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The challenges of climate mitigation in Latin America and the Caribbean: Some proposals for action[1]

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Latin American and Caribbean (LAC) countries have pledged to significantly reduce greenhouse gas (GHG) emissions by 2030 and become net zero by 2050. The level of climate ambition contrasts with the region's high economic dependence on fossil fuels, and the growing emissions caused by deforestation. Given the high transition costs, the region needs to develop financial plans that could include the use of carbon pricing as well as the adoption of green fiscal rules.

1 This paper is part of the ongoing research on energy transition at Columbia University's Center on Global Energy Policy.

2 Columbia University

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Introduction

In preparation for the 26th Conference of the Parties (COP26), which convened in Glasgow in 2021, most Latin American and Caribbean (LAC) countries updated their nationally determined contributions (NDCs) to reduce greenhouse gas (GHG) emissions by 2030 and to bring emissions to net zero by the middle of the Century. However, unless the region addresses several of the constraints that it faces in transitioning to a low-emissions economy, these pledges could remain aspirational.

As signatories to the Paris Agreement, LAC countries first established NDCs to cut emissions and adapt to climate change. Climate mitigation is one of the approaches detailed in the Paris Agreement to achieve the 1.5°C pathway goal or to limit the increase in global average temperatures to below 1.5°C above pre-industrial levels.[3] To achieve this, interventions include shifting electricity generation from fossil fuels to renewable energy, replacing GHG-emitting technologies with low-carbon and clean alternatives, minimizing waste and maintaining and restoring forest ecosystems.

The region's ambitious low carbon transition requires major investment, but funding is limited by inadequate fiscal capacity and financing restrictions that affect both the private and public sectors. LAC countries must also resolve policy dilemmas arising from tensions among different developmental goals that compete for financial and human resources. In addition to the NDCs, the region is committed to achieving the Sustainable Development Goals (SDGs) by 2030. Although some believe that the objectives of NDCs and SDGs mutually reinforce each other (Lankes and others, 2022), in practice, trade-offs exist. For example, should oil- and mineral-rich countries start by reducing the production of fossil fuels? Or should they wait until the demand for these products falls and, in the meantime, use the revenue from these activities to meet SDGs, such as the eradication of poverty?

This report argues that achieving the emissions reductions required by the NDCs and net-zero scenarios is extremely challenging and perhaps even out of reach for LAC countries under current policies. It further argues that acknowledging this reality is, in fact, a call for action in institutional and policy areas related to climate mitigation goals. Two challenges, in particular, make the low-carbon ambitions of LAC countries seem unrealistic. First, emissions reductions are very costly relative to the income of most LAC countries. Second, these countries face significant risks as a result of the transition, in the form of a loss in export and fiscal revenues, particularly from high-emissions sectors such as oil, gas and coal. To bridge this gap, LAC countries need to adopt a new framework to pay for the transition that would allow them to offset the expected fiscal losses and, importantly, develop new sources of income. Adopting "green fiscal rules" is one possible way in which fiscal management in the region could be aligned with climate goals.

This report outlines key challenges and trade-offs facing LAC countries in terms of the costs of climate mitigation. Its purpose is to propose policy and institutional changes that are necessary to effectively achieve the level of climate ambition set by the region. Rather than providing definitive answers, the goal is to encourage research and public debate that leads to new directions.

The report is organized as follows: Section 1 discusses the ways in which the composition of emissions in LAC countries differs from the rest of the world. Section 2 then outlines climate ambitions in LAC countries and models their transition trajectories under two scenarios: the net-zero scenario to meet the 1.5°C temperature target in 2050 and the NDC scenario to meet the pledged commitments. It also discusses the long-term climate

3 According to the Intergovernmental Panel on Climate Change (IPCC) (2022a), climate change mitigation involves human interventions to reduce the sources of GHG emissions or enhance carbon sinks. Mitigation efforts involve any action that pre-empts the investment in carbon-emitting technologies or the use of capital in a way that would emit GHG emissions, among other actions.

mitigation strategies of the region's largest economies. Sections 3 and 4 put a price tag on the transition to net zero, considering both the investment required and the indirect costs (lost revenues and transition risks) for LAC economies. Section 5 explores how LAC countries can pay for the transition by using various tools, such as carbon taxes and voluntary carbon markets.

Ultimately, the goal of this report is to build momentum towards making decisions that would make NDCs achievable. If these actions are not taken immediately, current NDCs could be out of reach.

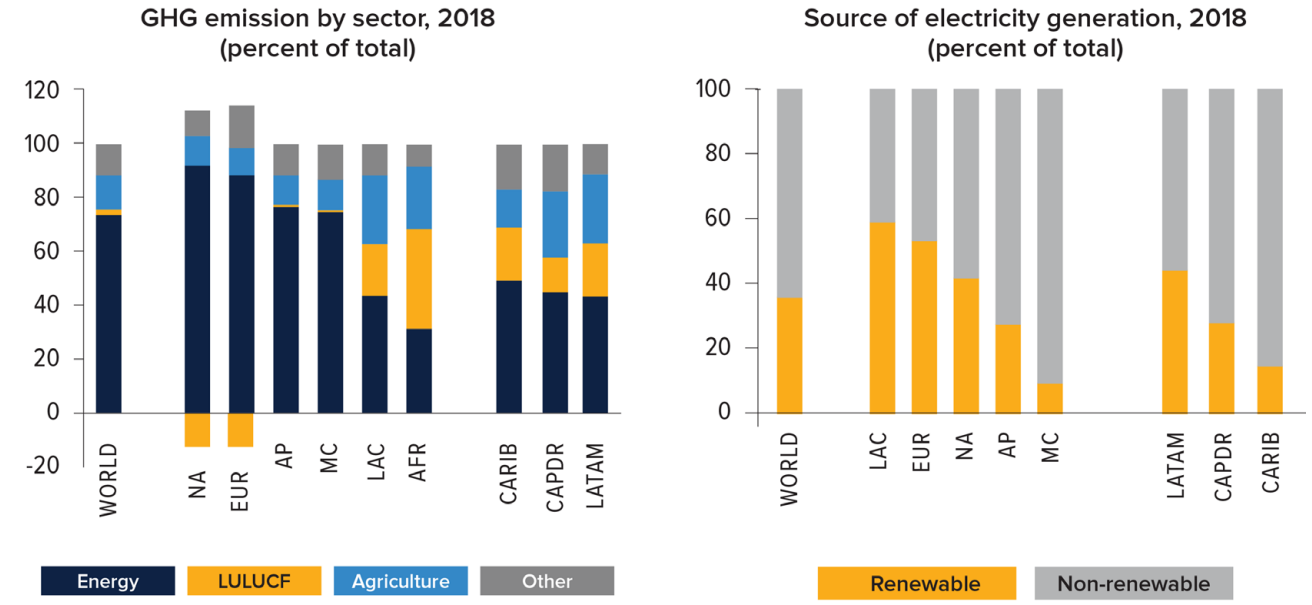
How do Latin American and Caribbean Emissions Differ from the rest of the World?

High levels of agriculture, forestry and other land use, coupled with low energy emissions

According to the World Development Indicators, LAC countries represent approximately 8 percent of the total world population and 6 percent of the global gross domestic product (GDP) (World Bank, 2021). Their share of global GHG emissions is around 7 percent (Ivanova and others, 2021).

The average per capita income and per capita net emissions in the region are close to global averages. However, vast differences exist within the region. For example, while the GDP per capita of Haiti is comparable to sub-Saharan African countries, Chile and Uruguay are upper middle-income countries. At 6.4 metric tonnes (t) carbon dioxide equivalent (CO2-eq), per capita net emissions in LAC countries are close to the global average (Ibid.). Yet, the per-capita emissions of Guyana, Suriname and Grenada are more than triple the global and regional average, while those of Chile, El Salvador and Guatemala are half of this average. In terms of overall emissions, Argentina, Brazil, Mexico and Venezuela are the largest emitters in LAC countries, responsible for 70 percent of the region's total emissions (Climate Watch, 2022).

Figure 1. Composition of emissions and energy matrices in Latin American and Caribbean countries



Source: Ivanova and others, 2021
Note: LULUCF – Land Use, Land-Use Change and Forestry

Where LAC countries differ from the rest of the world is in the composition of their emissions. The energy sector, including electricity generation, transportation and the use of fuel in industrial processes, accounts for 43 percent of total CO2-eq emissions, well below the global average of 74 percent. In contrast, the Agriculture, Forestry and Other Land Use (AFOLU) sector accounts for 40 percent of the region's total emissions, almost double the global average. The main contributors to AFOLU emissions are deforestation and land-use change, which, in addition to CO2, release nitrous oxide (N2O) and methane (CH4) emissions. To account for the region's high N2O and CH4 emissions, this analysis converts all emissions into CO2-eq to quantify total GHG emissions.[4]

There are two reasons behind the high levels of AFOLU emissions in the region. First, LAC economies have a higher share of land-intensive activities, including cattle raising and extensive agriculture. Second, the LAC region has a cleaner energy matrix than the rest of the world. While electricity generation is responsible for energy emissions in most of the world, this is not the case in LAC countries. Nearly 60 percent of electricity generation comes from renewable sources (Latin American Energy Organization, 2022), specifically hydropower, compared to the global average of less than 40 percent.[5]

A related aspect is that the driver of emissions in the LAC energy sector is transportation rather than electricity generation (Cárdenas, Bonilla and Brusa, 2021). Emissions in the transportation subsector are harder and more expensive to abate as they require the adoption of zero-emissions vehicles. However, the region has vast amounts of experience in producing biofuels to reduce emissions in the transportation sector.[6] In fact, LAC countries account for 34 percent and 24 percent of global ethanol and biodiesel production, respectively (International Energy Agency, 2021b). It is, however, debatable as to whether biofuels are carbon neutral, with some studies arguing that their use has increased CO2 emissions. This is especially true when land is diverted away from feeding humans and livestock and towards producing fuel, as the additional farmland required and the carving out of vegetation trigger very large releases of CO2.

