3 Achieving climate neutrality in the Latin America and the Caribbean region

In the past two decades, the Latin America and the Caribbean (LAC) region has seen a significant rise in emissions, despite contributing to less than 10% of global Green House Gas (GHG) emissions. National pledges, while crucial, fall short of addressing this issue comprehensively. To effectively combat this trend, LAC governments must adopt an integrated approach, prioritising energy efficiency, renewable energy adoption, emissions reduction in transport and agriculture, and forest preservation. The region's diversity results in varying climate impacts and challenges. Based on the discussions in a series of Regional Policy Dialogues and Workshops on these issues among LAC and OECD experts in the context of the OECD LAC Regional Programme (LACRP), this Chapter describes regional challenges, identifies mitigation priorities, and presents policy options for tailored sector-specific climate mitigation strategies.

Introduction

This chapter was developed from discussions held during the 2021 Regional Policy Dialogue on Environmental Sustainability, involving LAC and OECD experts as part of the LACRP. It provides a comprehensive review of the climate change mitigation challenges facing LAC countries and presents a set of policy measures aimed at achieving climate neutrality. Analysis on air pollution and GHG emissions paints a solemn picture, constituting the necessary improvement of regulatory frameworks at the national and local levels. A sectorial approach – with a focus on energy, transport, sustainable mining, cities, agriculture and tourism – highlights the opportunities available towards achieving climate neutrality in the region.

According to the 2022 United Nations Environment Programme (UNEP) Emission Gap Report, based on the Nationally Determined Contributions (NDCs) submitted before and updates since the twenty-sixth United Nations Climate Change Conference of the Parties (COP26), global actions taken to address the climate crisis have been insufficient to stop and reduce GHG emissions. If countries continue with their current policies, global warming is projected to reach 2.8°C by the end of century. However, the implementation of unconditional and conditional NDC scenarios would reduce this to 2.6°C and 2.4°C, respectively, which is still greatly insufficient. Despite calls to "revisit and strengthen" their 2030 targets at COP26, little progress has been made in closing the significant emissions gap for 2030, which represents the disparity between the promised emissions reductions and the reductions required to achieve the temperature goal of the Paris Agreement (UNEP, 2022[1]). The International Energy Agency (IEA) estimates that effective implementation of the pledges announced at the twenty-seventh United Nations Climate Change Conference of the Parties (COP27) could limit global warming to an increase of 1.7°C, thereby providing a pathway towards the more ambitious goal of limiting warming to 1.5°C (IEA, 2022[2]).

It is clear that the time for decisive climate action is now. The urgency of the crisis cannot be overstated since the future of our planet and the well-being of future generations depend on this. Pledges, while important, are insufficient on their own. In such a diverse region, climate change impacts countries differently, and presents a set of challenges as varied as the countries themselves. However, it also presents an opportunity to devise implementation mechanisms that enable the influx of green financial resources into LAC. This approach can catalyse development, foster a green transition, and generate green employment. The success of these depends in their transformation into tangible actions.

Despite LAC contributing to less than 10% of total GHG emissions, its emissions have been significantly increasing in the last 20 years, mainly driven by transport, electricity, and heat production. Moreover, the region plays a crucial role in global mitigation efforts due to its natural carbon capture potential in places such as the Amazon River basin (OECD, 2023[3])**.** Governments in LAC will need to adopt an integrated approach in order to achieve climate change mitigation goals and international commitments, focused on increasing energy efficiency and renewable energy use, reducing emissions in transport and agriculture, and restoring and protecting forests, mangroves and wetlands. It is important that countries adopt policy mixes that best suit their specific circumstances, ideally articulated as national strategies. At the same time, air pollution represents a real risk to the urban population due to the high level of urbanisation in LAC. Climate change mitigation efforts could also bring important environmental and health co-benefits including reductions in air pollution mortality and morbidity.

