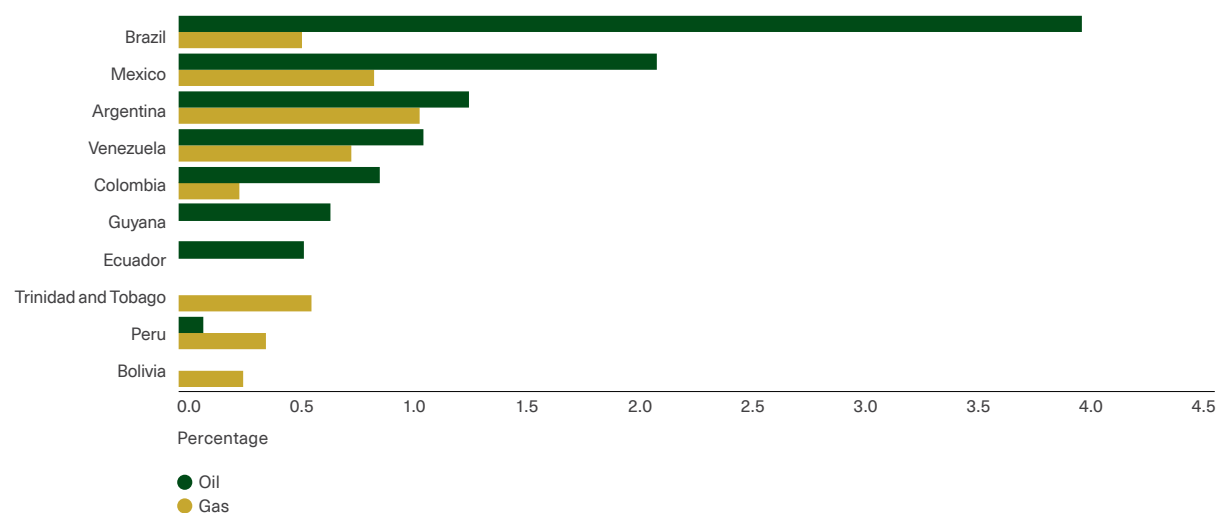
Bioenergy supplies close to one-fifth of total energy consumption in LAC, mainly through the use of biomass. Around one-sixth of this energy is used in households—predominantly rural—for cooking or heating, exposing residents to harmful particulate matter (Allub et al., 2024). In LAC, nearly 75 million people—11% of the population—lack access to clean cooking energy (IEA, 2023b).

Although most of the region’s oil and gas reserves are located in Venezuela, LAC countries play a significant role in global markets, accounting for about 11% of global oil production and nearly 5% of natural gas production (Graph 4.2). More than 60% of regional oil and gas production is consumed within LAC itself (IEA, 2023b). Coal production in the region is largely concentrated in Colombia, where coal and oil together accounted for 55% of the country’s exported goods in 2022 (IMF, 2023).

Extractive sectors are also important sources of national and subnational fiscal revenues through taxes, royalties, and other levies. This has direct implications for financing rural development projects via national budgets and transfers to producing regions. Table 4.2 shows mining-related fiscal revenues as a share of GDP in 12 LAC countries. These revenues can reach close to 3% of GDP, as in Chile, although the regional average is below 1%. Table 4.3 presents fiscal revenues from oil and gas exploitation and production as a percentage of GDP: in 2023, they reached 11.7% in Trinidad and Tobago and 9.4% in Guyana, with a regional average close to 4%.

Graph 4.2

Share of Latin American and Caribbean countries in global oil and natural gas production, 2024



Note: The bars represent the percentage of global production for each hydrocarbon.

Source: Author based on Energy Institute and Smil (2025; 2017), with major processing of Our World in Data.

Table 4.2

Mining fiscal revenues as a percentage of GDP, 2023

Country	Tax revenues	Non-tax revenues
Argentina	0.02%	0.01%
Bolivia	0.44%	0.54%
Brazil	0.10%	0.09%
Chile	0.90%	1.41%
Colombia	0.91%	0.59%
Dominican Republic	0.32%	0.27%
Ecuador	0.17%	0.16%
Guatemala	0.01%	0.00%
Jamaica	-	0.07%
Mexico	0.19%	-
Nicaragua	0.39%	0.18%
Peru	0.66%	0.23%
LAC	0.32%	0.27%

Note: Non-tax revenues are revenues that do not meet the OECD definition of "taxes." This category includes grants from foreign governments or international organizations, rents and royalties, other property income, sales of goods and services, fines and penalties, and miscellaneous and unidentified revenues (OECD et al., 2025).

Source: Author based on ECLAC (2025b).



Refinery in operation in Lujan de Cuyo,
Mendoza, Argentina.

Table 4.3
Oil and gas fiscal revenues as a percentage of GDP, 2023

Country	Tax revenues	Non-tax revenues
Argentina	0.06%	0.40%
Bolivia	0.13%	2.85%
Brazil	0.61%	1.16%
Colombia	1.25%	2.15%
Ecuador	-	7.64%
Guatemala	0.02%	0.01%
Guyana	-	9.43%
Mexico	0.02%	1.08%
Peru	0.32%	0.46%
Trinidad and Tobago	6.68%	5.01%
LAC	0.91%	3.02%

Note: Non-tax revenues are revenues that do not meet the OECD definition of “taxes.” This category includes grants from foreign governments or international organizations, rents and royalties, other property income, sales of goods and services, fines and penalties, and miscellaneous and unidentified revenues (OECD et al., 2025).

Source: Author based on ECLAC (2025b).

While these sectors generate high value added and are crucial for foreign exchange earnings and fiscal revenues, they are not labor-intensive. As shown in Graph 4.3, the share of employment generated by mining in Andean countries is notably low—below 2%, and below 1% in some countries with large mining sectors, such as Bolivia and Peru. Employment in hydrocarbons is consistently below 1%. These figures generally underestimate artisanal and small-scale mining due to its high levels of informality and underreporting. This data gap also obscures other sector-specific heterogeneities, such as the masculinization of mining employment and the growth of informal female employment and its implications for rural women’s incomes (see Box 4.1).



Mining remains a traditionally male-dominated sector, although gradual changes are underway. Access to mining employment plays an important role in the economic independence of rural women

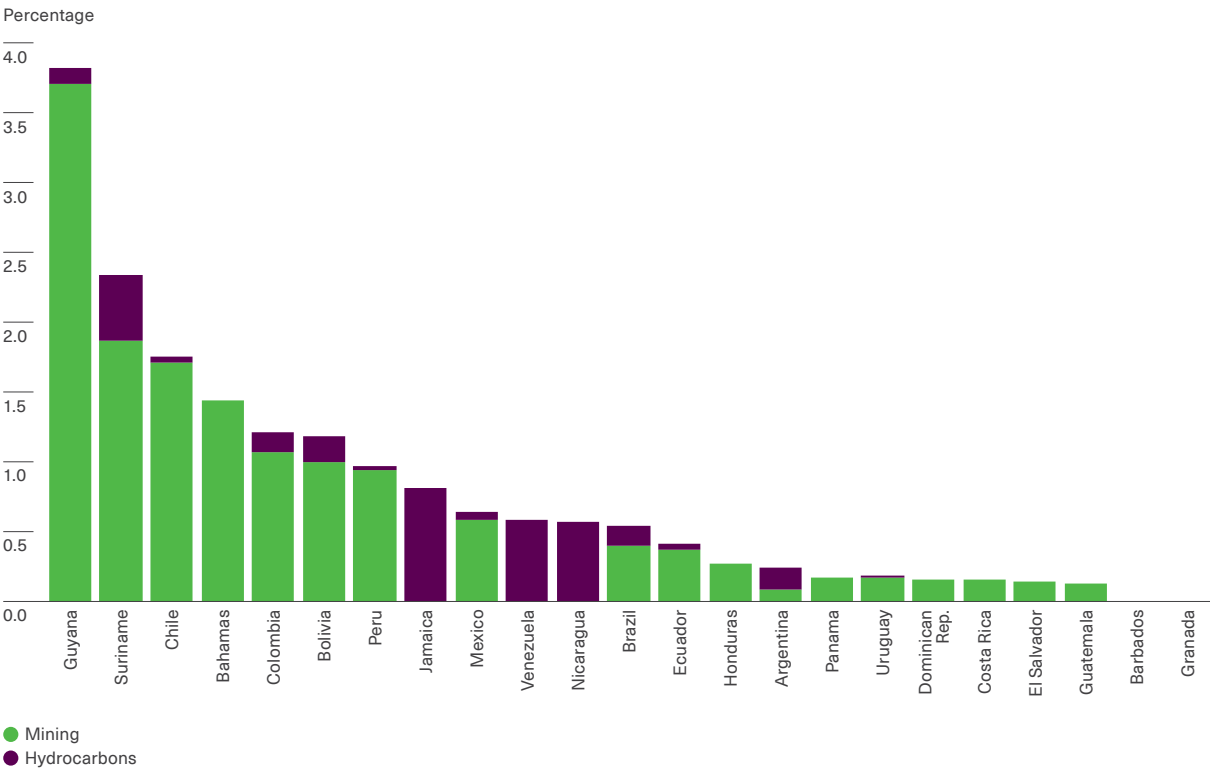
Part of this heterogeneity reflects the differing roles of large-scale mining and artisanal or small-scale mining. Large-scale mining is typically carried out by multinational firms that are highly productive, capital-intensive, and technologically advanced, offering formal jobs with above-average wages, better working conditions, and relatively low labor demand. Artisanal and small-scale mining includes a more diverse set of actors, ranging from small formal firms with low capital intensity to informal independent miners, and often coexists with illegal mining. Illegal mining is more prevalent in gold extraction and less so in resources critical to the energy transition, such as lithium—which

requires more capital-intensive and technologically advanced extraction—or copper, where illegal activities tend to occur on lower-yield veins with less environmental impact than illegal gold mining (Pachas, 2024).

Household survey data allow identification of rural employment within mining, as shown in Graph 4.4.