Abatement costs are higher in manufacturing (where clean technologies are not fully developed) and in transportation (where significant investment is required) relative to preventing deforestation and land-use changes. All of this suggests that the transition to a low-emissions economy in LAC countries should, therefore, prioritize actions in the AFOLU sectors.

Public opinion on climate action

In the last two decades, LAC countries have experienced an average of 0.3 extreme climate-related events per year (or one major event every three years), a 50 percent increase compared to the 1980–2000 period. According to the Global Climate Risk Index, 10 LAC countries (the Bahamas, Dominica, Dominican Republic, El Salvador, Grenada, Guatemala, Haiti, Honduras, Nicaragua and Puerto Rico) are among the 25 most vulnerable countries in the world to climate risks (Eckstein, Künzel and Schäfer, 2021). Central America and the Caribbean

4 GHG emissions include CO2, N2O and CH4 emissions, among others. To quantify the total GHG emissions, all GHGs are expressed in this report in CO2-eq using the 100-year global warming potential (GWP100) values from the Intergovernmental Panel on Climate Change (2022a). GWP100 values equal to 27 for CH4 and 273 for N2O are used, unless stated otherwise. Ivanova and others (2021) use the Fifth Assessment Report (where the GWP100 value is equal to 28 for CH4 and 265 for N2O).

5 However, there are also significant differences within the region as there is much more hydropower available in South America than in Central America and the Caribbean.

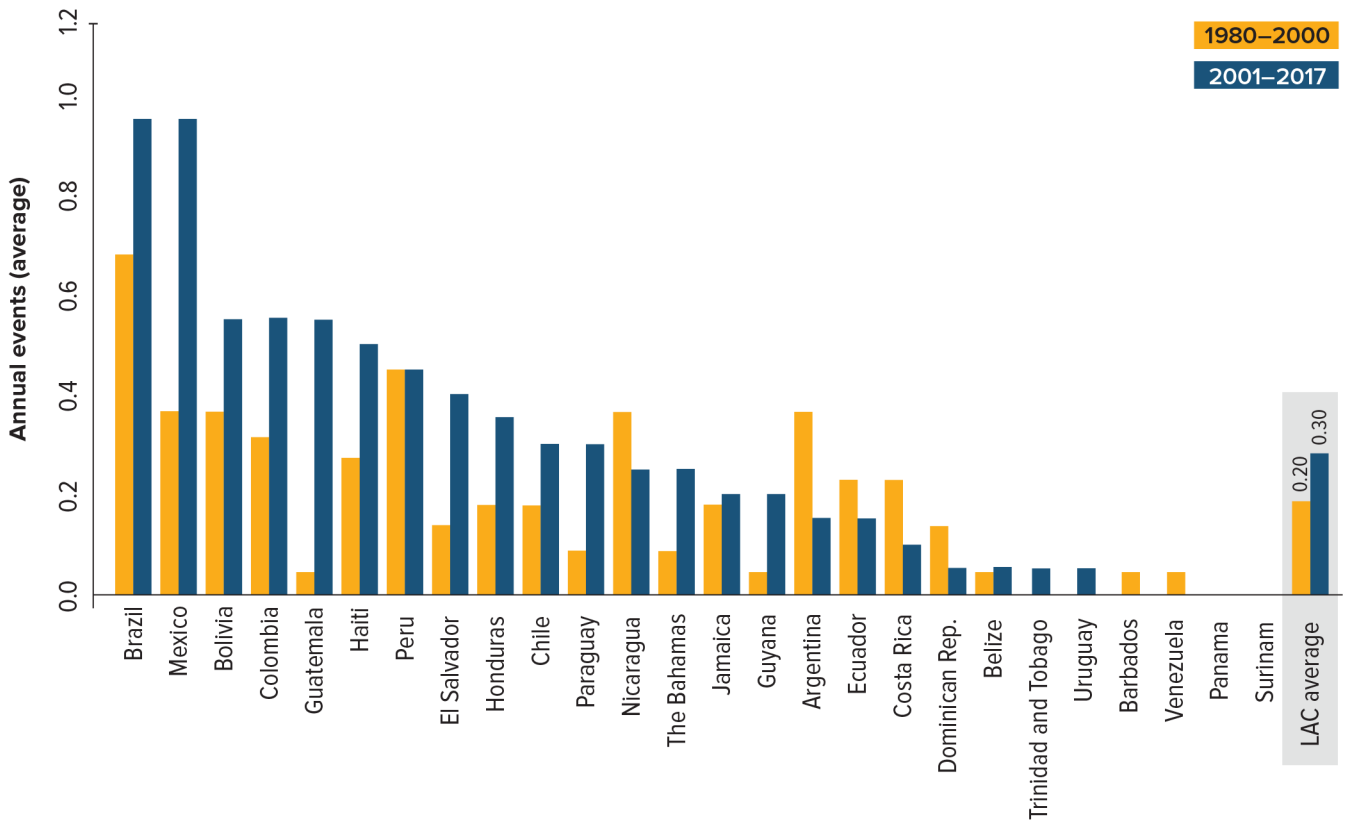
6 Most biofuels in Latin America come from sugarcane-based ethanol and soy- and palm-oil biodiesel. Brazil's ethanol production programme was launched in the early 1970s, largely to increase energy independence. Scientific research completed over the past two decades using improved life cycle emissions assessment (LCA) methods indicates that Brazil's sugarcane ethanol has lower GHG emissions than petrol. It has also shown that emissions have fallen due to increased yields, decreased fertilizer use and improved ethanol production processes. Existing technologies and agricultural practices have the potential to make further significant improvements in the reduction of LCA GHG emissions of ethanol from approximately 40 percent today to over 70 percent compared to a petroleum baseline. However, biofuel critics also consider the direct and indirect impact of the destruction of rainforests and other natural ecosystems in producing biofuels, as such ecosystems serve as carbon sinks. Land-use change analysis relies on complex models and the findings are heavily influenced by underlying assumptions.

are particularly vulnerable to hurricanes, droughts and rising sea levels. Extreme weather events are also frequent in Brazil, Colombia and Mexico—three of the largest economies in the region.

Furthermore, according to the United Nations Office for Disaster Risk Reduction (2021), between 1997 and 2017, one out of every four disasters in the world was in the LAC region. Nine out of ten people impacted by these disasters were affected by climatic events (mostly floods). Between 1998 and 2017, 53 percent of global economic losses from climate-related disasters occurred in Latin America and the Caribbean. Similarly, the region accounted for 46 percent of global disaster losses during the last decade.

Faced with frequent extreme, and even catastrophic, weather-related events, the majority of the population has internalized climate change as a global emergency (United Nations Development Programme, 2021). However, support for climate action is inconsistent across the region. In one global survey, more than 80 percent of respondents in Chile, Colombia and Peru agreed with government action to combat climate change, compared to 57 percent and 35 percent of respondents in the United States of America and Russia, respectively (Ipsos, 2020). However, at the regional level, support for climate action in Latin America is comparable to that in Eastern Europe and Central Asia, but lower than that in Western Europe and North America (Ibid.).

Figure 2. Extreme climate-related weather event frequency in Latin American and Caribbean countries (1980–2017)



Source: Alejos, L. (2018). Estimating the Fiscal Impact of Extreme Weather Events. Ann Arbor, MI: University of Michigan.

Political platforms based on preventing deforestation, on the electrification of public transport or on the development of renewable energy, as well as economic models that de-emphasize the role of extractive industries, are popular among voters. However, even in countries where reducing emissions is broadly supported by the electorate, such as in Colombia and Ecuador, recent social unrest suggests that citizens are not ready to accept the reduction of energy subsidies and, even less, the adoption of carbon prices.

Climate Ambition, Transition Trajectories and Long-term Strategies

Climate ambition

Parties to the Paris Agreement are required to present NDCs every five years, and successive NDCs are supposed to include increasingly ambitious climate actions. To do this, countries can either update their existing NDCs, enhancing their goals and means of implementation for the same principles, or propose new NDCs. In general, LAC NDCs are of a higher quality than the global average, reflecting strong stakeholder engagement, transparency mechanisms and an interest in global carbon markets (United Nations Development Programme, 2022).