COVID-19 and Russia's war of aggression against Ukraine have highlighted and exacerbated the region's vulnerability to external economic shocks, historically rooted in its structural challenges. Global disruptions to the energy and food supplies have increased prices which have forced countries to implement policies aimed at controlling inflationary pressures and protecting the well-being of its citizens, particularly the most vulnerable population. In LAC, during the first five months of 2022, the region witnessed an average price increase of 3.6% higher than the nationally representative household, with estimates suggesting that by the end of 2022, approximately 33.7% of the population would be in poverty

and 14.9% in extreme poverty. In this sense, it is crucial for governments to complement monetary measures with fiscal policies that include targeted safety net interventions, as well as to advance towards universal, comprehensive, resilient, and sustainable social protection systems (OECD et al., 2022[4]).

Some countries have established policies, such as regressive energy subsidies to fossil fuels (Cárdenas and Hernández, 2022[5]), **which have negative environmental consequences**, sometimes leading to delays or cancellations in the implementation of NDCs submitted to the UNFCCC. Therefore, countries must plan for a post-pandemic intelligent fiscal consolidation, gradually phasing out measures introduced to support consumption, while considering the inflation caused by higher food and energy prices (Cárdenas and Hernández, 2022[5]); (OECD, 2022[6]).

LAC mitigation contributions in Glasgow and Sharm el-Sheikh

Many LAC countries have made international commitments to reduce their GHG emissions and take action to mitigate the impacts of climate change. At COP26, nearly 200 countries signed the Glasgow Climate Pact, which recognises the urgent need for a rapid, deep, and sustained reduction in GHG emissions, and limit global warming to 1.5°C. The pact calls for increased efforts to collectively reduce GHG emissions through accelerated action and implementation of domestic mitigation measures. Parties are urged to communicate new or updated NDCs and long-term strategies (LTS) and to revisit and strengthen their 2030 targets. Additionally, the Glasgow Climate Pact calls on nations to phase down unabated coal power and inefficient subsidies for fossil fuels (UNFCCC, 2021[7]). Furthermore, countries finalised the *Paris Agreement Rulebook*, which includes agreements on an enhanced transparency framework for reporting emissions, common timeframes for emissions reductions targets, and mechanisms and standards for international carbon markets.

Additional pledges were made at COP26 in key strategic sectors. Some of these include:

- the *Global Methane Pledge*, where countries committed to take voluntary actions to reduce global methane emissions by at least 30% from 2020 levels by 2030, representing 70% of the global economy and nearly half of anthropogenic methane emissions, where 25 out of 105 signatory countries are from LAC[1],
- the *Glasgow Leaders' Declaration on Forests and Land Use*, where, to the date, 145 countries, 24 from LAC[2], committed to halt and reverse forest loss and land degradation by 2030 while delivering sustainable development and promoting an inclusive rural transformation, and
- the *Global Coal to Clean Power Transition Statemen*t with countries committing to scale up the deployment of clean power generation, scale up technologies and policies to achieve a transition away from unabated coal power generation and stop issuance of new permits for new unabated coal-fired power generation projects, new construction of unabated coal-fired power generation projects and to end new direct government support for unabated international coal-fired power generation.

At COP27, countries approved the *Sharm el-Sheikh Implementation Plan*, emphasising the need for immediate, deep, rapid, and sustained reductions in global GHG emissions across all applicable sectors. Countries recognised that limiting global warming to 1.5 °C requires a 43% reduction in global GHG emissions by 2030 compared to 2019 levels. The Plan calls on countries to accelerate the development, deployment, and dissemination of low-emission technologies and the adoption of policies that promote the transition to low-emission energy systems. This includes clean power generation, energy efficiency measures, phasing down unabated coal power, and eliminating inefficient fossil fuel subsidies. The plan also emphasises the importance of providing targeted support to the poorest and most vulnerable, while ensuring a just transition (UNFCCC, 2022[8]).

Global efforts to reduce methane emissions have gained momentum, with the number of countries endorsing the Global Methane Pledge increasing from 105 at COP26 to 150 by the conclusion of COP27. As a result, approximately 95% of countries are either including methane reduction commitments or plan to include them in their next revision of climate goals. Moreover, 50 countries have methane action plans or are working to develop one. More than 70 endorsing countries have already incorporated specific measures to target methane reduction in their NDCs (USA and EU, 2022[9]).