The region displays considerable heterogeneity: in Chile, with large mining operations, rural employment represents around 10% of total mining employment, whereas in Central American countries such as Costa Rica and El Salvador, it has fluctuated between 50% and 80% over the past two decades.

Graph 4.3
Share of mining and hydrocarbons in total national employment, 2023



Source: Author based on ILO (n.d.).

Box 4.1

The situation of women in mining in LAC

Mining is a traditionally male-dominated sector. Although data limitations prevent a comprehensive characterization, it is estimated that in countries with a strong mining presence, women account for roughly one in ten mining jobs. In recent years, however, there has been a gradual increase in women's participation in the sector.

This trend is mainly driven by three factors. First, sector modernization has reduced tasks involving high physical demands and risk. Second, demand for skilled labor has increased—a segment where women have higher labor force participation. Third, companies have adopted formal gender-equality commitments and public policies promoting gender equity have been implemented.

Nevertheless, significant frictions remain. These include requirements for specific training or prior experience that limit women's ability to compete for positions and perpetuate sectoral masculinization. Another major barrier is the sector's androcentric culture, which exposes women workers to discriminatory practices, abuses of power, exclusion, and so-called “camouflage strategies”—behaviors aimed at going unnoticed, such as changes in dress or self-invisibilization at the workplace—further deepening exclusion.

Although masculinization is gradually declining, the largest growth in female employment has occurred in artisanal and small-scale mining. This segment is characterized by poorer working conditions, lower incomes, and even more androcentric cultures. At the same time, it provides rural women with economic independence and flexibility to manage household responsibilities, where women remain overrepresented (Marchionni et al., 2025).

Source: Author based on Puglia et al. (2024).



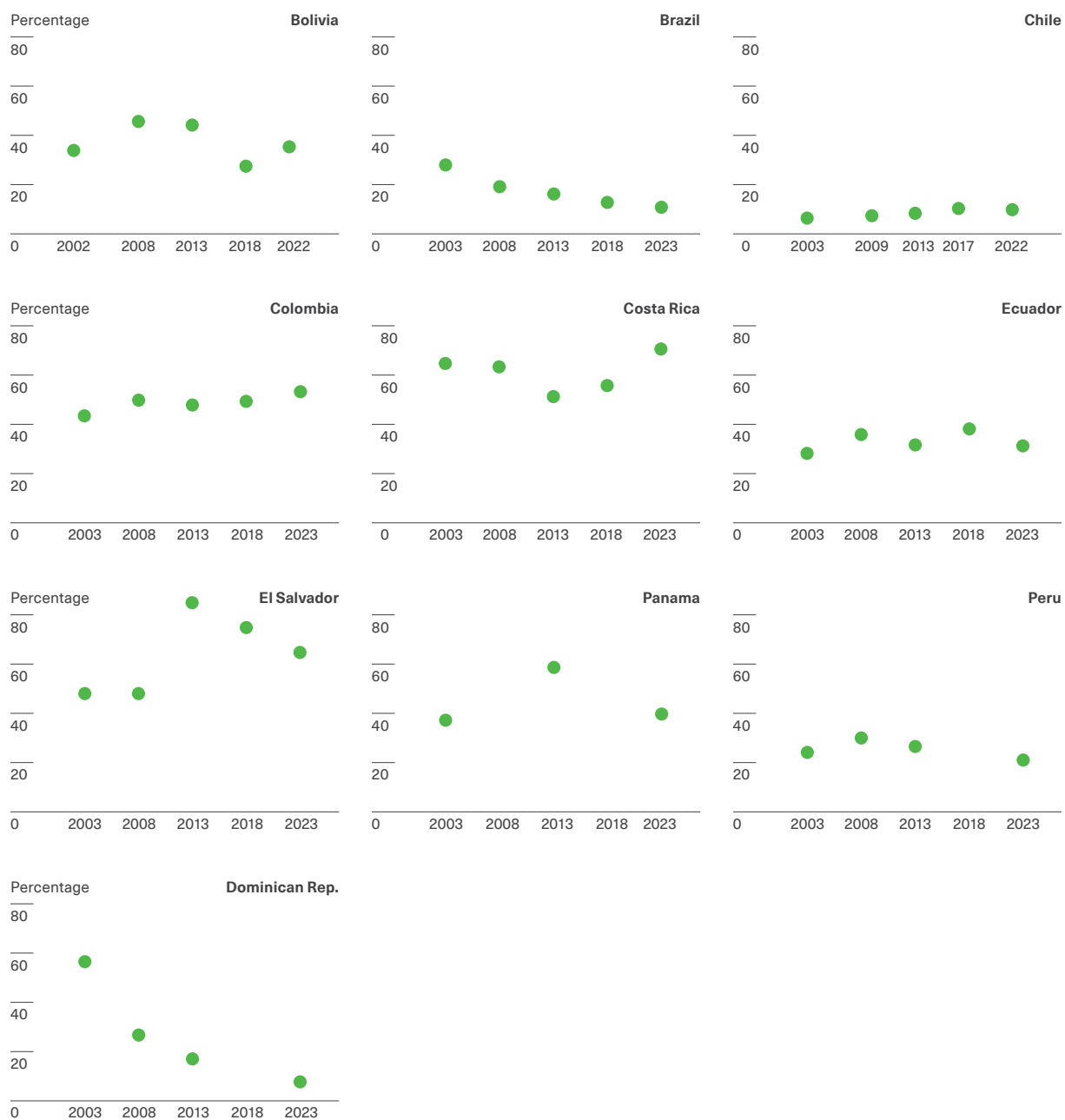
Mining wages are generally higher than average rural wages, reflecting higher demand for skilled labor, but also the presence of unskilled jobs with more precarious and unsafe working conditions

Low labor demand in these sectors reflects their high capital intensity. In contrast, average wages are high relative to rural averages. As shown in Graph 4.5, mining wages in all South American

countries are significantly higher than average rural wages over at least the past 20 years. In Central America, this pattern holds for Panama, but not consistently for other countries, partly due to the greater presence of artisanal or small-scale mining. This may reflect the creation of skilled jobs, but also the prevalence of unskilled jobs with more precarious and unsafe working conditions.

Graph 4.4

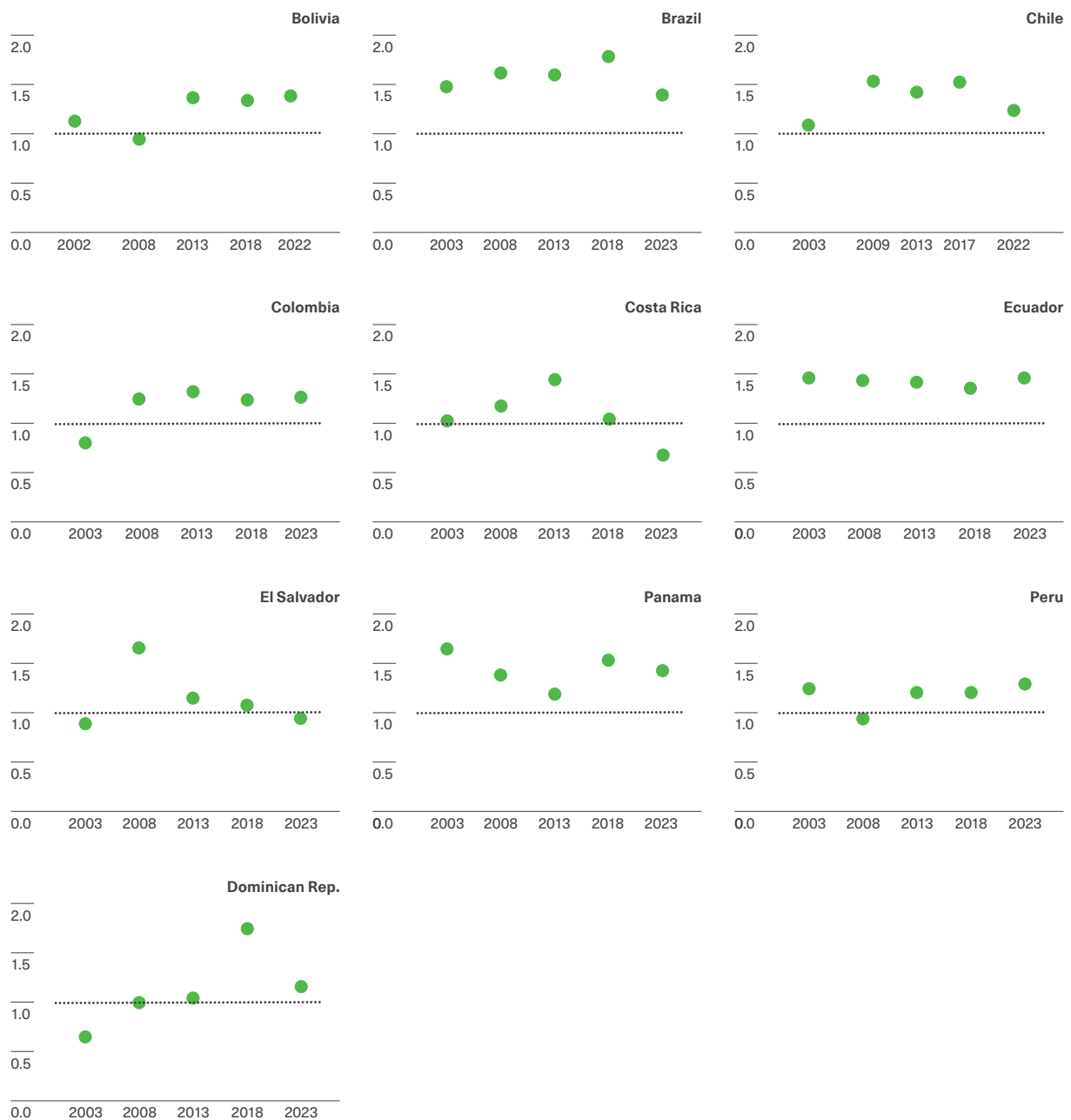
Rural employment in mining relative to total mining employment



Source: Author based on CEDLAS (2025).