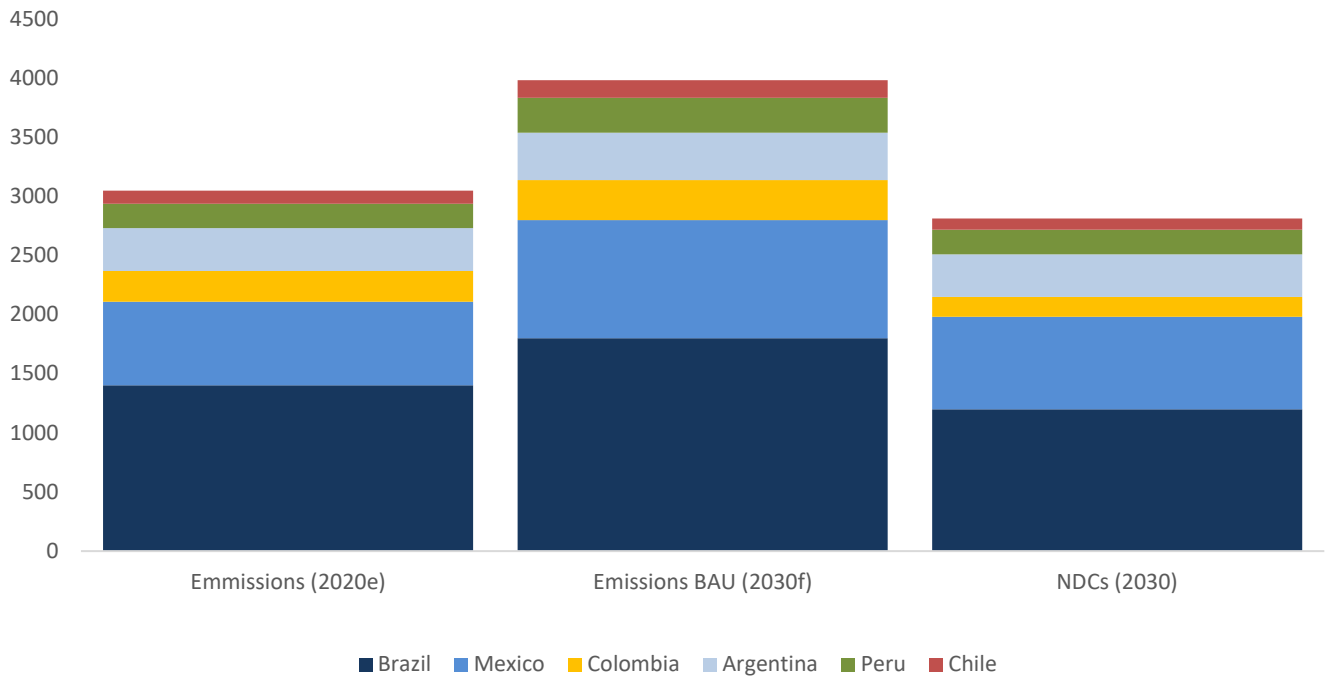
Between 2020 and 2022, 20 of the 33 LAC countries updated or submitted a new NDC, and nine became more ambitious (for example, by lowering the 2030 emissions cap). This includes the six largest economies of the region, also referred to as LAC-6: Argentina, Brazil, Chile, Colombia, Mexico and Peru (Table 1). Of these, only Argentina submitted a new NDC.

In their revised NDCs, Argentina and Chile increased their targets to reduce GHG emissions in absolute terms while Peru and Colombia increased their targets as a percentage of a baseline. Argentina and Chile have pledged to be carbon neutral by 2050 while Peru and Colombia are developing national strategies aimed at working towards this goal.

In contrast, Brazil and Mexico did not expand their climate commitments. The Government of Brazil updated its commitment by adopting a higher reduction percentage but changed the base year for calculating emissions. As a result, Brazil can emit an additional 500 million metric tonnes (Mt) of carbon dioxide equivalent (CO2-eq) by 2025 and 400 Mt CO2-eq by 2030. Although the Bolsonaro government has faced criticism for not taking a tough stance against deforestation, Brazil has pledged to be GHG neutral by 2050 (which means it could be carbon neutral by 2040). Mexico has not set a carbon-neutrality target. The current government is prioritizing investments in oil production and the construction of a new refinery, as well as the use of fossil fuels for electricity generation. This approach also strengthens the role of Pemex and CFE (the federal electricity commission), which are the state-owned enterprises responsible for these sectors.

Bolivia and Venezuela, two prominent fossil-fuel producers, have been notably absent from these conversations.

Figure 3. Comparison of current and expected emissions under a business-as-usual and the nationally determined contribution scenario



Source: Author's analysis based on the Network for Greening the Financial System (NGFS) Data Explorer, MESSAGEix-GLOBIOM 1.1 model results.

Overall, LAC-6 countries pledged to reduce emissions by 34.5 percent compared to the 2030 business-as-usual (BAU) scenario.[7] Nevertheless, there are sizeable differences in the level of climate ambition among different countries. Colombia has pledged to reduce its emissions by 51 percent compared to the 2030 BAU emissions, while Argentina has committed to reducing emissions by only 8 percent, and Mexico has announced a negligible reduction.

7 This is based on an analysis of the Network for Greening the Financial System (NGFS) current-policies scenario, using the MESSAGEix-GLOBIOM model (Network for Greening the Financial System, 2022), which simulates the dynamics among energy, land use, water, economy and climate systems under the current policies as implemented by the respective governments.

Table 1. Summary of commitments in the Latin American and Caribbean nationally determined contributions

Country	First NDC submission date	Second NDC submission date	2030 GHG target (MtCO2e)		Notes	Carbon neutrality in 2050?
			Unconditioned	Conditioned		
Argentina	November 2016	November 2021	359	N/A	Equivalent to a 19% reduction in emissions compared to the historical peak reached in 2007	Yes
Brazil	Original submission: September 2016; most recent update: April 2022	N/A	1,200	N/A	Reduce greenhouse gas emissions by 37% below 2005 levels by 2025 and by 50% below 2005 levels by 2030	Climate neutrality
Chile	Original submission: February 2017; most recent update: April 2020	N/A	95	N/A	Reach peak emissions by 2025 and a GHG emissions budget of no more than 1,100 MtCO2e for 2020–2030	Yes
Colombia	Original submission: July 2018; most recent update: December 2020	N/A	169	N/A	Equivalent to a 51% reduction compared to BAU	Developing a national strategy
Mexico	Original submission: September 2016; most recent update: December 2020	N/A	781	644	Reduce GHG emissions by 22% in 2030, compared to the BAU scenario; depending on the availability of financial resources, reduce GHG emissions by 36%	No
Peru	Original submission: July 2016; most recent update: December 2020	N/A	209	179	Equivalent to a 30% reduction compared to BAU; depending on the availability of financial resources and favourable conditions, reduce emissions by 40%	Developing a national strategy

Source: Authors' analysis of NDCs; see Ministerio de Ambiente y Desarrollo Sostenible (2020), Federative Republic of Brazil (2022), Gobierno de Chile (2020); Gobierno de Colombia (2020), Gobierno de México (2020) and Gobierno del Perú (2021).
Note: Mexico and Brazil committed to a percentage reduction target, rather than an absolute number. The numbers presented in the table are the implicit targets.

Transition trajectories to a low-carbon economy

To understand the possible scenarios for LAC countries to transition to a low-carbon economy, this section presents the results of the MESSAGEix-GLOBIOM model used by the Network for Greening the Financial System (NGFS).[8] Simulating the dynamics among energy, land use, water, economy and climate systems, the model presents two dramatically different scenarios (see Figure 4 for the two transition trajectories in terms of absolute emissions):

» **The net-zero scenario:** This is the more ambitious and globally optimal scenario. This projection assumes an orderly transition to meet the 1.5°C temperature target in 2050, which implies net-zero CO2 emissions and reductions in other GHG emissions. This scenario is the result of global welfare optimization, which can deviate from the countries' preferences, as stated in their own NDCs. Under this scenario, some countries will achieve net-negative emissions to offset the net-positive emissions in other countries.

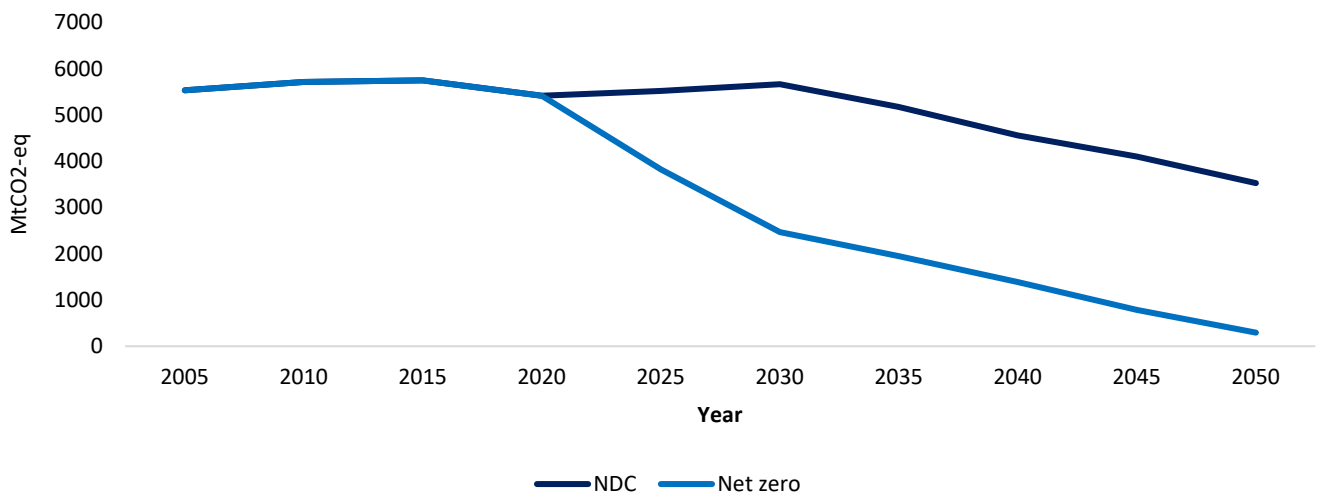
8 This is one the most frequently used models out of the integrated assessment models, which are representations of the physical and economic systems, focusing on the interaction between the economy, society and environment (Intergovernmental Panel on Climate Change, 2022b). These models forecast economic outcomes, emissions, and energy and land-use pathways under a set of policy, economic and demographic assumptions. One specific advantage of the MESSAGEix-GLOBIOM model is that it includes several endogenous variables and abatement measures in the AFOLU sector.