The LAC region has made important developments towards reducing methane emissions. In March 2022, Brazil launched its National Zero Methane Programme, aiming to promote the reduction of methane emissions in alignment with the Sustainable Development Goals (SDGs) (IEA, 2023[10]). The programme also seeks to encourage the use of biomethane and biogas. Chile announced its intention to accelerate methane reduction efforts by 2025, while Colombia indicated its intent to prepare a national methane action plan by COP28 (USA and EU, 2022[9]). Additionally, Mexico is in the planning stages for implementing methane reduction actions under the Global Methane Pledge (USA and EU, 2022[9]).

Furthermore, at COP27 a *Mitigation Work Programme* was launched with the objective of urgently scaling up mitigation ambition and implementation. The programme started immediately after COP27 and will continue until 2026. Governments were requested to revisit and strengthen the 2030 targets in their national climate plans by the end of 2023, as well as to accelerate efforts to phase down unabated coal power and phase out inefficient fossil fuel subsidies.

Snapshot of Nationally Determined Contributions in LAC

Due to the COVID-19 pandemic, many parties submitted new or updated NDCs at COP26 in 2021 instead of in 2020, despite the Paris Agreement requiring parties to submit increasingly ambitious NDCs every five years. While these new and updated NDCs showed some progress, they remained insufficient to bridge the emissions gap for 2030. As a result, the Glasgow Climate Pact, adopted at COP26, called for parties to "revisit and strengthen" their 2030 targets by the end of 2022 (UNFCCC, 2021[7]). In LAC, nine countries sent their updated NDCs by 2022.[3] In the region, some countries have set ambitious emissions reduction targets in their NDCs, while others have focused on adaptation measures or capacity building to support the transition to a low-carbon future (Annex B).

Out of the 33 LAC countries that have submitted GHG emission reduction commitments to the UNFCCC under the Paris Agreement, only 22 have presented clear enough NDCs to infer targets for 2030 and beyond. Moreover, only 16 countries have committed to achieving net zero by 2050 or earlier, and just seven countries cover all GHGs in their pledges (OECD, 2023[3]). The region faces challenges in effectively measuring and monitoring decarbonisation plans, with only the Dominican Republic, Panama, and Peru having proposed or developed national monitoring systems for tracking commitments (OECD et al., 2022[4]). This information gap hampers sound policymaking; for instance, Costa Rica's GHG emission inventories are issued with a significant time lag, with the latest inventory, released in 2021, containing data up to 2017 (Ministry of Environment Costa Rica, 2021[11]) (Annex B).

Challenges for the implementation Nationally Determined Contributions in LAC

There are different ways LAC countries can address climate change and reduce GHG emissions and Short-lived Climate Pollutants (SLCPs), such as carbon dioxide (CO_2), methane, nitrous oxide (N_2O) and fluorinated gases (f-gases), in order to achieve sectoral net-zero targets and climate neutrality goals by 2050. LAC governments should develop and implement mitigation strategies and action plans in a systematic and integrated manner, aligning them with their respective NDCs and the Paris Agreement. These policies and actions will vary depending on the specific challenges in each country and will involve

different levels of government and relevant stakeholders, including the private sector and civil society. Some of these include developing climate mitigation policies to reduce air pollution, promoting clean fuels in transport, and enhancing the quality, reliability, and durability of cooking stoves. Moreover, countries in the region can increase the share of renewable energy sources in their energy supply mix, adopt energy-efficient production processes, improve the energy efficiency of consumer goods and services, and conserve and expand carbon sinks like forests and wetlands (OECD, 2023[3]). Committing to deeper emissions reduction targets within their NDCs, transitioning to low-carbon energy systems, and addressing emissions from sectors like transport, agriculture and from land use, land use change and forestry (LULUCF) are essential steps to achieve climate neutrality goals by 2050.