Graph 4.5

Rural mining wages relative to average rural wages



Source: Author based on CEDLAS (2025).

Opportunities and challenges

Rural areas in LAC will be central to the energy transition, given their abundance of natural resources. At the same time, the energy transition will play an important role in rural areas, primarily by

improving living conditions. The former is essential for the development of regional economies, while the latter is key to closing gaps in living standards and advancing progress toward the SDGs.

Rural areas as suppliers of inputs for the energy transition

Two main opportunities stand out that could allow the region to position itself as a key player in energy markets over the medium term. The first lies in the extraction, production, and development of value chains for critical minerals required for the energy transition. The second involves the production of low-carbon fuels. Advancing along these two paths would enable the region not only to play a decisive role in global energy markets, but also to accelerate its own energy transition and meet its nationally determined contributions (NDCs).²

These opportunities, however, are not without challenges. In the case of critical minerals, two closely related constraints stand out. The first concerns the environmental impacts of mining activities, particularly the degradation and overexploitation of water resources and damage to landscapes and ecosystems. The second relates to governance challenges, including regulatory uncertainty, resource nationalism, unstable institutional frameworks, and climate-driven opposition to mining activities. For low-carbon fuels, the main constraints stem from tensions with other key sectors—most notably agriculture—due to competition for land and, in the case of freshwater, potential threats to local consumption. Finally, harnessing both opportunities will require substantial investment. The region will need to act to create the right incentives, while also ensuring the effective capture of resource rents.

Critical minerals, governance, and sustainability

According to the most recent Critical Minerals Report by the International Energy Agency (IEA, 2025b), demand for critical minerals has already increased sharply. In 2024 alone, global demand for lithium rose by nearly 30%, while demand for nickel, cobalt, graphite, and rare earths increased by between 6% and 8%, accompanied by higher production that remains concentrated among a limited number of suppliers. Graph 4.6 presents projected demand for critical minerals under three IEA decarbonization scenarios. Over the next 25 years, total demand for these minerals could nearly double, with particularly strong growth for lithium—almost five times its 2024 level—and increases of 50–60% for other minerals such as cobalt and rare earths by 2040.

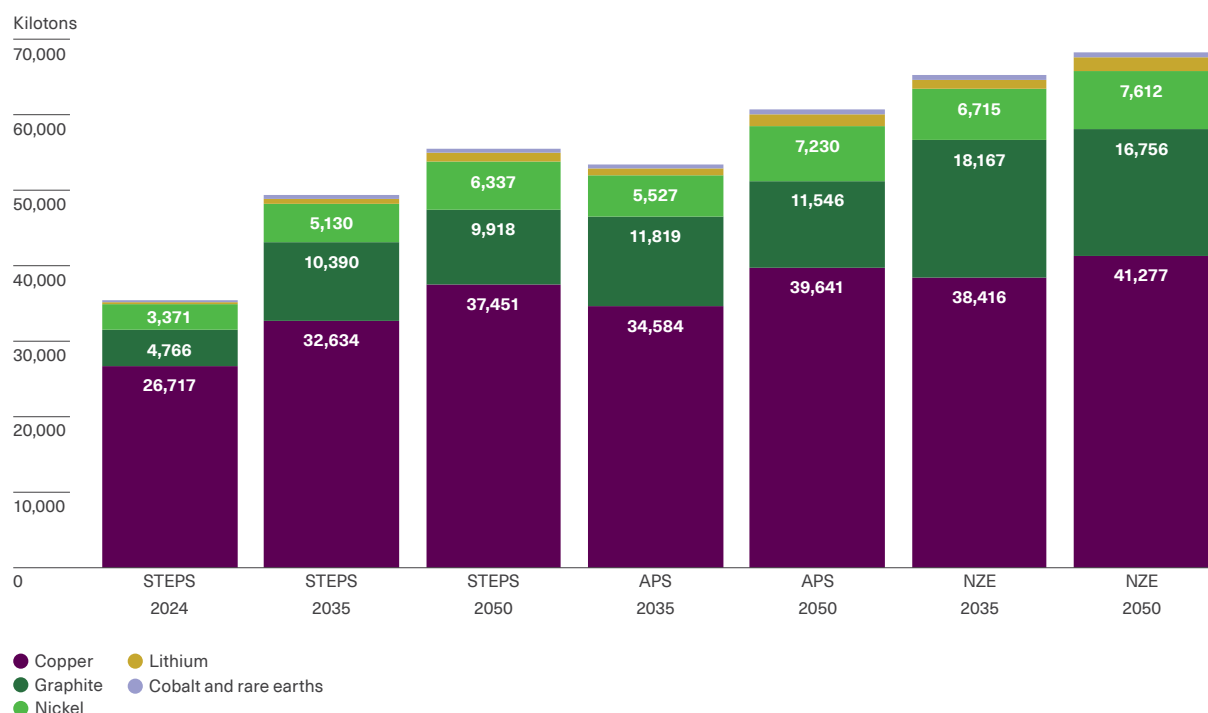


Over the next 25 years, demand for critical minerals could double, with lithium expected to see the largest increase

² The Paris Agreement requires countries to submit nationally determined contributions every five years, reflecting progressively greater ambition in their mitigation targets while taking into account each country's capacities and specific circumstances.

Graph 4.6

Projected demand for critical minerals under alternative scenarios



Note: Demand is expressed in kilotons. STEPS refers to the Stated Policies Scenario, which includes existing policies and those under development or implementation. APS refers to the Announced Pledges Scenario, which incorporates policies that have been announced but not yet implemented. NZE refers to the Net Zero Emissions by 2050 Scenario.

Source: Author based on IEA (2025a).

LAC has the reserves required to ensure a reliable supply of critical minerals for the global energy transition. Countries such as Chile and Peru are already key players in mineral markets. However, when comparing countries' shares of global reserves and production of copper and lithium (Graph 4.7), there remains significant untapped potential to expand production. Lithium provides a notable example: the market is currently dominated by Australia, despite the fact that Australia has smaller reserves than Chile and Bolivia.³

This outcome reflects two main factors. First, deposit characteristics differ. Australia's lithium is primarily found in hard rock (spodumene), which allows the use of traditional mining methods and shorter development timelines. In contrast, lithium reserves in Chile and Bolivia are located in brine deposits, which require newer technologies and chemical processes with much longer development times. Second, governance models vary. Australia has a highly developed private mining sector and service providers, whereas lithium in Bolivia is under strong state control, limiting foreign investment and

³ Reserve data do not include Bolivia. Although Bolivia has been identified as the country with the world's largest lithium resources, these are not yet considered economically, technically, or legally exploitable (USGS, 2024a).

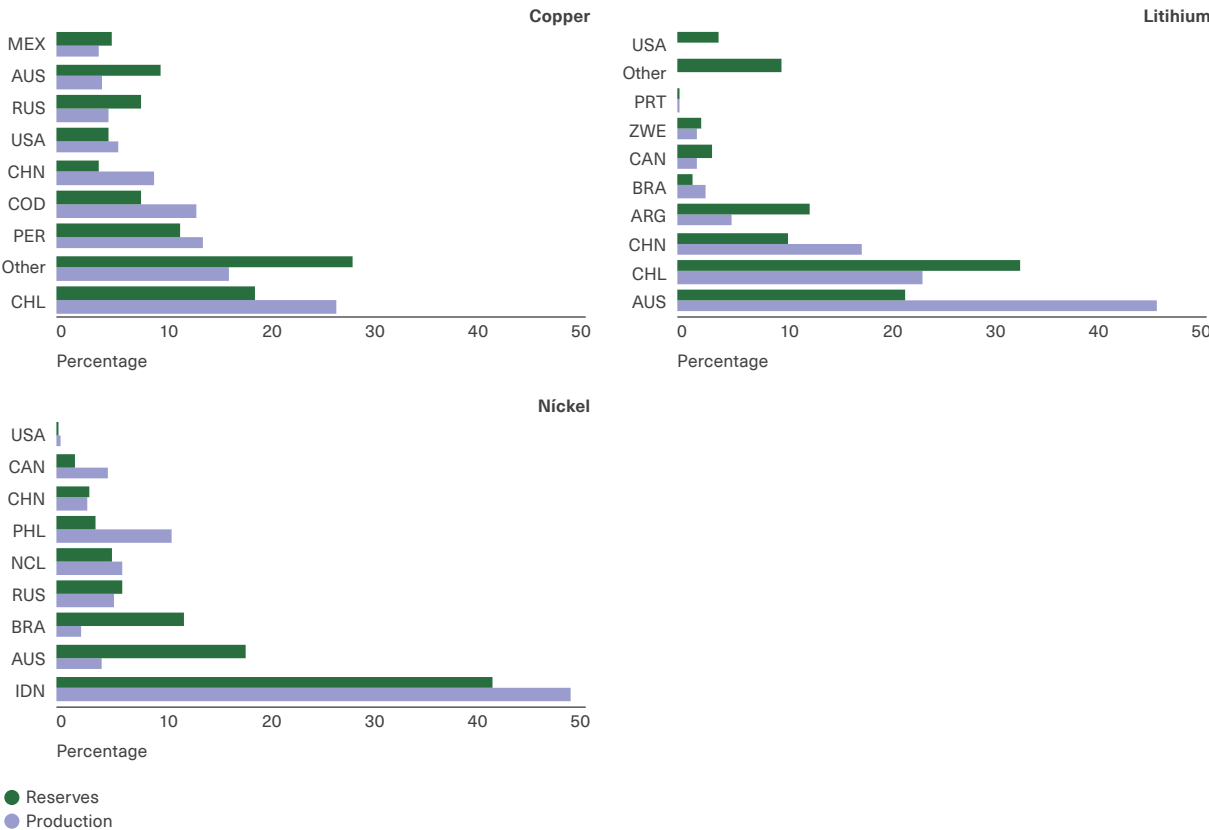
leading to political or contractual delays. In Chile, public and private actors coexist, but regulatory constraints, debates over state participation, and environmental litigation have slowed some projects.