Under the global net-zero scenario, LAC countries shall reach a net-negative CO2-eq emissions state in 2050, with front-loaded reductions from 2020 to 2030. The rationale for the rapid phase-out of CO2 and other GHG emissions is that faster reductions in the near term are required to avoid deeper reductions in the longer term (DeFries and others, 2019; Riahi, 2015; Luderer and others, 2016). On a worldwide scale, this is beneficial as LAC can reduce emissions by reversing deforestation, which is a less costly mitigation strategy than most other alternatives. Going beyond net zero and becoming net negative is a global optimum through the use of carbon offsets. The net-zero pathway assumes the allocation of a global carbon budget. In this respect, LAC countries will reduce CO2-eq emissions much more quickly, giving space to regions with hard-to-abate industries that face high costs or unavailable technologies. However, this is a theoretical proposition as currently there are no incentives or price signals to ensure this outcome.

» **The NDC scenario:** This scenario is less optimal but more realistic. It assumes that the current, unconditional NDCs are fully implemented to meet the 2030 emissions targets. After 2030, the model assumes the climate policy ambition at the levels implied by the NDCs. This transition, resulting from the targets announced by individual governments, is a slower one. In this case, emissions reductions will be less front-loaded and more concentrated towards the 2030–2050 period. As a result, the region will continue to have positive net-GHG emissions until the middle of the Century.

Overall, the results of the MESSAGEix-GLOBIOM model show that although ambitious, the NDC commitments fall short of the 1.5°C pathway target of the Paris Agreement, in addition to the transition to carbon neutrality by 2050.

Figure 4. CO2 emissions path of Latin American and Caribbean countries in the nationally determined contribution and net-zero scenarios



Source: Network for Greening the Financial System (NGFS) Data Explorer, MESSAGEix-GLOBIOM 1.1.

How agriculture, forestry and other land use, and the transportation and industrial sectors affect transition trajectories

The sectoral impacts of the transition are as follows (see Figure 5 for emissions reduction trajectories by sector):

» **AFOLU sector:** The AFOLU sector is the largest emitter of GHGs in LAC countries. However, the abatement costs are relatively low in this sector, making it the largest contributor in the transition to a low-carbon economy. As it acts as a natural carbon sink, it also creates the possibility of removing carbon dioxide emissions generated by other sectors and regions. This is why the AFOLU's net-negative CO2 emissions are key to offsetting the emissions of hard-to-abate sectors, such as heavy industry and transportation.[9] In the net-zero scenario, emissions reduction takes place mainly from 2025 to 2030, and negative AFOLU CO2 emissions are reached after 2035. This finding underscores the importance of reforestation and restoration of native forests in the transition of LAC countries, and it is especially relevant for countries such as Brazil and Colombia, which depend on intensive land-use activities.[10]

» **Transportation and industrial sectors:** These sectors will have a slower transition under both scenarios and will not experience significant reductions from 2020 to 2030. According to this model, the projected costs of renewing the current fleet of vehicles with low-carbon technologies and implementing cleaner industrial technologies are larger than the projected costs of reforesting and managing forests in the region.

These results reflect the differences in the costs of abating carbon emissions across sectors. However, while the AFOLU sector will be the primary driver behind reducing GHG emissions in LAC countries, in both NDC and net-zero scenarios, to achieve carbon neutrality, a decline across all subsectors is needed in the region after 2030. Action on land use alone is insufficient without greater ambition in the transportation and other sectors. There are two reasons for this. First, there are obstacles to reducing AFOLU emissions, and the resulting uncertainty calls for a more diversified strategy. For example, deforestation in Colombia has increased despite its NDC goal to reduce deforestation by around 35 percent between 2020 and 2035. Second, progress on all fronts would lower total emissions in LAC countries, allowing the region to monetize economic opportunity by providing more carbon offsets to the rest of the world.

Box: Policy focus: The agriculture, forestry and land use sector

For the region to achieve its climate ambition, it must consider policies targeted at avoiding the expansion of the agricultural frontier. Based on the results of the model in this study, it can be argued that, without emissions reductions in this sector, it will be extremely difficult for LAC countries to achieve the NDCs and practically impossible for them to achieve global net-zero CO2 emissions. In the global net-zero scenario, AFOLU emissions in LAC countries decrease by 71.4 percent between 2020 and 2025. If countries moving in this direction hope to come close to this ambition, they will need to significantly step up their policy frameworks, as well as their legal and fiscal state capacities.

Even achieving more modest targets may require an overhaul of policies in some countries. Policies to consider include the following:

9 Although CH4 and N2O emissions remain positive.

10 In countries such as Argentina, Chile and Mexico—which are less dependent on land-use activities but have a higher uptake of fossil fuels in their energy matrix—emissions from electricity generation also show a sharp decline.

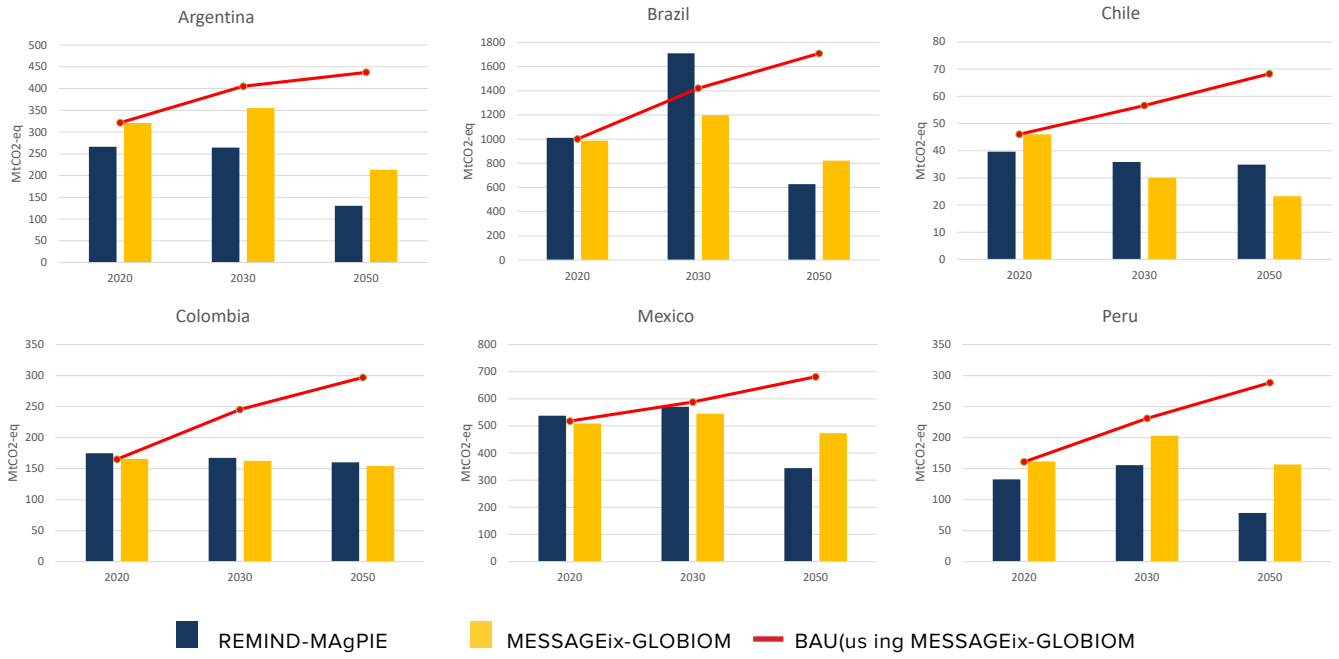
1. Adherence to Article 6 of the Paris Agreement through international cooperation: Article 6 of the Paris Agreement is intended as a framework for the transfer of offset credits between countries. These internationally transferred mitigation outcomes are expected to support environmental integrity and sustainable development and be subject to robust accounting practices.[11]

2. Regional long-term strategies, such as efforts to reduce emissions from deforestation and forest degradation in developing countries (REDD+), and policies relating to initiatives for and the transition to low-carbon cattle raising and agriculture.[12]

Country trajectories

Based on the NDC scenario, every LAC-6 country has its own expected GHG emissions reduction trajectory for the 2020–2050 period, compared to their business-as-usual (BAU) projections (Figure 5). For the emissions trajectories, this report applies two models, which are widely used in the literature. These are MESSAGEix-GLOBIOM 1.1 and REMIND-MAgPIE 2.1-4.2 (Intergovernmental Panel on Climate Change, 2022b). Chile and Columbia have the steepest expected decline in emissions, as they are the only two countries that have committed to a reduction in absolute emissions by 2030. In contrast, Mexico has the lowest foreseeable reduction in emissions within the region.