Taking ambitious mitigation actions in diverse sectors across LAC, from renewable energy to sustainable transport and urban development, is vital to combat climate change while aligning with national climate adaptation strategies. Mitigation actions in LAC are needed across different sectors, such as energy (e.g., transitioning from fossil fuels to renewable energy sources and energy efficiency improvements in buildings), transport (e.g., investments in the production and use of low carbon public transport and electric vehicles), urban development/cities, industry/infrastructure development, innovation, agriculture, forestry, land use and tourism. Both NDCs and NAPs are complementary processes (see Chapter 2).

Unlocking the path to a sustainable future in the LAC region demands strategic planning, financial support, and public engagement. Essential factors like economic growth, political will, stability, and strong institutions play a crucial role in providing the necessary investments for net-zero development and emissions reduction, as well as to foster effective mitigation efforts. However, LAC countries often face challenges in funding their NDCs and decarbonisation plans due to the lack of an assigned budget, making them vulnerable to underfunding during crises or external shocks. The LAC governments have recognised they are expecting to shift financial resources away from climate budget due to COVID-19, including co-financing for projects already agreed upon with multilateral climate funds. Considering the growing financial burden of climate change, the LAC countries have consistently asked for support to mobilise climate finance, particularly by involving private sector investors. Expanding technical support for project preparation and improving access to international climate finance is essential to effectively implement its NDCs (NDC Partnership, 2020[12]).

Mitigation strategies should be designed to promote equitable outcomes, addressing existing inequalities within the LAC region while creating green jobs. Additionally, fostering social awareness and developing skills for transitioning to a green economy are vital components to achieve net-zero emissions economies in the region. Empowering citizens with knowledge and understanding of climate change can lead to collective demands for more sustainable practices across sectors. Encouraging behaviours that reduce carbon footprints, such as responsible consumption and waste management, is key to achieving emission reduction targets (OECD, 2023[13]). Furthermore, public engagement in addressing critical environmental issues and advocating for stronger climate policies will provide greater traction and accelerate the implementation of effective mitigation measures.

Air pollution: A major concern in LAC

Air pollution is the primary environmental health risk in LAC, with the most vulnerable populations being children, the elderly and pregnant women (PAHO, 2016[14])**.** Combustion of fossil fuels are the primary source of particulate air pollution in the region, including $PM_{2.5}$ (Gouveia et al., 2021[15]). Fine particulate matter concentrations are associated with respiratory infections, ischemic heart disease, stroke, cancer, and chronic respiratory diseases. In 2019, chronic respiratory diseases, particularly chronic obstructive pulmonary diseases, were responsible for over 180 000 deaths in LAC, with Brazil accounting for 43% of the cases of the region, followed by Mexico, Colombia, Venezuela, Peru, Cuba, Ecuador, and

Bolivia. The associated average welfare cost in the region was under 3% of GDP, but considering factors like labour productivity losses, medical treatment, and agricultural productivity were considered, this cost would rise further. In the Caribbean, welfare losses due to air pollution reached approximately 7% of GDP in Barbados (OECD, 2023[3]). Additionally, Dominica reached 5%, Grenada 5%, the Dominican Republic 3.8%, Jamaica 3.6%, and Antigua and Barbuda exceeded 3.2% (OECD, 2023[16]).

The percentage of people living in urban areas in LAC has doubled since 1950, with approximately 81% of the region's population living in urban areas in 2021 (World Bank, 2022[17]). The Caribbean has also experienced a significant increase in urbanisation, with the urbanisation rate rising from 36.3% in 1950 to 72.2% in 2020. The Dominican Republic and Haiti have seen the fastest increase of urbanisation rates from 23.7% to 82.5% and from 12.2% to 57.1%, respectively in that same period (OECD et al., 2022[4]).

The high urbanisation rates in LAC have resulted in increased demand for transport, particularly by private vehicles, leading to higher GHG emissions, air pollution, and traffic congestion. Between 2005 and 2015, the region witnessed a 58% growth in car ownership, more than double the global average which was at 27%. Private motorised transport was responsible for 75% of CO_2 emissions and 82% of PM_{10} pollutants (OECD et al., 2022[4]); (SLOCAT, 2021[18]).