Another relevant mineral is nickel. Brazil holds the largest nickel reserves in the region and the third largest globally, accounting for 12% of global reserves, yet it contributes only 2% of global production (USGS, 2024a).

Lithium presents a particularly complex case for the region. As noted earlier, deposit characteristics strongly influence development timelines and

extraction costs. Brine-based lithium projects are capital-intensive, with initial costs ranging from USD 300 million to USD 900 million (Razmjou, 2024) and estimated development periods of 5–12 years. As a result, even in the absence of governance constraints, the region’s response to global demand is inherently slower. The discovery of hard-rock deposits in other economies and the rapid expansion of production in those sites erode LAC’s dominance and diversify global supply, reducing geopolitical pressure on buyers. Although LAC still holds the world’s largest lithium reserves, it is gradually losing its comparative advantage.

Graph 4.7
Shares of global copper, lithium and nickel production and reserves, 2023



Source: Author based on Ritchie and Rosado (2024).



LAC countries that lead in lithium reserves and production will need to move up the value chain, particularly in refining and battery manufacturing

To remain competitive, the region must move up the lithium value chain, particularly in refining and battery production (ECLAC, 2023; López et al., 2019). Refining activities have shorter development timelines and generate more employment and value added than extraction alone. Additional investment in this segment could create opportunities for growth and economic diversification, including the development of local processing capabilities and the manufacture of components for clean-energy technologies (IEA, 2023b). Some countries, such as Chile, have already taken steps in this direction by financing research and development linked to lithium industrialization (ECLAC, 2023). However, significant challenges remain, including limited access to technology and specialized skills, cost-competitiveness constraints, the geographic concentration of demand, and market barriers for new entrants (IEA, 2023c).

In many cases, the region has the technical capacity and infrastructure required to exploit critical minerals for the energy transition. Nonetheless, political, economic, and regulatory instability, and social resistance, are associated with governance challenges, potentially weakening environmental protection, rent capture and distribution, and incentives for innovation. In this regard, LAC is the region with the highest number of reported environmental, social, and governance complaints raised by local communities (IEA, 2023b). The proliferation of mining conflicts in Chile, Peru, and Bolivia further illustrates the tensions surrounding some projects (Lagos et al., 2022). For example, Peru's Office of the Ombudsman reported 123 socioenvironmental conflicts related to the mining industry in 2016, representing 65% of all conflicts recorded in the country that year (FIO et al., 2020).

These challenges are not unique to mining. In the hydrocarbons sector, beyond well-documented oil spills, protests have emerged around hydraulic fracturing (fracking). One example is the conflict with Mapuche communities opposing this practice in Vaca Muerta, Argentina (Acacio & Wyczykier, 2021). In some cases, even non-conventional renewable energy projects face resistance due to visual impacts and potential land devaluation associated with wind or solar farms (Dröes & Koster, 2021; Gaur & Lang, 2020).

Low-carbon fuels

Low-carbon fuels whose production benefits from the abundance of natural resources found in rural areas of LAC include hydrogen and its derivatives, as well as fuels of agricultural origin. Low-carbon hydrogen represents a particular case, given its current cost structure, which makes it relatively expensive compared with other petroleum-based energy products (Allub et al., 2024; IEA, 2024). However, these costs are trending downward, and in the case of LAC, conditions are in place to produce green hydrogen at the lower end of the global cost range (IEA, 2024).



The production of low-carbon fuels in Latin America and the Caribbean benefits from the abundance of natural resources in rural areas

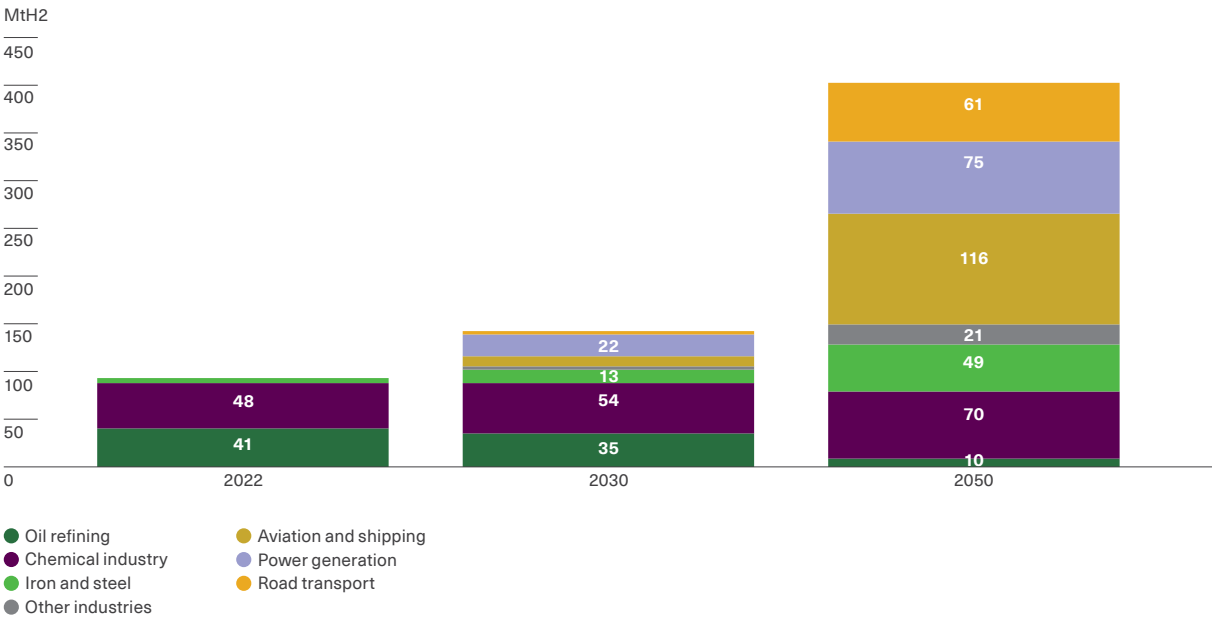
Hydrogen and its derivatives, such as ammonia and methanol, are attractive because they are versatile energy carriers that can be used as fuels for aviation, maritime, and land transport, as well as for heat generation in hard-to-abate industrial processes, including steel and cement production (Allub et al., 2024). Another important feature of hydrogen is its potential for energy storage, although its handling and transport pose technological challenges specific to the industry. These aspects are illustrated in Graph 4.8, which

shows current uses of green hydrogen in 2022 and projected uses under the IEA's Net Zero Emissions scenario (left axis).

The graph also shows, on the right axis, the projected share of green hydrogen in total hydrogen demand under the same scenarios for 2030 and 2050. In the Net Zero scenario, hydrogen production would need to increase by more than 300%, with green hydrogen accounting for a significant share—reaching 97% by 2050. The advantages already identified position LAC as a potential key player in these markets. To do so, however, the region must overcome challenges related to financing capacity, private investment attraction, and the regulation of water resources.

Production costs are one of the main constraints on accelerating low-carbon hydrogen production. The IEA (2024) estimates global levelized costs of green hydrogen production by 2030. Based on these projections, Latin America and Australia together could supply close to 50% of the hydrogen required under decarbonization scenarios, with production falling within the lowest cost range. These projections do not account for the cost or availability of freshwater—dimensions that further strengthen LAC's position relative to other potential suppliers, such as Middle Eastern countries, where access to freshwater is more limited.

Graph 4.8
Uses of green hydrogen under the Net Zero Emissions scenario for 2050



Note: The 2022 data correspond to actual use, while 2030 and 2050 figures are IEA projections under the Net Zero Emissions scenario (IEA, 2023c).
Source: Allub et al. (2024) based on IEA (2023c).

Most hydrogen projects announced in LAC rely on water electrolysis (green hydrogen), a technology that requires intensive use of freshwater.⁴ However, the volume of water needed to produce an amount of green hydrogen consistent with net-zero targets—through partial substitution of hydrocarbons—would represent only between 0.06% and 0.12% of current agricultural water withdrawals (IEA, 2023b). For this reason, such projects must be located in areas without water stress, ensuring adequate access to freshwater for both production and human consumption. It is worth noting that most of the large-scale hydrogen projects announced in the region and located in coastal countries (Chile, Colombia, and Brazil) plan to use desalinated seawater, thereby avoiding competition for freshwater resources.



Latin America and Australia could supply nearly half of the hydrogen required under decarbonization scenarios, at the lowest production cost range

The potential for biofuels remains largely untapped in LAC, with the clear exception of Brazil. According to the IEA (2023b) the region could produce nearly 200 billion cubic meters equivalent

(m³e) of biogas and biomethane from agricultural residues and waste, of which at least 10% would be located within 20 kilometers of major gas pipelines. This proximity makes large-scale production and injection into gas networks feasible. In addition, nearly half of this potential would be close to road networks, facilitating transport for refining and use in transport. While more than half of this potential would be concentrated in Brazil, the study also identifies production opportunities in Argentina, Chile, Costa Rica, and Mexico.

The potential of these biofuels is significant for three main reasons. First, biomethane can directly substitute fossil fuels in transport without requiring vehicle modifications. Second, biogas has multiple applications, including electricity generation, heat production, injection into natural gas networks, or conversion into biomethane for transport use. Third, by using agricultural residues, biofuel production fosters local linkages and provides a source of productive diversification and new income opportunities for rural populations.

One of the main constraints on the development of low-carbon fuels overall is access to financing. With the exception of large-scale renewable energy projects, local banks often lack the capacity to assess the risks of clean energy investments. In addition, data availability and reliability—identified throughout this report as a key shortcoming—are essential for improving transparency and enabling access to credit for these projects.