Figure 5. Emissions trajectories for the LAC-6 countries: Nationally determined scenarios



Source: Authors' analysis based on the NGFS NDC 2050 scenario using REMIND-MAgPIE and MESSAGEix-GLOBIOM.
Note: Chile's NDCs exclude the AFOLU sector (in which the country is already net negative). Therefore, projections for Chile have been adjusted in the MESSAGE-ix-GLOBIOM model, assuming a constant value of AFOLU negative emissions.

11 To prevent the reduction or removal of emissions from being double counted by two different countries, Parties to the Paris Agreement have agreed to apply corresponding adjustments. Although the concept of corresponding adjustment has been agreed upon, negotiations on implementation rules, including how corresponding adjustments will be applied and tracked, are ongoing (World Bank, 2021).

12 "REDD+ is a framework created by the United Nations Framework Convention on Climate Change Conference of the Parties (COP) to guide activities in the forest sector that reduce emissions from deforestation and forest degradation, as well as the sustainable management of forests and the conservation and enhancement of forest carbon stocks in developing countries" (UNFCCC, 2022).

Long-term strategies for climate mitigation

Most LAC-6 countries have designed and shared long-term strategies to achieve the emissions reductions they committed to in the NDCs,[13] with high-impact initiatives associated with the AFOLU sector (Table 2). What's missing are financial plans to support the implementation of these strategies. This deficiency casts a doubt on the feasibility of delivering NDCs, even though LAC countries have better access to both public and private finance than the global average (United Nations Development Programme, 2022).

In the AFOLU sector, several countries have committed to reforesting, restoring and better managing native forests, in addition to implementing programmes under the REDD+ framework. Other initiatives include implementing measures for sustainable agriculture and livestock farming, payment for environmental services and management of protected areas.

In the energy sector, most LAC-6 countries identify the need to increase the proportion of non-hydro renewable energy used and to promote energy-efficiency measures in commercial and residential sectors. Argentina, Chile and Colombia also highlight actions regarding small-scale renewable electricity generation.

In the transportation subsector, the most common strategy is to increase the proportion of biofuels used and to accelerate the transition to light-duty electric vehicles. Meanwhile, for freight transportation, countries are implementing diverse measures. For example, Argentina and Colombia are proposing both a renewal of heavy-duty fleets and modal changes, shifting to rail-based transportation and fluvial routes (in the case of Colombia). Chile is planning to use hydrogen in heavy-duty vehicles and Brazil is increasing the share of sustainable biofuels available for transportation. Other measures include replacing carbon-intensive technologies, investing in energy efficiency in the industrial sector and promoting circular economy programmes.

These countries have all identified capacity-building, technology transfer and information systems as prerequisites for NDC implementation. However, only Chile, Colombia and Peru are working on climate-financing plans, and Colombia has mentioned using carbon taxes to finance these policies.[14] Countries have also not been explicit about the fiscal impact of the energy transition, both in terms of foregone revenues and new expenditures required.

Although there are several market and regulatory mechanisms, such as renewable energy auctions, emissions caps and clean fuel standards, these policies are not nearly enough to support the NDC targets. Large carbon abatement actions, such as afforestation and forestry management, require the creation of a deep and liquid market for carbon offsets. International cooperation from advanced economies is another source of funding. However, based on past experience with aid budgets, it is unlikely to be available at the required scale.

All of this suggests an urgent need to bring economic and financial authorities into the conversation with the specific mandate of developing financial plans to support mitigation strategies. These plans could then be incorporated into medium-term fiscal frameworks, which fiscal responsibility laws require many countries to produce on an annual basis. It is important for LAC countries to consider financing plans that are not limited to the provision of fiscal support and that include the design and implementation of a policy framework that enables private-sector investment to flow into carbon-abatement actions. Government interventions may be

13 Ministerio de Ambiente y Desarrollo Sostenible (2020); Federative Republic of Brazil (2022); Gobierno de Chile (2020); Gobierno de Colombia (2020); Gobierno de México (2020); Gobierno del Perú (2021).

14 Gobierno de Chile (2020); Gobierno de Colombia (2020); Gobierno del Perú (2021).

needed to provide carbon offsets for afforestation and forest conservation efforts. Participation of development banks and deepening the market for thematic bonds (e.g. green, sustainable and sustainability-linked bonds) will help the private sector access long-term financing and support in de-risking projects.

Table 2. Summary of the long-term strategies of LAC-6 countries (non-exhaustive)

Country	Sector				General
	AFOLU	Energy	Industry	Residues	
Argentina	- Changes in agricultural technology and increases in crop productivity - Reforestation and native forestry management - Prevention of forest fires - Integration of environmental services in forest management	- Promotion of energy efficiency - Promotion of renewable energy - Sustainable mobility, including light-duty electric vehicles, heavy-duty fleet renewal and shifting to rail-based freight transportation	- Replacement of carbon-intensive technologies	- Promotion of a circular economy	- Elaboration of a territorial diagnosis to allow the construction of climate policies (including gender perspective) - Strengthening sustainable employment - International cooperation for capacity-building, financing and technology transfer
Brazil	- Implementation of the Low-Carbon Agriculture Plan, including recovering degraded land, integrating forest management with , crops, cattle breeding, agroforestry and forest planting - Enhancement of sustainable native forest management systems - Implementation of REDD+ initiatives	- Increase in the share of sustainable biofuels in the energy mix - Expansion of the use of renewable energy sources other than hydropower in the total energy mix	- Promotion of new clean technology standards and further enhancement of energy-efficiency measures and low-carbon infrastructure		- International cooperation for capacity-building, financing and technology transfer
Chile	- Sustainable management, recovery and reforestation of native forests - Reduction of forestry sector emissions (due to deforestation and degradation of native forests) by 25% - New protected oceanic areas and creation of management plans for previously protected oceanic areas	- Implementation of renewable energies to replace thermal power plants - Sustainable buildings, efficient heating and distributed generation - Electromobility, including electric vehicles, in public transportation. Commercial and private electric vehicle penetration of 60% - Hydrogen use in freight transportation, blending of hydrogen with natural gas	- Sustainable industry, including energy efficiency, electrification and renewable thermal processes	- Biogas capture and use in urban landfills, efficient use of fertilizers	- Development of the Strategy of Development of Capabilities and Climate Empowerment, which includes institutional capability building, research and development, and education for climate action - Development and implementation of the Strategy of Technological Development and Transfer for Climate Change - Development of a strategy for climate financing

Colombia	- Sustainable cattle raising - Consolidation of commercial forest planting - Expansion of ecological restoration - Deforestation reduction (including REDD+ programmes) - Payment for environmental services - Management of protected areas	- Diversification of the energy matrix, promoting self-generation of energy from alternative sources - Regulatory and financial framework to accelerate the transition to light-duty electric vehicles - Replacing commercial and residential fridges	- Promotion of energy-management and energy-efficiency projects in the industrial sector, especially brick and cement production	- Creation of the National Strategy for Circular Economy	- Development of the National Climate Change Information System - Carbon tax - International cooperation for capacity-building, financing and technology transfer
Mexico	Non-specific actions on: - Nature-based solutions and protection of the oceans - Circular economy - Energy efficiency - Emissions market				- Development of financing strategy - Capability building
Peru	Not defined in the NDC				

Sources: NDCs, authors' analysis

The Price of the Transition to a Low-Carbon Future

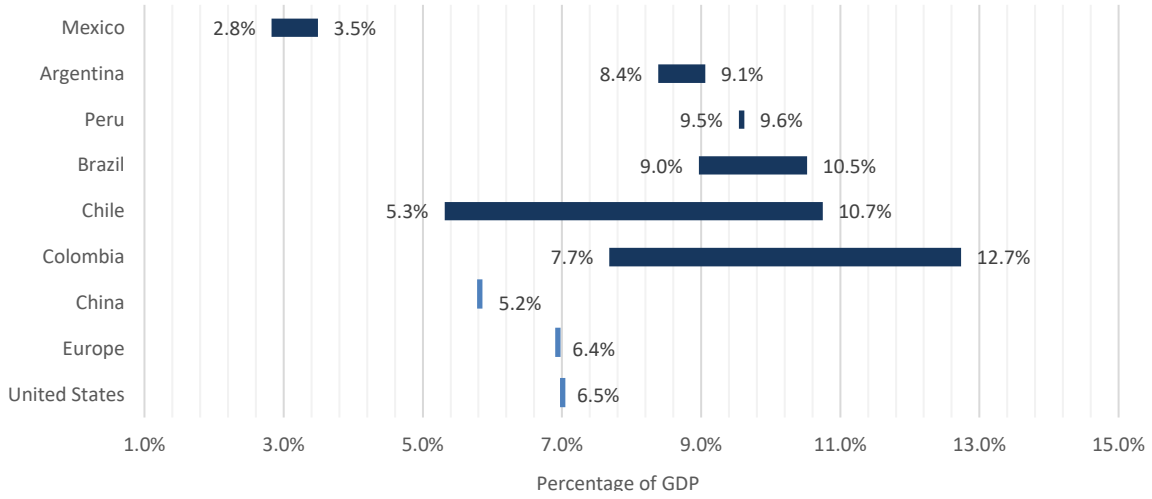
Investment required to achieve the nationally determined contributions

LAC's transition to a low-carbon economy will require significant capital expenditure. To estimate the required investment spending, as a percentage of the GDP for LAC-6 countries, this report applies two models: the MESSAGEix-GLOBIOM model, which explicitly includes a number of endogenous AFOLU measures, and the REMIND-MAgPIE model, which does not have the same level of specificity in relation to AFOLU, but is used to provide an upper bound for the costs of reducing emissions.