Some LAC countries have introduced various policy measures to address air pollution, including green urban planning, more effective use of economic instruments and regulations on emissions from industrial and transport sources, promotion of cleaner fuels and vehicles and the development of sustainable transport programmes. For example, Argentina's *2022 National Plan for Sustainable Transport* aims to establish a roadmap toward 2030 by regulating different modes of transport and promoting the adoption of natural gas and electric mobility (Government of Argentina, 2022[19]). Mexico has implemented the *National Strategy for Air Quality*, which guides and co-ordinates actions between different governmental agencies to control and mitigate pollutant emissions until 2030 (Government of Mexico, 2017[20]).

As of 2020, at least 12 countries in LAC have adopted national emission standards for industries through laws and regulations. These measures include the use of environmental impact assessments (EIAs) to regulate industries, the establishment of industrial emission standards, and policies on efficient resource use for fuel and electricity. Additionally, a total of 17 countries regulate the burning of waste, although only 5 of them do so strictly, as open burning remains a common practice in the region even when regulations exist. Furthermore, at least eight countries in LAC have a national air quality management strategy, framework, or action plan, which is generally implemented through a national environmental action plan. A total of 21 countries in the region had legal instruments that considered ambient air quality standards (UNEP, 2021[21]).

Implementing climate mitigation policies in the LAC region aiming to reduce air pollution can provide multiple co-benefits and synergies, including resource efficiency, economic security, sustainability of ecosystems, biodiversity and increased economic dynamism (UNECE, 2016[22])**.** Air pollution and climate change are closely related. CO_2 is the major cause of climate change, due to the extraction and burning of fossil fuels, as well as a major source of air pollutants. Many air pollutants contribute to climate change by reflecting or absorbing sunlight, with some pollutants warming and others cooling the earth. These SLCPs include methane and black carbon, which are among the top contributors to global warming after CO_2. The 2018 IPCC special report on the impacts of global warming underlines that deep reductions in non-CO_2 climate forcers, particularly in methane and black carbon, will be vital to reach the Paris Agreement goal of limiting warming to 1.5°C or even 2°C (RIFS Potsdam, 2022[23]).

Sulphur, nitrogen emissions and ground-level ozone impact ecosystems due to air pollution. Emissions of both sulphur dioxide and nitrogen oxides deposit in water, on vegetation and on soils as "acid rain"; with increasing adverse effects on flora and fauna. Acidification affects the ability of ecosystems to provide "ecosystem services", such as nutrient cycling and carbon cycling, but also water provision, on

which the planet and human life is dependent (UNECE, 2022[24]).Furthermore, air pollution has negative impacts on both terrestrial and aquatic ecosystems, degrading environments and reducing biodiversity by affecting lower life forms regarding number of species and sensitivity of individual species, such as lichens, bryophytes, fungi, and soft bodied aquatic invertebrates. On land, plants are more affected than animals, but not in freshwater. While most affected species decline as a result of air pollution, it is important to note that there are some species, for instance aphids, which appear to be stimulated by air pollutants, while others are resistant and tend to expand (Air Pollution and Climate Secretariat (AirClim), 1997[25]).

Recognising the connection between GHG emissions and local air pollution, suggests developing integrated strategies that reduce GHG emissions and air pollutants, thus implementing "win-win" solutions for both climate and health policy objectives. Effective pollution prevention and control measures are especially important. They need to be tailored to local circumstances as both the sources of air pollution and severity of exposure vary across and within countries (OECD, 2023[3]).

Air pollution poses an important health risk in LAC

Governments should align environmental and health policies to protect the environment and public health while considering synergies between emission reduction and broader well-being objectives, such as reducing air pollution and improving health. Around 25% of global deaths and diseases can be attributed to avoidable environmental risks, resulting in approximately 13 million deaths annually (WHO, 2019[26]). In LAC, about 13% of premature deaths in high-income countries[4] and 19% in low- and middle-income countries[5] in the Americas are attributable to known avoidable environmental risks, amounting to approximately 1 016 000 deaths each year (Korc and Hauchman, 2021[27]). Air pollution alone leads to 7 million preventable deaths worldwide each year, with over 90% of the population breathing polluted air (WHO, 2019[26]). Furthermore, almost 3 billion people worldwide and 80 million people in LAC still rely on polluting fuels like solid fuels or kerosene for lighting, cooking, and heating. In LAC, ambient and household air pollution was linked to about 250 000 premature deaths in 2016 (WHO, 2019[26]); (Korc and Hauchman, 2021[27]).