The contribution of the energy transition to local development

Beyond the two major opportunities offered by critical minerals and low-carbon fuels for rural development in the region, energy markets provide two additional pathways with the potential to improve living conditions. The first stems from the sharp decline in the costs of residential solar panels and distributed generation, which makes it possible to reach rural households and producers

in isolated areas without the need for large-scale infrastructure investments. The second relates to the ability of rural households to replace the use of biomass for cooking and heating—an important source of indoor air pollution due to particulate matter released during combustion—with cleaner alternatives. These include electricity (for air conditioning and electric stoves or ovens) or

4 Approximately 10 liters of water per kilogram of hydrogen (L/kg H₂) as an input, plus an additional 30–70 L/kg H₂ of water for cooling processes (IEA, 2023b).

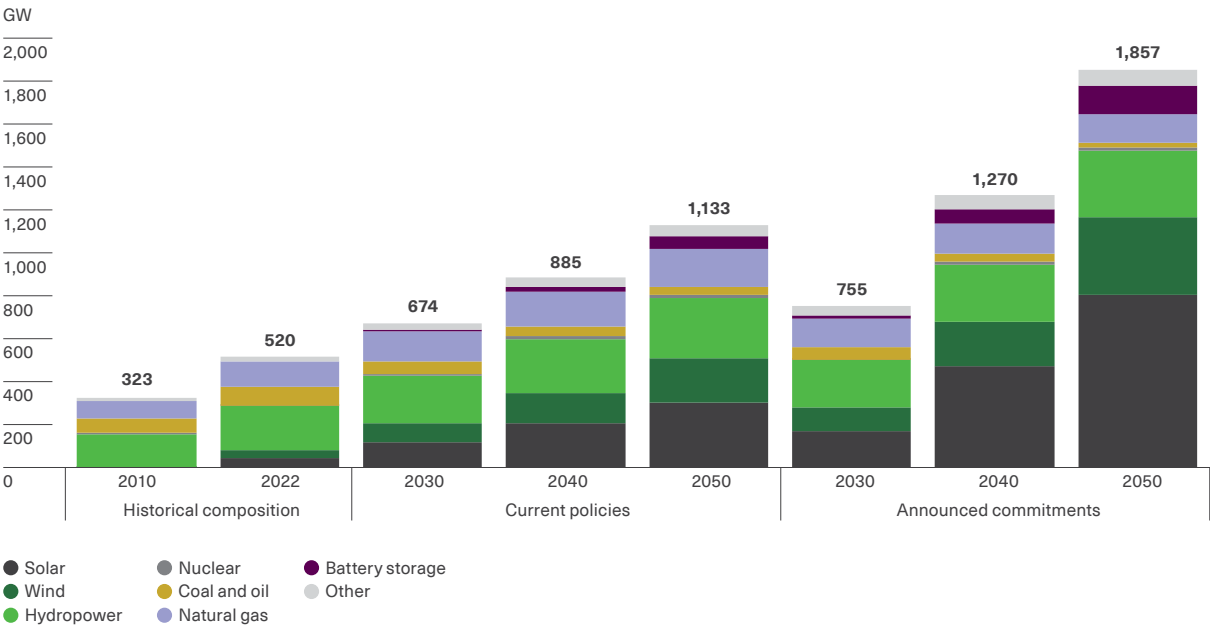
natural gas (for heaters and cooking appliances). In addition, investment in and development of energy and mining projects in rural areas can generate spillover effects on local infrastructure and employment.

Projected electricity capacity in LAC over the coming years, shown in Graph 4.9, points to significant increases across all scenarios, driven primarily by non-conventional renewable energy (NCRE), with solar power playing a dominant role. As shown in Chapter 8, part of the recent expansion of distributed solar energy has

accompanied the process of extending electricity networks into rural areas.

● ●
The decline in distributed generation costs and the resulting improvement in electricity access enable the replacement of biomass for cooking and heating, improving indoor air quality in rural homes

Graph 4.9
Current and projected electricity capacity



Source: Allub et al. (2024) based on IEA (2023b).



Salar de Uyuni, Bolivia.

Leaving aside artisanal and small-scale mining and the private installation of solar panels, large firms dominate most of the activities discussed in this chapter. From a social perspective, this translates into the creation of formal employment—both skilled and unskilled—with wages that are generally higher than average rural wages (Graph 4.4). The establishment of large facilities also increases demand for local goods and services, such as food, transport, and housing, thereby stimulating private investment and job creation. However, these benefits depend critically on the extent to which extractive and energy companies integrate with local economies (Bainton, 2020; Remy & McMahon, 2001). In the case of large mining operations, it is not uncommon for most inputs and skilled labor to be sourced externally, limiting potential benefits for rural communities while also introducing cultural frictions (Addison & Roe, 2024; Aragón & Rud, 2013). Moreover, increases in demand that are not matched by income growth can generate local inflation, gentrification, and rising inequality, potentially displacing local communities (Arellano-Yanguas, 2011a).

Large companies can also generate significant sociocultural changes, some of which may pose challenges for rural communities. The arrival of non-local workers may represent a cultural shock for communities with long-standing rural livelihoods (Romero-Toledo, 2019). Such reconfigurations can, in some contexts, be associated with increases in

sex work—often linked to human trafficking—and heightened insecurity (Eftimi et al., 2009). Additional impacts may arise from changes in land use, particularly when industrial operations are developed in areas previously used for agriculture or holding cultural or heritage value for Indigenous or local communities.

●● The development of large projects driven by the energy transition can generate new dynamics in rural employment and have positive spillovers for local infrastructure

At the same time, growing demand for both minerals and renewable energy can give rise to new dynamics in rural employment, shifting jobs from traditional extractive activities toward those linked to emerging technologies. These include construction of hydrogen or biofuel production facilities (where located in rural areas), installation of enabling infrastructure, and operation and maintenance of solar and wind parks. In addition, the energy transition can create permanent, high-quality jobs, particularly in hydrogen and biofuel plants and in large-scale mining operations.

Policies for rural-led and rural-inclusive development

The global energy transition is still at an early stage, although it has already made significant progress in areas such as NCRE and electric vehicles. This makes it crucial for LAC countries to seize the current window of opportunity to deepen the diversification of rural economies. To do so, the region must address the constraints discussed

earlier, including those that are intrinsic to some countries—such as higher political, economic, and regulatory instability or the need to attract private investment—as well as challenges that are specific to these sectors, such as mineral governance and the mitigation of environmental impacts.



CAF Action.
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Governance and sustainability of extractive sectors

A common challenge across extractive activities is the need to strengthen natural resource governance. This requires clear legal frameworks, strong institutions, and effective anti-corruption measures. Transparency in the management of extractive rents is critical. Initiatives such as the global standard of the Extractive Industries Transparency Initiative (EITI), to which ten LAC countries⁵ have already adhered, commit participating countries to disclose information along the entire value chain of the industry (Chêne, 2017; EITI, 2023). Prudent fiscal rules are also recommended to manage the volatility of revenues generated by extractive industries—for example, through the creation of stabilization funds or sovereign wealth funds that accumulate savings during boom periods. Peru's Fiscal Stabilization Fund is one such example (Sy et al., 2012; MEF, 2025). Equally important is ensuring compliance with existing laws and the effective monitoring and sanctioning of illegal activities. This helps increase investor confidence, reduce risks to private investment, and lower levels of social conflict. Achieving these objectives requires strengthening monitoring capacity, particularly environmental monitoring, reinforcing labor regulation and supervision to prevent abuses and informality, and improving coordination across different levels of government.



Governance and sustainability in extractive sectors are closely intertwined and represent the main challenge for countries in Latin America and the Caribbean

The private sector plays a fundamental role in the exploitation and development of natural resources, given both its technical capacity and its financial contribution. In mining countries across LAC, a substantial share of foreign direct investment (FDI) is already directed toward strategic sectors such as mining, hydrocarbons, and, more recently, critical minerals. Examples include offshore discoveries and exploration in Guyana, large-scale investments in Vaca Muerta in Argentina, and FDI in traditional mining in Peru.

Leveraging this FDI requires clear, stable, and long-term state policies that recognize that comparative advantages derived from natural resource endowments translate into development only when predictable rules are in place. However, in several countries, tensions linked to resource nationalism and perceptions of legal uncertainty persist, shaping investment decisions and limiting sectoral potential. Overcoming these barriers requires strengthening institutions, ensuring predictable regulatory frameworks, and promoting public–private partnership mechanisms that facilitate responsible and sustainable private-sector participation.

In this context, governments can contribute by establishing and prioritizing long-term state policies to attract investment in mining and processing activities, defining clear regulations and incentives, and ensuring compliance with environmental, social, and governance (ESG) standards.⁶ Governments must also strengthen existing legal frameworks to ensure that mineral and hydrocarbon extraction minimizes environmental and social impacts. Sector sustainability is essential to effective governance. This also requires dialogue with stakeholders, including investors and local communities, as well as greater regional cooperation. Prioritizing rural communities' access to safe drinking water is a clear example. If a project requires large volumes of water, it should include investments to improve

⁵ They are Argentina, Colombia, the Dominican Republic, Ecuador, Guatemala, Guyana, Mexico, Peru, Suriname, and Trinidad and Tobago. At the time this chapter was written, the participation of Guatemala and Mexico was suspended.

⁶ ESG criteria are used to assess whether a company's investments are socially responsible.

local water efficiency, such as support for the modernization of agricultural irrigation systems or the installation of drinking-water treatment plants. In water-stressed regions, regulations should include provisions requiring companies to reuse water, rely on desalinated seawater, and prioritize human consumption.

The adoption and enforcement of ESG standards are essential to protect the environment and the rights of local communities, as well as to strengthen governance around critical minerals. In recent years, several countries in the region have made progress in implementing environmental licensing frameworks and regulations aimed at raising these standards. For example, Chile's National Mining Strategy sets ambitious targets, including reducing water use in the mining industry, achieving carbon neutrality by 2040, and eliminating tailings disposal by 2050. A robust regulatory framework and adequate monitoring of risks and waste are essential to prevent accidents and mitigate environmental contamination. In this regard, effectively identifying and managing risks requires the allocation of sufficient resources to local governments and regulatory agencies.