To arrive at the required investment per year as a percentage of GDP (country-specific GDP projections are taken from NGFS), the analysis uses the average expenditure per tonne of CO2-eq for the region, derived from the REMIND-MAgPIE model as calculated by Krishnan and others (2022). This results in a carbon abatement cost of between US$200/t CO2-eq and $300/t CO2-eq.

This cost represents a weighted average of the costs of the emissions reduction paths for all sectors (energy, AFOLU, industrial process, etc.) resulting from the integrated assessment models used. While there are sectors with higher abatement costs, such as electricity generation or heavy industry which cost over $300 per tonne (Friedmann and others, 2020), most of the abatement in LAC is forecasted to be in the AFOLU sector, where the cost of abatement measures is much lower. Eriksson (2020) shows that up to 275 million t CO2-eq per decade can be abated in LAC at prices of under $100 per tonne (at a cost of $150, nearly 400 million t CO2-eq can be abated). This analysis shows that even though the abatement cost for LAC countries is 25–40 percent lower than in North America and Europe, the transition is more costly for LAC economies. For LAC-6, the low-carbon transition will require an average investment of 7–11 percent of GDP per year between 2021 and 2050, compared to around 6 percent of GDP per year for the European Union and United States over the same period (Figure 6). Colombia will face the highest cost (8–13 percent of GDP per year), reflecting its greater level of ambition. Mexico, with much lower ambition and a higher GDP, will face a lower expenditure of around 4 percent of its GDP per year. Countries with higher ambitions and lower GDP, such as those in Central America and the Caribbean, will face higher transition costs.

Figure 6. Expenditure required as a percentage of 2020–2050 yearly gross domestic product to achieve the nationally determined contributions



Source: Authors' analysis based on the Network for Greening the Financial System NDC 2050 scenario using the REMIND-MAgPIE and MESSAGEix-GLOBIOM models, and assuming abatement costs as estimated by McKinsey & Company (Krishnan and others, 2022).

There are three reasons why the LAC region faces higher costs relative to the rest of the world:

1. **Higher spending relative to the size of the economy:** Although the world's largest economies (United States, China, the EU, Japan and the United Kingdom) account for about half of global expenditure on physical assets required for the transition and face a higher cost per t CO2-eq abated, their expenditure is a lower percentage of their GDP compared to LAC countries.

2. **Higher rates of economic growth:** As emerging economies grow faster than advanced economies, the need to reduce carbon emissions in absolute terms requires a greater reduction in carbon content per unit of GDP compared to industrialized countries.

3. **Reallocation of spending from high- to low-emissions assets:** Several LAC countries, such as Brazil, Colombia and Mexico, must reallocate investments from high- to low-emissions assets. This increases the price of the transition as there are costs associated with stranding relatively young assets.

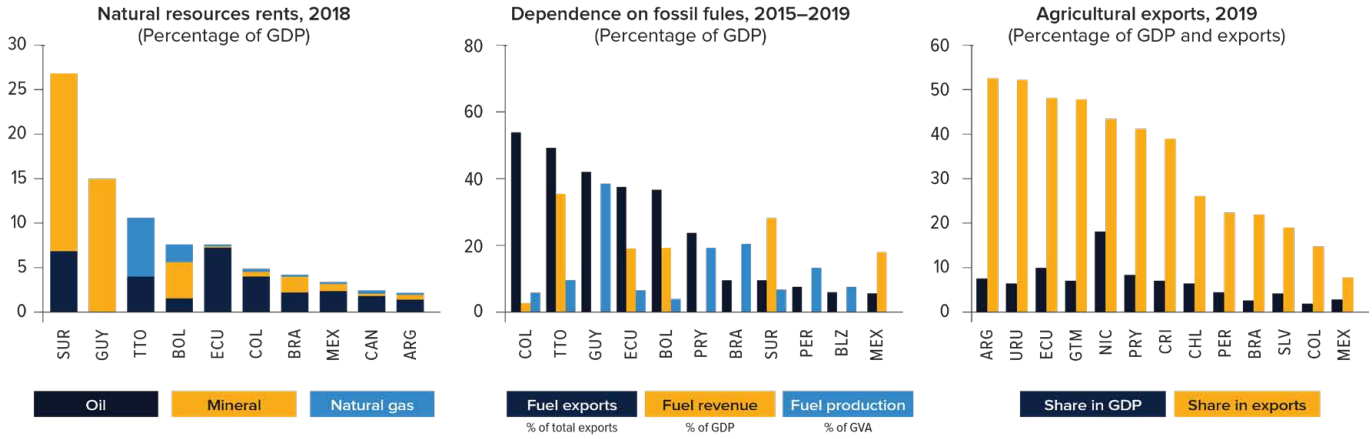
Our estimations are in line with recent findings from the Inter-American Development Bank on the costs of responding to the climate crisis. According to Galindo, Hoffman and Vogt-Schilb (2022), annual spending on infrastructure and social services to confront climate change ranges from 7 percent to 19 percent of annual GDP by 2030.[15]

15 A disaggregated analysis by country or sector is not provided.

Additional Costs: Revenue Losses and Transition Risks

Direct costs of emissions reduction are just one component of a complex equation facing the LAC region as it pursues climate mitigation goals. In addition to investments in emissions abatement, LAC countries face the challenge of reduced income given their dependence on GHG-intensive exports, such as fossil fuels and agriculture. Oil, natural gas and minerals represent a large percentage of the GDP and exports in many Latin American countries, including Bolivia, Colombia, Ecuador, Guyana, Mexico and Trinidad and Tobago. Agricultural products represent a significant share of exports in Argentina, Ecuador, Guatemala, Nicaragua and Uruguay.

Figure 7. Dependence of Latin American and Caribbean countries on several commodities



Source: Ivanova and others, 2021

Revenue Losses

In the global net-zero scenario, fossil fuels and high-emissions products would see shrinking demand over the next two decades. Coal production for energy use will have almost ended by 2050, and demand for cars with internal combustion engines will eventually cease, thus reducing oil exports. Likewise, demand for emissions-intensive food products such as beef and lamb will likely decrease in favour of lower-emission options such as poultry. According to the International Energy Agency (2021a), reducing meat consumption in households with the highest current levels of per capita consumption to the global average level would reduce GHG emissions by more than 1 gigaton CO2-eq in 2050.

This shift in global demand for GHG-intensive commodities could affect the region in several ways. Estimates suggest that fossil-fuel exporters would see a decrease not just in foreign exchange receipts, but also in fiscal revenues associated with royalties, corporate income taxes and revenues from excises on the consumption of fossil fuels. For the 1.5°C pathway, regional oil production needs to fall by 60 percent below pre-pandemic levels, from around 9 million barrels/day (mb/d) in 2019 to less than 4 mb/d in 2030 (Cavallo and others, 2022). This scenario implies that fiscal revenues in LAC countries will fall to $1.3–$2.6 trillion by 2035, compared to $2.7–$6.8 trillion (Solano-Rodriguez and others, 2021).

However, LAC countries may not see such a drastic reduction in revenues for the following reasons:

1. **Oil production forecasts in Latin America are not conclusive.** Much will depend on relative production costs and whether light and sweet oil can find a place in the market, replacing heavy and sour oil from other regions. Oil consumption in 2050 will not fall to zero but will probably be limited to light, sweet oil, mostly for non-energy uses. Crude oils from a number of producers in the region (notably Venezuela, which has the highest reserves) are heavy and sour (McGlade and Ekins, 2015). Countries with more mature fields and heavier crudes (such as Colombia, Ecuador, Mexico and Venezuela) are likely to lose revenue as a result of the energy transition. Meanwhile, the transition risks to other countries, such as Argentina, Brazil, Guyana and Suriname (with increasing unconventional production from Vaca Muerta), which have lighter and sweeter crudes, are likely to be much lower. Production in Brazil and Guyana is likely to add significant volumes because of long-cycle projects that will continue to deliver additional barrels on the lower end of the global CO2 intensity curve. Overall, Colombia, Ecuador, Mexico and Venezuela might be at greater risk during the energy transition due to oil with a higher CO2 intensity.

2. **There are new energy security considerations.** Russia's invasion of Ukraine is adding new considerations, such as reliability, stability and strategic friendship, in addition to cost and emissions, in order to ensure energy security. If "friend-shoring" takes hold, barrels from LAC countries will be of strategic value to the United States and Europe.