Countries in the region should integrate preventive environmental health actions as a core component of universal health coverage through strategies and programmes targeting specific diseases and risks. They should promote the systematic consideration of health in the development of policies and sectors relevant to health, such as energy, transport, housing, labour, industry, food systems and agriculture, water and sanitation, and urban planning. Strengthening governance mechanisms to facilitate cross-sectoral collaboration and comprehensive cost-benefit analysis is important. LAC countries could foster the integration of environmental monitoring (especially in air pollution) and health surveillance to assess health impacts from environmental risks and services, as well as to monitor changes and the implementation of relevant strategies at regional and country levels (WHO, 2019[26]).

Many LAC countries could improve the performance of environmental public health programmes and institutions, to reduce the burden of disease associated with environmental risks. This can be done by placing emphasis on air quality while considering chemical safety, climate change-related impacts, solid waste management, and water and sanitation factors that influence human health and their related behaviours (Korc and Hauchman, 2021[27]). Moreover, it is important that countries consider the health risks on vulnerable populations such as the very young, the elderly and pregnant women (PAHO, 2016[14]).

Black carbon in the transport and the residential sector in LAC

Black carbon (BC) is one of the largest contributors to global warming, following CO_2 (Bond et al., 2013[28]). Despite BC being a SLCP with a lifetime of only days to a few weeks, it significantly accelerates the melting of snow and ice, increasing climate change by reducing the albedo effect.[6] Additionally, BC affects precipitation patterns in the Amazon basin (OECD, 2023[3]), where biomass burning contributes to air pollution and smoke. BC also leads to lower agricultural yields and food security concerns. These

impacts directly affect the livelihoods of Andean inhabitants, agriculture, and hydropower generation, the latter accounting for 8% of the total energy supply in LAC, and 54% of electricity production in the region in 2020 (OECD, 2023[3]).

Reducing BC emissions can bring immediate co-benefits to the environment, air quality, and public health. BC and its co-pollutants are significant components of fine particulate matter $(PM)_{2.5}$ air pollution, which is a leading environmental cause of poor health and premature deaths (UNEP and CCAC, 2018[29]). The LAC region contributes less than 10% of the total BC emissions. The transport sector and the combustion of solid fuels in the residential-commercial sector are responsible for about three-quarters of BC emissions in the region, with Brazil and Mexico accounting for more than 60% of it (UNEP and CCAC, 2018[29]). Within the transport sector, high-emitting diesel vehicles are the primary sources of BC emissions (Natural Resources Defense Council, 2014[30]).

Considering the short atmospheric lifetime of BC, targeted policies have proven to be effective in achieving relatively fast climate and health benefits (ICCT, 2009[31]). In the transport sector, it is crucial for LAC to promote clean fuels and adopt common fuel standards that reduce sulphur levels to ultra-low levels, ideally below 15 ppm. Additionally, the region should strengthen its emissions standards for new vehicles by mandating the installation of diesel particulate filters or encouraging the use of comparably effective emerging alternative fuels and advanced vehicle technologies (e.g., natural gas-powered, hybrid-electric, or electric vehicles). Complementary programmes should also be developed to reduce in-use emissions from older diesel vehicles, with a focus on urban fleets, as successful strategies have been implemented in other cases (Natural Resources Defense Council, 2014[30]).

In the residential sector, the use of fuelwood for cooking poses the most significant emissions-related health risks to LAC citizens, particularly affecting lower-income households in rural areas. Approximately 90 million people in LAC relied on solid fuels for cooking in 2017, accounting for around 15% of the region's population. To address this issue, the region could develop and enhance its regulatory frameworks, including measures to improve the quality, reliability, and durability of cooking stoves. Implementing certification and field tests to ensure stoves meet quality standards, alongside policies addressing affordability, accessibility, and awareness of health impacts, will be essential. Supporting sustainable forestry practices and women's economic empowerment can also contribute to addressing the underlying social and environmental issues that necessitate improved cooking stoves (Levy et al., 2020[32]).