● ● **Clear regulatory frameworks, long-term national policies, the adoption of ESG standards, rent-redistribution mechanisms, and participatory approaches can help build sustainable governance of natural resources**

Even in the absence of catastrophic accidents, extractive activities can lead to significant landscape transformation, such as in open-pit mining, and to alterations of watercourses, particularly in the case of illegal and artisanal mining, which often rely on rudimentary and highly polluting methods. These impacts affect traditional livelihoods, including those of small-scale farmers. Communities located downstream may experience reduced fishing or irrigation capacity, while Indigenous peoples may lose sacred sites or

hunting grounds (Rebolledo Monsalve et al., 2022; Scheidel et al., 2023). Water is frequently at the center of these conflicts. Mining and oil extraction compete with agriculture and human consumption for this resource. Several studies indicate that in arid regions of Chile and Peru, mining activities have exacerbated water scarcity, triggering protests and restrictions on new projects (Bebbington & Bury, 2009; Lagos et al., 2022). As a result, companies increasingly face demands to implement rigorous environmental management plans, participatory monitoring with communities (see Box 4.2), and, where impacts are unavoidable, compensation mechanisms such as alternative development projects.

● ● **Well-designed revenue-redistribution mechanisms enable local impacts from extractive projects and, in turn, help ease the social tensions associated with these activities**

A key strategy for ensuring that extractive activities promote rural development and mitigate social conflict is the adoption of revenue-redistribution mechanisms. In LAC countries with extractive sectors, governments allocate a share of royalties or extractive taxes to local governments in producing areas. In Peru, for example, the *canon minero* transfers 50% of the corporate income tax paid by mining companies to the regions and municipalities where extraction takes place, financing local public works. This mechanism has resulted in substantial annual infrastructure investment in Andean regions, although in some cases it has been accompanied by challenges related to spending effectiveness (see Box 4.3). In Colombia, the General Royalties System ensures that a share of oil, gas, and mineral royalties is allocated to regional development and science and technology funds, with local authorities participating in their management (DNP, 2024). While these mechanisms tend to increase social acceptance of projects by distributing part of the wealth generated and delivering tangible local impacts, they can also generate frustration when communities perceive that funds are misused

or that bureaucratic constraints hinder concrete outcomes (Arellano-Yanguas, 2011a). It is therefore important to accompany these mechanisms with strengthened subnational management capacities,

so that resources are invested effectively in projects that diversify rural economies (Alves et al., 2025; OECD, 2016).

Box 4.2

Participatory Environmental Monitoring Committees (PEMCs) in the mining sector in Latin America and the Caribbean

Participatory Environmental Monitoring Committees (PEMCs) are environmental governance instruments that enable communities, companies, and governments to jointly monitor and mitigate environmental impacts in mining areas, while maintaining continuous dialogue among stakeholders. Beyond facilitating mining governance, these committees contribute to the achievement of multiple development objectives, including SDG 6 (clean water and sanitation) and SDG 15 (life on land), among others.

These committees are not without challenges. Participatory logistics—which involve multiple actors often dispersed across rural areas—can complicate implementation and sustained engagement. This is compounded by high participant turnover and initial reluctance or mistrust on the part of both communities and companies. Other recurring limitations include a lack of consensus on which environmental aspects should be prioritized, heterogeneity in monitoring techniques, and weaknesses in communicating results to communities or relevant authorities.

The main requirement for these committees to function effectively is trust among all actors involved—the committee itself, the community, companies, and government authorities. Given the innovative nature of these mechanisms, such trust must be built progressively. To this end, participants' capabilities are critical, not only in technical terms but also their capacity for communication, leadership, and knowledge generation.

Where PEMCs have been implemented, tangible improvements have been observed, including better detection of pollution sources, the generation of early-warning alerts, and improvements in corporate practices. These committees have also generated positive spillovers, such as the identification of pollution originating from non-mining productive activities, including those carried out by the communities themselves.

Key recommendations for the effective implementation and functioning of these committees focus on institutionally consolidating PEMCs within legal and environmental management frameworks, so that their operation extends beyond the life cycle of individual mining projects. Additional priorities include strengthening the inclusion of women, youth, and Indigenous peoples in their governance structures; ensuring sustainable and transparent financing mechanisms; and reinforcing the technical, legal, and communication capacities of committee members. It is also essential that companies maintain open channels of communication and respond promptly to committee findings, and that public authorities incorporate these findings into environmental decision-making processes, thereby promoting more participatory and effective governance.

Source: Author based on Pareja et al. (2019), a document drawing on lessons learned from nine case studies in Argentina, Bolivia, Panama, and Peru.

Box 4.3

Royalties from the exploitation of non-renewable natural resources

Revenues from royalties, fees, or canon associated with the exploitation of non-renewable natural resources constitute an important source of financing for subnational governments in several LAC countries. In cases such as Bolivia and Peru, these revenues can account for up to 60% and 35% of total regional or local revenues, respectively. However, following the commodity price boom of the 2000s, royalty-derived revenues have remained volatile and have exhibited limited growth over the past decade (Alves et al., 2025). In most countries, revenues are collected by the national government and subsequently transferred, in part, to subnational jurisdictions. Argentina constitutes an exception, as this authority is vested directly in provincial governments.

The distribution of royalties raises tensions between equity and efficiency. On the one hand, allocating revenues to producing regions is justified, as these areas bear the environmental and infrastructure costs associated with the exploitation of non-renewable natural resources. On the other hand, concentrating resources in these areas can exacerbate territorial inequalities and generate distortive fiscal incentives. Striking a balance is therefore critical, particularly in the context of the energy transition. To harness extractive resources effectively, sector governance must promote responsible development while avoiding situations in which local governments become obstacles to investment.

Studies in Brazil and Colombia have shown that royalties have had a limited impact on the quality of public services and that local spending is highly sensitive to changes in transfers (Martínez, 2025; Monteiro & Ferraz, 2010). In addition, volatility in international hydrocarbon and mineral prices generates financial instability and risks of unsustainable spending. As a result, many countries earmark royalty revenues for capital investment; however, this mechanism does not always prevent the diversion of resources toward current expenditure or eliminate investment volatility. In this context, the establishment of stabilization funds emerges as a key tool for smoothing revenue cycles and strengthening subnational fiscal sustainability.

Mining royalties in LAC have not always translated into local economic development or poverty reduction. For example, in Colombia, Moyano and Wright (2016) find that direct royalty payments have produced only modest improvements in poverty reduction, while Saavedra and Romero (2017) show that reductions in transfers may coincide with an increase in illegal mining and adverse health outcomes. In the Brazilian state of Minas Gerais, regression analyses indicate that greater dependence on mining royalties is associated with lower human development and negligible employment gains (De Cássio Rodrigues et al., 2016). In Peru, statistical studies link substantial inflows of mining revenues to increased social conflict and poor fiscal allocation in contexts characterized by weak local government capacity (Arellano-Yanguas, 2011a, 2011b; Ponce & McClintock, 2014). By contrast, a qualitative study in Brazil highlights that community-based management can foster local autonomy and social cohesion (Demeda & de Carvalho, 2018). More recently, Bancalari and Rud (2025), analyzing transfers received by non-mining municipalities, find that these transfers boosted productive public spending, employment, and local incomes—particularly in rural areas—while reducing poverty and territorial gaps. They also show that each dollar transferred generated between USD 2.8 and USD 3.9 in local economic activity.

In the case of hydrocarbon rents, Acuna et al. (2024) examine the impact of a 2008 reform of Law 010 in Ecuador, which modified the allocation of royalties. The authors find positive effects in education, including higher completion rates at the primary and secondary levels, as well as improvements in income, accessibility, and school infrastructure. They also observe increases in labor demand; however, this rise is associated with a decline in tertiary education enrollment. In Brazil, Castro (2020) and Postali et al. (2025) document improvements in selected health indicators resulting from transfers of municipal oil royalties.

In sum, there is substantial evidence of the positive impacts of extractive-resource royalties on local development, and that these impacts depend primarily on three factors:

1. The strength and effectiveness of local institutions.
2. The design and targeting of revenue-transfer mechanisms.
3. The model used to manage royalties, whether state-led or community-based.

One mechanism that can help reduce social conflict and incorporate social demands is the public prior consultation process, which must include Indigenous and tribal peoples in accordance with international law (ILO, 2015; Oxfam, 2019). Beyond legal formalities, this requires dialogue in local languages, respect for community deliberation timelines, and good-faith negotiation of project adjustments. When a project is rejected by a clear majority within a community, governments should consider alternative locations or less intrusive designs, avoiding coercive imposition, which often leads to prolonged conflict.

Despite implementation shortcomings in some of these schemes, governments can also promote market-based mechanisms that allow extractive activities to generate positive impacts for local communities. Examples include local employment quotas, established through percentage targets (with exceptions for highly specialized positions or senior management roles), as well as workforce training and apprenticeship programs for rural labor and youth in mining or energy-related trades. Additional measures include establishing preferences or quotas for local suppliers of goods and services, incentivizing companies to source locally, and organizing supplier fairs to integrate

local SMEs into value chains (Hira & Busumtwi-Sam, 2021; IGF, 2017).

Some countries, such as Brazil and Argentina in the oil sector and Chile in mining, have implemented local content policies requiring companies to invest in training small local firms and integrating them as suppliers (e.g., transport, catering, basic maintenance). Aragón and Rud (2013) find positive effects of gold mining in Peru on income and infrastructure, driven precisely by these market mechanisms. Increases in local demand raise labor and land incomes and indirectly improve rural living conditions. Community development programs that include investments in health, education, or scholarships should form part of long-term state policy. For instance, requiring community development plans as part of licensing processes helps align private investment with local priorities (Hira & Busumtwi-Sam, 2021).