3. **It is also difficult to make generalizations about agriculture.** The question is whether agricultural products from the region will have a high or low carbon footprint and whether production costs will be lower than those in other regions. Contrary to fossil fuels, demand for agricultural products could increase significantly. Crops for biofuels and low-carbon agriculture for human consumption are likely to expand, in contrast to cattle raising and other carbon-intensive food products (especially those used to feed animals).

A taxonomy of transition risks

Not all countries are equally exposed to transition risks. This report presents a taxonomy of risks related to the climate transition across LAC countries (Figure 8). The taxonomy classifies countries according to their economic structures as fossil-fuel producers, agriculture-based countries and land-use-intensive, subsistence agriculture countries:

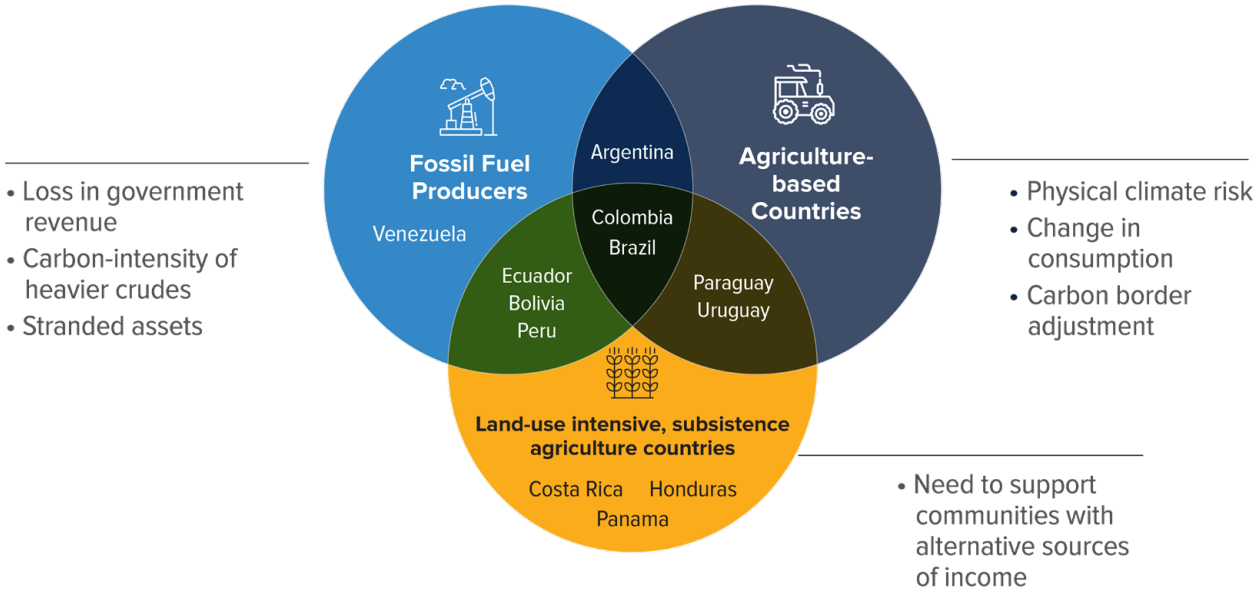
- **Fossil-fuel producers:** These countries face the risks of losing government revenues, stranded assets of extractive industries and falling demand of high-carbon-intensive exports. As discussed earlier, risk levels depend on the CO2 intensity of oil reserves and production.

- **Agriculture-based countries:** These countries are exposed to transition risks because of the sizeable share of the agriculture sector in their economies and the need to reduce the sector's emissions. These economies face physical climate risk from changes in weather conditions that may affect agricultural production, as well as risks associated with changes in consumption patterns that favour foods with a lower GHG footprint. Depending on the carbon content of the agricultural products, potential carbon border adjustment tariffs (CBAT) imposed by importing countries are another risk to consider. This would affect export countries that fail to meet their goal in reducing emissions. CBATs can also be applied to products from countries that fail to adopt prices on carbon as a way of compensating countries that impose carbon taxes for their production costs. Not all countries are equally committed to the idea of adopting CBATs, with the EU leading conversations in this regard. Mechanized soy production in deforested areas to produce feedstock for cattle raising is more likely to be affected by such measures than small-scale, labour-intensive food production.

» **Land-use-intensive, subsistence agriculture countries:** The economies of these countries largely depend on their natural capital and land-use-intensive activities, including extensive cattle raising and forestry. Changes to land use would have a sizeable effect on these countries, as they would need to curb deforestation or regulate the use of their existing forest area. These countries face a loss of income for communities that depend on land-use-intensive subsistence activities. Finding alternative sources of income for vulnerable and disenfranchised populations that depend on these economic activities is another challenge.

The three types of transition risks coexist in places such as Brazil and Colombia. Not only are these countries fossil-fuel producers, but their forests are also being converted, at the same time, into pastures or arable land for both subsistence and modern agriculture.

Figure 8. Taxonomy transition risks facing Latin American and Caribbean countries



Source: Authors' analysis

Paying for the Transition with Market Mechanisms

LAC countries can adopt a number of mechanisms to offset the expected fiscal losses and, importantly, develop new sources of income to pay for the transition. These include carbon pricing, green fiscal rules, voluntary carbon markets and carbon offsets. This section includes a brief discussion of each mechanism.

Carbon pricing

Carbon prices are rare in LAC countries. In fact, fossil-fuel subsidies in the region are significant and increasing, especially in the current context of high oil prices. Considering the region's dependence on high-emissions products for government revenues, dismantling expensive fuel subsidies and raising revenues through the

adoption of carbon taxes offer an opportunity to compensate for the loss of revenues from reduced hydrocarbon and carbon-intensive agricultural production. However, only four countries (Argentina, Chile, Colombia and Mexico) have established a carbon tax, and the rates are among the lowest in the world.

Offsetting the loss in fiscal revenues from oil production with carbon taxes would require tax rates comparable to the highest in the world, which is unrealistic given the per capita income in LAC countries. To achieve a neutral fiscal impact, carbon prices would have to be increased to levels that would provoke a political backlash of the kind seen in France and Ecuador. Colombia has kept local petrol prices almost constant since the social upheaval of mid-2021, reflecting the difficulty in raising domestic prices even when justified by the increase in international prices.

Despite these difficulties, LAC countries looking to finance the low-carbon transition will benefit from considering how revenues from carbon tax could offset losses in oil export and fiscal revenues. A recent paper from the United Nations Economic Commission for Latin America and the Caribbean optimistically estimates that Mexico could make up roughly half of its losses, while Brazil and Colombia would experience a net revenue increase from carbon taxes (Titelman and others, 2022). Overall, carbon prices can be a part of the solution, however it is unlikely that the entire region can offset the revenues associated with the production of fossil fuels by taxing their consumption.

Green fiscal rules

A number of LAC countries, such as Chile, Colombia and Peru, have a long and mixed experience with fiscal rules that try to enhance fiscal sustainability by adopting ceilings on expenditure, debt levels and fiscal deficits. These rules have been constantly modified a history of permanent modifications, which has reduced their effectiveness and relevance. Most countries abandoned or deactivated fiscal rules during the pandemic (International Monetary Fund, 2021). This presents an opportunity to redesign fiscal rules, taking into account the challenges of the transition to a low-carbon economy. Many of these rules have been adopted by governments—either by law or decree—often with the advice of the International Monetary Fund and other international financial institutions (Eyraud and others, 2018; International Monetary Fund, 2022).

The current thinking regarding fiscal rules underscores the importance of using a structural primary fiscal balance—the difference between structural or full employment revenues and expenditures, excluding interest payments—as a target. This calculation estimates the level of revenue and expenditure that corresponds to projected long-term full employment, isolating fluctuations that result from short-term cyclical effects, including those caused by volatile commodity prices.

Some countries, such as Colombia, have introduced an innovation in current fiscal rules, whereby the speed of convergence to the desired target is made contingent on the level of public debt. If the level of debt is above a certain threshold, greater efforts should be made to reduce the structural fiscal deficit.

However, fiscal rules, which are mechanisms to ensure discipline, are completely silent when it comes to achieving NDCs or net-zero goals. All expenditure or revenue is treated equally, regardless of its carbon footprint. A new generation of fiscal rules could include special provisions to finance the transition to a low-carbon economy. Undoubtedly, the question of whether financial markets will support green fiscal rules requires further exploration. However, the emergence of climate and environmental, social and governance finance suggests that markets favour issuers that not only repay their obligations but also show commitment to climate goals. Furthermore, a new generation of fiscal rules could help drive a convergence of these two dimensions.

This report suggests the following enhancements to advance towards green fiscal rules:

1. **Provide proportionally more fiscal space for governments that raise carbon taxes (or reduce energy subsidies) vis-à-vis other taxes.** Investments aimed at reducing CO2 emissions (e.g. electric buses) could also be treated more favourably relative to investments that cause higher emissions (e.g. airports). Income and expenditure measures that have the desired effects on mitigation (or adaptation) can have second-round positive effects for fiscal sustainability as they reduce the risk of contingent liabilities associated with climate change. The rationale is that revenue and expenditure that contribute to environmental sustainability can help to broaden the narrowly defined concept of fiscal sustainability.

2. **Incorporate environmental contingent liabilities into fiscal rules.** These liabilities should be measured in financial terms, thus creating an incentive to invest in adaptation and mitigation. Reducing these labilities will help countries achieve more sustainable levels of debt. Recently, some countries (under the auspices of the multilateral and regional development banks) have developed "green taxonomies," which can be used as an input for the design of green fiscal rules.