The adoption of new technologies can simultaneously make the extractive sector more efficient and environmentally sustainable. Many companies are deploying Industry 4.0 tools—such as sensors, artificial intelligence, and remote monitoring—to optimize processes and reduce waste. For example, optimizing truck routes lowers

diesel consumption and emissions; pipeline sensors enable early leak detection, preventing fugitive emissions and accidents; drones and satellites support surveillance of illegal activities; and electrification of motors or heat generation reduces CO₂ emissions (Cacciuttolo et al., 2023; Egbumokei et al., 2021; Karimipour et al., 2021). In addition, automating hazardous tasks improves miners' health and safety, although in some cases it may displace local labor (Long et al., 2024).



Modernization of the extractive sector enables improvements in sustainability as well as in workers' health and safety

A major shift in recent years is that mining companies and energy producers are investing in renewable self-generation. Examples include copper mines in Chile partially powered by solar parks, or Argentina's state-owned oil company YPF, which has installed wind farms to supply its operations. These initiatives not only reduce carbon footprints, but can also deliver surplus energy to neighboring communities. The spread of satellite internet has even enabled the operation of large mining projects in remote areas of the Andes. While such actions are primarily driven by the private sector, policies that facilitate access to these technologies—such as concessional financing, promotional campaigns, or targeted subsidies in cases of regulatory priority—can help accelerate the sector's transition toward sustainability.

Because many challenges transcend national borders—such as shared river basins affected by illegal mining—regional cooperation is unavoidable. Although progress has been made in mining-related coordination, collaboration remains a pending task for the region as a whole. Examples include the exchange of good practices in regulation and rural extractive development, such as the Andean Committee Against Illegal Mining, formed by Bolivia, Colombia, Ecuador, and Peru. In this context, countries should seize the

current momentum to advance the 2030 Agenda, as several SDG targets are directly linked to these sectors (SDG 7 on affordable energy; SDG 8 on decent work in mining; SDG 13 on climate action; and SDG 15 on terrestrial ecosystems and mining-related deforestation, among others).

Diversification of rural economies

In countries with abundant strategic minerals for the energy transition, there is a clear opportunity to develop domestic value chains. For example, Chile and Argentina are debating policies aimed not only at exporting raw lithium, but also at producing batteries locally. Brazil is seeking to attract investment in the refining of its critical metals. Jamaica and Guyana could develop aluminum industries based on their bauxite resources, rather than focusing primarily on raw exports (IDB Invest, 2025). If implemented, these initiatives could foster industrial hubs in rural areas or in intermediate cities near extraction sites, generating more employment and technological capabilities. However, they require improvements in the investment climate, human capital, and technology transfer agreements.

In the case of green and blue hydrogen, promoting production hubs would help address one of the main current constraints on its use: transport. The region's strong potential to produce green and blue hydrogen at low cost (IEA, 2024) could become a source of comparative advantage, strengthening downstream manufacturing activities—for example, in iron and steel production, among others (Allub et al., 2024).

With respect to biofuels, LAC countries can draw on the lessons learned from Brazil's successful experience. Brazil adopted an early, planned, and long-term policy approach, with the dual objective of diversifying sugarcane incomes and ensuring energy security. This strategy included mandatory biofuel blending with conventional fuels, with blending requirements updated multiple times over the years. These measures were accompanied by the introduction and expansion of flex-fuel vehicles—capable of running on gasoline,

ethanol, or blends—along with fiscal incentives and credit programs for both biofuel production and the purchase of such vehicles. Brazil also has dedicated financial institutions and credit lines for bioenergy and its research and development. Finally, the country applies import tariffs on ethanol to protect its domestic market. Elsewhere in the region, some progress has been made along similar lines. Countries such as Argentina, Colombia, Peru, and Uruguay have blending mandates in place, although with lower ethanol shares than those observed in Brazil.

●● **Brazil's track record of policies promoting biofuel production and use can serve as a valuable asset for advancing biofuel production across the region**

Finally, in anticipation of a potential reconfiguration of energy markets, countries should adopt proactive strategies to reduce the risk of stranded assets resulting from the phase-out of coal mines, refineries, pipelines, and related infrastructure. Possible alternatives include using existing wells for carbon storage, repurposing oil platforms for offshore wind generation, adapting refineries for hydrogen or biofuel production, and converting pipelines for biofuel transport (Allub et al., 2024; ESMAP, 2024; Saussay et al., 2024; Vona et al., 2018). As noted earlier, although these industries are not labor-intensive, it will be essential to invest in training and education to help redirect rural labor toward emerging jobs linked to the energy transition (Bray et al., 2022; Lim et al., 2023).

Investment for rural well-being

From an infrastructure perspective, extractive activities can have positive effects on rural communities. Large-scale extractive projects place substantial demands on infrastructure, including roads, electricity, and water and sanitation systems. In many cases, companies themselves—often as part of contractual arrangements—assume responsibility for investing in this infrastructure through corporate social responsibility (CSR) programs. However, such infrastructure projects must be properly regulated, as they can increase deforestation and further alter landscapes if not adequately planned (Bebbington et al., 2018). Large extractive firms may also invest in the construction of schools or health centers as part of their CSR strategies. Some governments have established frameworks to align corporate social investments with local development plans, seeking to avoid duplication or clientelism (see Box 4.4). ECLAC, the OECD, and the United Nations have published good-practice guidelines to support coordination among governments, companies, and social organizations, with the aim of generating mutual benefits (FIO et al., 2020; IRP, 2020; OECD, 2020).

●● **Several countries in the region have established frameworks to align corporate social investments with local development plans**

Although illegal mining is currently only weakly linked to minerals critical for the energy transition and is primarily associated with gold extraction, combating this practice is essential for the well-being of rural populations and for curbing the loss of high-value resources in rural areas of LAC (see Box 4.5).

Box 4.4

Regulatory mechanisms in Latin American and Caribbean countries

Argentina. Resolution 47/2020 approved Argentina's Plan Estratégico Minero (Strategic Mining Plan), aimed at building a shared vision for sustainable mining development that contributes to socioeconomic development. Its objectives are increasing mining's contribution to GDP, reviewing the cost of fiscal incentives, generating local opportunities, communicating and legitimizing mining activity, ensuring transparency, protecting the environment in accordance with Law 24,585, promoting the sustainable use of resources, and strengthening sector governance and international integration. In addition, a memorandum of understanding was signed with the European Union under the Global Gateway initiative, which envisages up to EUR 300 billion in investments to develop sustainable raw-materials value chains. The agreement seeks to promote a competitive mining sector aligned with the energy and digital transitions, fostering quality employment, innovation, ESG standards, and workforce training.

Brazil. Brazil's framework for critical and strategic minerals was developed in several stages. The National Mining Plan 2030 (adopted in 2011) defined 11 strategic objectives and three groups of minerals: those imported on a large scale, those linked to advanced technologies, and those in which the country has comparative advantages. In 2020, the Mining and Development Program translated these guidelines into targets related to geological knowledge, the circular economy, investment, and socioenvironmental responsibility. In 2021, the national policy Prominerais Estratégicos (Decree 10,657) and Resolution No. 2 established a list of priority minerals and an interministerial committee to accelerate projects, promoting lithium plants, the expansion of rare earths, and sustainable programs in the Amazon. In 2022, Decree 11,108 consolidated the Brazilian Mining Policy with a focus on sustainability, value added, and regional development. In 2024, a National Policy on Critical and Strategic Minerals was proposed, centered on supply security, the circular economy, digitalization, and regional integration.

The National Bank for Economic and Social Development (BNDES) has launched initiatives to promote these minerals, including a BRL 5 billion call for proposals targeting lithium, rare earths, and silicon value chains, as well as an investment fund—together with Vale, one of the world's largest mining companies—of up to BRL 250 million.

Chile. This Andean country has one of the most advanced mining strategies in the region, integrating innovation, sustainability, inclusion, and a long-term vision. Fundación Chile, a public–private partnership created in 1976, has become a catalyst for innovation through initiatives such as the Mining Skills Council (created in 2010) and the Expande program (launched in 2013), focused on open innovation and the development of technological suppliers. The Mesa Nacional Mujer y Minería (National Roundtable on Women and Mining) (established in 2018) promoted commitments to increase female participation and foster diverse leadership. In 2022, the National Mining Policy 2050 set out a roadmap for sustainable, competitive, and inclusive mining, with targets including carbon neutrality by 2040, institutional strengthening, and female participation of 20% by 2030 and 35% by 2050. Finally, the National Lithium Strategy (2023) established a public–private model with the future National Lithium Company, prioritizing rent capture, technological development, and the protection of salt flats, at least 30% of which are to be designated as protected areas by 2030.

Colombia. In 2016, Colombia adopted its National Mining Policy as a roadmap for a more competitive, orderly, and inclusive industry, based on legal certainty, improved conditions and infrastructure, expanded geological information, and institutional strengthening.

In 2023, the policy *Una Nueva Visión de la Minería en Colombia* (A New Vision for Mining in Colombia) was presented (aligned with the 2022–2026 National Development Plan and with a 2035 horizon). This new policy incorporates human rights, gender, ethnic diversity, climate change management, and a transition from an extractive to a productive model. It identifies ten structural problems, ranging from institutional weaknesses and deficiencies in title oversight to informality and poor environmental practices. It also proposes measures to address them, including the formalization of small-scale mining, industrialization of strategic minerals, the creation of a public mining company, enhanced traceability (particularly for gold), responsible mine-closure plans, and mechanisms to combat illegal mining. The objective is to reorient mining toward a competitive, sustainable, and inclusive model that contributes to economic and territorial development with social legitimacy.

Dominican Republic. The Dominican Mining Company (EMIDOM) was recently created to carry out exploration and, in the future, exploit rare-earth deposits, with the aim of positioning the country in the global market for critical minerals. The development of this sector will depend on international cooperation, technical training, technological innovation, and the implementation of public policies that promote sustainability and supply security.