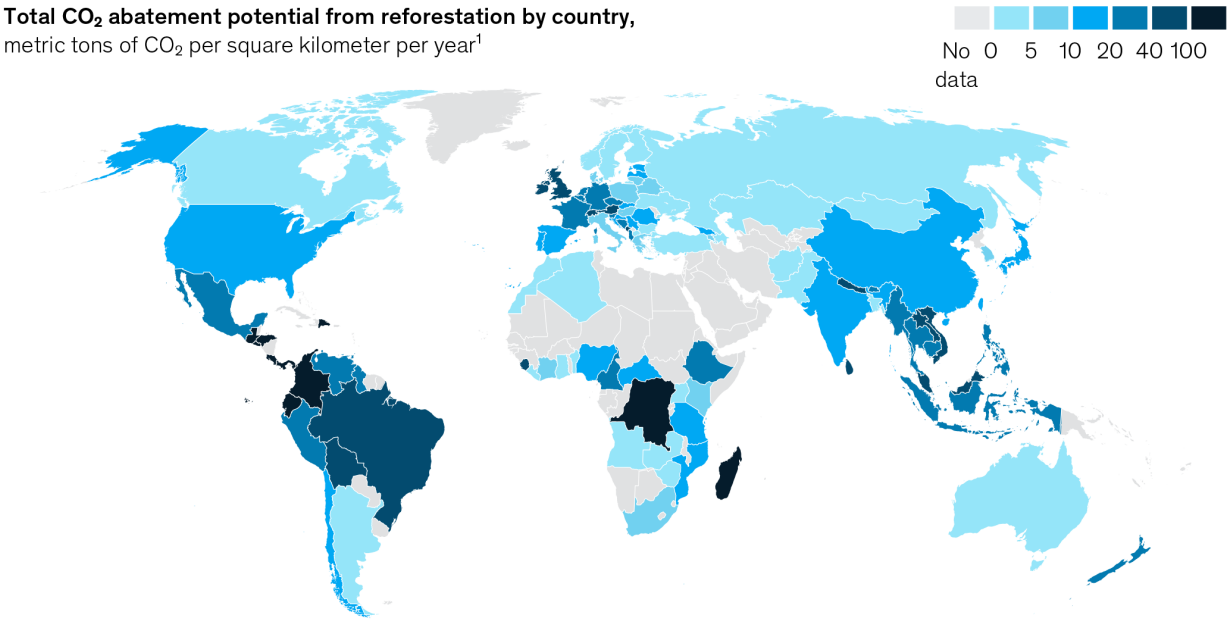
3. **Introduce specialized monitoring and verification for this new generation of fiscal rules.** Fiscal councils that oversee compliance with current fiscal rules should be complemented with the creation of carbon councils. Their role would be to monitor not just the level of emissions, but also the measurement of liabilities. Such councils would also be responsible for defining the expenditure and revenue considered to be critical to climate mitigation and adaptation.

Voluntary carbon markets and carbon offsets

Forests play a twofold role in climate change. First, forests serve as natural carbon sinks, removing carbon from the atmosphere. Second, they regulate several environmental processes, including temperature, rainfall, water filtration, prevention of soil erosion and crop pollination. Restoration via reforestation, afforestation, peatland and coastal restoration would represent the most significant contribution to decarbonization from LAC countries.

Among all regions in the world, the LAC region has the highest potential to abate carbon emissions from deforestation. Approximately 250 million hectares could be reforested today, especially in Brazil, Central America, Colombia and Panama (Eriksson, 2020; Benitez and Obersteiner, 2005; Krishnan and others, 2022). This provides an opportunity for LAC countries to trade negative emissions to offset hard-to-abate emissions in sectors such as cement and steel in industrialized countries.

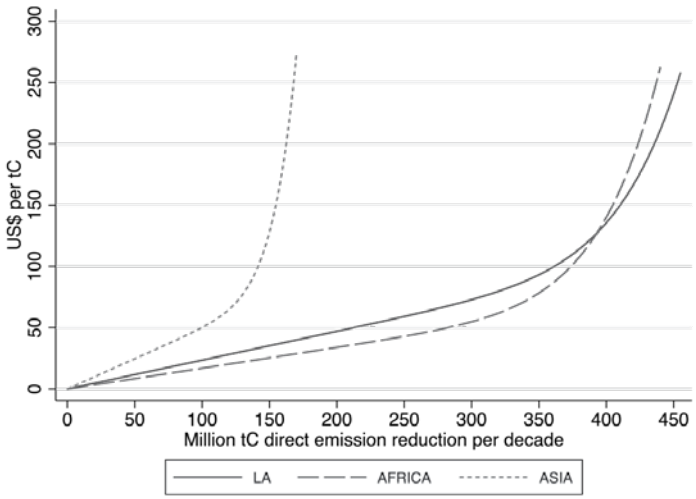
Figure 9. Total CO2 abatement potential from reforestation by country



Source: Krishnan, M. and others (2022). "The net-zero transition: What it would cost, what it could bring." McKinsey & Company. January 2022. www.mckinsey.com/capabilities/sustainability/our-insights/the-net-zero-transition-what-it-would- cost-what-it-could-bring.

As mentioned, preventing deforestation is cheap. This is because, in LAC countries, the cost of most of the relevant carbon abatement measures is marginal, at under $150 per tonne of CO2 (Eriksson, 2020). In addition, these types of measures mitigate emissions immediately.

Figure 10. Marginal abatement cost curve from avoiding deforestation



Source: Eriksson, M. Afforestation and avoided deforestation in a multi-regional integrated assessment model. Ecological Economics, vol. 169 (March 2020).

Carbon offset markets, at both the local and international levels, are still being developed. Emissions trading is lagging behind in Latin America, with only Mexico operating a pilot carbon market. However, Argentina, Brazil and Columbia, are in early stages of developing this market (International Carbon Action Partnership, 2022).

Article 6 of the Paris Agreement states that some parties may choose to pursue voluntary cooperation in the implementation of their NDCs and allows international transfers of mitigation outcomes in international carbon markets. Negotiations at COP26 in 2021 resulted in a rule book for international carbon markets. This rule book, which helps implement Article 6, provides countries with the tools needed for environmental integrity, to avoid double counting and, ultimately, to clear a path for private capital to flow into developing countries. However, international carbon markets are still not yet available to finance climate-related projects. Economic incentives to reduce carbon emissions and meet the NDC and net-zero goals hinge on the market signals that would eventually make it more attractive to engage in reforestation rather than deforestation.

There are, however, some preconditions that are required for carbon offset markets to develop in LAC countries. The state should be able to implement, monitor and verify projects where property rights are clearly established, local communities should benefit directly from the revenues associated with these projects and the rule of law must be enforced to ensure that projects are not challenged by illegal activities such as logging, mining, illicit crops and so on.

It is just as critical for governments to address coordination failures in the supply and demand of carbon offsets. A potential starting point is to establish a large pipeline of projects, with government entities acting as initial offtakers of carbon credits. Early support from governments or multilateral, regional and national development banks, which cover some of the costs, will encourage state-owned enterprises to act as offtakers of carbon credits, helping to create the right incentives and reduce the risk for other market participants.

Conclusions

Although the LAC region is not a sizeable emitter, it is experiencing the harsh consequences of climate change, with the number of extreme weather events doubling over the last two decades. Unsurprisingly, some countries have made very ambitious pledges to reduce emissions. However, there is a disconnect between aspirations and action. The investment required to meet climate goals is approximately 7–11 percent of GDP per year and it is not clear how the region will finance that.

Emissions differ within the region but, broadly speaking, are concentrated within the AFOLU sectors. Long-term strategies do address programmes relating to deforestation and reforestation, energy transition and the circular economy. However, no fiscal or financial support is available to implement these strategies. Moreover, LAC countries lack adequate state capacity in areas such as enforcement and monitoring, as well as provision of public goods and alternative opportunities to isolated communities that engage in deforestation for subsistence. Building state capacity requires political incentives and resources. Future studies should consider these investments when assessing the costs of preventing deforestation.

A BAU approach is untenable. The region faces serious, physical risks from climate change, as well as a range of transition risks as it pursues its climate ambitions. Hydrocarbon and agricultural exports may fall, losses in fiscal revenue may have significant effects on social expenditure and importers may impose carbon border adjustment tariffs on products from the region.

If the region wants to address these risks, it must consider increasing the use of carbon prices (per t CO2-eq) and voluntary international carbon markets.[16] A well-designed programme to supply carbon offsets will allow LAC countries to stop deforestation while generating the revenue required to finance the energy transition in areas such as the electrification of transport.

From a fiscal perspective, the region must work towards a new set of fiscal rules that explicitly measure the liabilities associated with the physical and transitional risks of climate change. Rules should be designed so that governments have a strong incentive to introduce carbon taxes while investing in climate mitigation and adaptation to reduce physical climate risks. In other words, fiscal sustainability should be coupled with planetary sustainability.

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16 These carbon markets should follow a GWP100 approach (a 100-year global warming potential approach) and also consider other GHGs such as CH4 and N2O, with trading quantities converted to CO2-eq based on an agreed standard.

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