Ecuador. In 2021, through Decree 151, Ecuador approved an Action Plan for efficient and socially and environmentally responsible mining. The strategy seeks to assess geological potential, attract investment, and apply best practices in resource use. To this end, it establishes transparency obligations—the Ministry of Energy and Non-Renewable Resources must publish statistics and projections within 100 days, based on a long-term economic model (profitability, contribution to GDP, exports, investment, production, and socioenvironmental costs)—and declares transparency in mining revenues a state policy. It also reforms the permitting process, introducing guidelines for fair allocations (including expired areas) that ensure equal access for domestic and foreign companies.

Mexico. A presidential decree created LitioMx, a state-owned company under the Ministry of Energy, to control all lithium projects in the country. Its mandate includes the exploration, extraction, processing, and utilization of lithium, as well as the management of value chains, in compliance with the Mining Law, environmental regulations, and the rights of Indigenous peoples. LitioMx is tasked with developing strategic plans, executing engineering and research projects, coordinating with the Mexican Geological Service to register reserves, and developing domestic technology. It also aims to promote the sustainable use of lithium in the energy transition and to manage the production, transformation, and distribution of derivative products in coordination with public and private institutions.

Peru. Law 31,283 of 2021 declares the exploration, extraction, and industrialization of lithium and its derivatives activities of public necessity, national interest, and strategic importance, in order to ensure their sustainable development. The law also recognizes lithium commercialization as a key resource for national development and mandates the Executive Branch to issue regulations governing its sale, promote a domestic battery industry, and establish processes for lithium-battery recycling.

Source: Prepared by Luisa Rivas.

Box 4.5

Illegal gold mining

A particularly concerning phenomenon in the extractive sector is the proliferation of illicit mining activities, especially illegal gold mining. The term illegal mining refers to extraction carried out outside the law, without permits, often in prohibited areas (such as natural reserves and Indigenous lands), and using extraction methods that are highly harmful to both the environment and people, typically involving the use of mercury. Over the past decade, driven by record-high gold prices and weak enforcement, illegal mining has expanded across several countries, bringing with it severe socioenvironmental and security consequences (UNODC, 2025c; Wagner, 2016).

South America has become one of the global epicenters of illegal gold mining. Some estimates suggest that in countries such as Colombia, Ecuador, and Venezuela, illegal production may account for well over 70% of total gold output (Wagner, 2016). The Amazon region, in particular, has been affected by a clandestine gold rush.

A recent report by the United Nations Office on Drugs and Crime (UNODC, 2025c) warns that criminal organizations, including drug-trafficking groups, have increasingly turned to illegal gold extraction due to its high value and the possibility of laundering proceeds through the legal gold supply chain. Unlike drug trafficking, where the product itself is illicit, illegally extracted gold can be introduced into formal markets by mixing it with legally produced gold, using falsified documentation, and operating through shell companies. This feature has made gold particularly attractive to illicit groups, which view it as a means to diversify income sources while facing lower risks (UNODC, 2025c).

Illegal mining has devastating effects on rural communities and the ecosystems in which it occurs. It generates informal economies and violence, establishes extortion structures and the collection of “illegal taxes” from small-scale miners by armed groups, and is frequently associated with increased prevalence of human trafficking, labor and sexual exploitation, and child labor in rural areas (Heck, 2014; UNODC, 2025c). UNODC highlights that these activities fuel other serious crimes in the same territories, intertwining with drug and arms trafficking.

From an environmental perspective, illegal mining causes irreversible damage. It typically relies on alluvial techniques (using dredges in rivers) or land excavation with heavy machinery, resulting in the destruction of native forests. It is estimated that in countries such as Brazil, Peru, and Venezuela, illegal mining has deforested hundreds of thousands of hectares of the Amazon over the past decade (Heck, 2014; UNODC, 2025c). In addition, illegal miners use prohibited substances such as mercury to amalgamate gold, discharging large quantities into rivers. This contaminates food chains (with mercury-tainted fish) and affects the health of Indigenous populations that depend on fishing and water resources, causing neurological diseases (UNODC, 2025c). Soil and water degradation is also severe: abandoned pits and trenches disrupt drainage patterns, while sediments cloud rivers and affect downstream water quality and aquatic fauna.

From an economic standpoint, illegal mining leads to tax evasion and undermines rural development. The expansion of illegal gold implies that states and communities potentially lose billions of dollars in revenue, particularly in a context of record prices and high profitability of this precious metal (UNODC, 2025c). By contrast, gold mining remains an important source of income for rural populations in some contexts; however, where organized crime is involved, these revenues accrue to illegal groups that do not reinvest in local communities. Artisanal miners generally capture only a small share of these rents, perpetuating rural poverty. Moreover, the mixing of illegal and legal gold depresses prices paid to formal producers and damages the international reputation of Latin American gold, as it becomes associated with deforestation and human rights violations (UNODC, 2025c).

Coordination among the public sector, private companies, and security forces is vital to prevent the expansion of illegal economies. Governments in the region have pursued a range of strategies to combat illegal mining, with mixed results. In Colombia, efforts have focused on prosecuting money laundering linked to gold and deploying innovative technologies—such as satellite imagery and machine-learning tools—to identify new unregistered mining operations (Saavedra, 2025). However, as long as profitability remains high and alternative economic opportunities for rural populations are limited, illegal mining tends to reemerge. A complementary approach has been the creation of formalization programs for artisanal mining, which help small-scale miners obtain licenses, technical training, and access to legal markets in exchange for compliance with environmental standards (IGF, 2017). International cooperation is also crucial given the transnational nature of the gold trade. Coordinated efforts are required to trace supply chains, impose due-diligence requirements on refineries and buyer markets, and close channels for the commercialization of illicit gold (UNODC, 2025c).

NCRE sources have played a significant role in improving access to electricity in rural areas (see Chapter 8). To sustain and deepen this progress—while also improving service quality—the region will require substantial investment not only in generation assets such as solar panels and wind turbines, but also in electricity infrastructure, including transmission and distribution networks. The energy transition, together with demographic change, compels the region to expand its electricity infrastructure overall, with new capacity largely supplied by renewable sources. At the same time, the intermittency of NCRE generation underscores the need for robust backup mechanisms to meet demand during periods when renewables are not producing. In this context, hydropower—widely available across the region—will play a key role. Significant investment in battery storage will also be required (Allub et al., 2024), alongside upgrades to existing hydropower infrastructure (see Box 4.6).

Finally, improvements in electricity and natural gas connectivity enable rural households to replace biomass with cleaner energy sources for cooking and heating. Beyond efficiency gains and potential cost reductions, this transition delivers substantial health benefits by reducing exposure to air pollutants generated by biomass combustion. To ensure these positive health impacts, governments can implement awareness-raising campaigns and support the purchase of electric or gas appliances through subsidies or financing schemes, prioritizing those with higher energy efficiency (Allub et al., 2024).



Access to electricity through distributed generation can result in lower energy costs, higher levels of productive efficiency, and a reduction in local pollution

Box 4.6

Resilience of hydroelectric infrastructure in LAC

Hydropower accounts for nearly half of electricity generation in LAC (Allub et al., 2024). This form of energy is expected to play an even more prominent role in the coming decades, operating in tandem with nonconventional renewable sources, such as solar and wind, and helping to ensure grid continuity and reliability.

Changes in hydrological regimes have caused many hydropower plants to operate outside the conditions for which they were originally designed, resulting in greater operational variability and lower energy efficiency. This has led to accelerated wear of electromechanical equipment, efficiency losses due to low-load operation, deterioration of electrical insulation, and damage to discharge pipelines caused by operating beyond recommended limits (Ubierna & Alarcón Rodríguez, 2022).

In the face of climate change, many hydropower plants will need to adapt to hydrological conditions that differ from those anticipated in their original designs. Modernizing these facilities requires assessing future hydrological scenarios and ensuring robust designs capable of withstanding climatic uncertainty. This process also presents an opportunity to incorporate advanced monitoring, measurement, and forecasting technologies that can improve operational management. Ubierna et al. (2020) estimate that total investment needs to modernize the region's existing hydropower fleet amount to USD 33 billion, a figure that is expected to rise as infrastructure continues to age.

CAF -Development bank of Latin America and the Caribbean- promotes the resilience of hydropower infrastructure through the financing of climate-adapted infrastructure projects, technical assistance to strengthen risk management, and support for regulatory frameworks aimed at reducing the vulnerability of the water sector to climate impacts and natural disasters. CAF also provides technical support to ministries and governments to enhance disaster risk management and improve public investment planning for infrastructure.

Increasing financing for adaptation projects is essential not only to strengthen resilience to climate change, but also to promote inclusive and sustainable growth. Investment in climate-resilient infrastructure not only helps avoid future losses, but also reduces risks associated with existing infrastructure and preserves social and environmental benefits, thereby generating the so-called triple dividend.

Roadmap for the development of key sectors for the energy transition

Throughout this chapter, the main challenges and opportunities facing sectors linked to the energy transition have been identified. A set of policy actions can help strengthen the development of these sectors while improving living conditions for rural workers. Figure 4.3 presents a roadmap that

synthesizes the current situation and outlines key measures that can be adopted.

Figure 4.3
Opportunities, challenges, and policy recommendations

Critical minerals for the energy transition	Development of low-carbon fuels: biofuels and hydrogen
Development of value chains in extractive sectors	Modernization and digitalization: efficiency gains and improved working conditions
Infrastructure investment driven by rising extractive rents	NCRE for households and enterprises in isolated rural areas
Green local employment	Electric or gas appliances for cooking and heating in rural households
Environmental governance and sustainability	Access to financing
Legal and regulatory frameworks	Conditions in artisanal and small-scale employment
Adoption of good mining practices and international standards	Non-conventional renewable energy as a driver of electricity expansion
Support for value-chain development	Promotion of investment in low-carbon fuels and the introduction of fuel-blending mandates
Support for the formalization and training of small-scale miners	Programs to promote the adoption of electric or gas stoves and appliances in households
Mechanisms for redistributing rents and royalties from extractive sectors	Professional and technical training for green jobs
Support for and promotion of digitalization	Regulatory frameworks for water resources

- Opportunities
- Challenges
- Policies