Greenhouse gas emissions in LAC

From 1990 to 2019, the LAC region increased its GHG emissions by 61%, despite representing only 6.7% of the global GHG emissions, excluding Forestry, and Other Land Use (LULUCF) (OECD, 2023[3]) and 8.1% including them. This was mainly driven by increased emissions from transport, electricity and heat production, being proportional to its 8.4% share in total world population, and slightly higher than its 6.4% share in global GDP. Total emissions in the Caribbean increased 23.5% from 1990 to 2019, despite it representing only 5% of the region's total emissions throughout that period (OECD et al., 2022[4]). Although the region's contribution to climate change is not significant, LAC, particularly the Amazon River basin, plays a crucial role in global mitigation efforts due to its natural carbon capture potential (OECD, 2023[3]).

There are sectors with high emissions that are rapidly increasing their climate forcer emissions due to the absence of economic incentives for improving, developing, and introducing proper technology and infrastructure (UNEP and CCAC, 2017[33]). In terms of sectoral breakdown, three sectors represented 88.3% of total emissions in LAC in 2019, energy (43.5% including transport), agriculture (25.3%) and LUCF (19.5%). The energy sector remains the most emission-intensive for all three LAC sub-regions, although each one has its particularities. South America's high emitting sectors are agriculture, 28.5%, LUCF, 23.8%, and transport, 13.4%. The Caribbean differs slightly, with electricity and heat

accounting for 24.8% followed by agriculture, 15.6% and LUCF, 13.4%, very similar to transport at 11.1%. In Central America, electricity and heat accounts for 23.8% of emissions, while transport accounts for 21.4%, followed by agriculture with 16% (OECD et al., 2022[4]).

Both Brazil and Mexico have shown increased emissions targets compared to previous targets due to a change in the baseline methodology used to calculate the targets in their NDCs. At the same time, Mexico is the only G20 country without a net-zero target by 2050. Per capita emissions vary widely across G20 members, with Mexico not expected to peak its emissions until 2030 under current policies and NDC scenarios, while Argentina and Brazil have already peaked (UNEP, 2022[1]).

LAC's contribution to global net GHG emissions is largely driven by Brazil, Mexico and Argentina, which are the three largest emitters in the region, representing 5.4% of the total global emissions. In 2020, these three countries accounted for 38%, 16%, and 10% of the regional GHG emissions, respectively, making up 63.8% of the region's total GHG emissions. Heavily reliant fossil-fuel exporters like Bolivia, Colombia, Ecuador, Guyana, Suriname, Trinidad and Tobago and Venezuela, represent only 1.7% of global net GHG emissions (Anna Ivanova et al., 2021[34]). Despite significant investments in renewable energy projects over the last decade, the Caribbean remains highly dependent on imported fossil-fuel energy, with most countries being net-energy importers, except for Trinidad and Tobago, Suriname, and Guyana (UN ECLAC, 2021[35]).

Since 2014, emissions in LAC grew at a slower pace than economic growth suggesting a relative decoupling. In order to mitigate and stabilise GHG emissions in the atmosphere, it is crucial to implement both national and international low-carbon strategies and further decouple emissions from economic growth (OECD, 2023[3]). This can be achieved through the adoption of multiple low-carbon strategies, such as increasing the share of renewable energy sources in the energy supply mix, adopting energy-efficient production processes, enhancing the energy efficiency of consumer goods and services, and preserving and expanding carbon sinks, such as forests and wetlands (OECD, 2023[3]). LAC countries could commit to deeper emissions reductions targets on their NDCs and transition to low-carbon energy systems, as well as to reducing emissions from specific sectors such as agriculture and LULUCF, since these sectors account for one third and one fourth of South America's net emissions. In Central America and the Caribbean, energy production and transport are major emitters (OECD, 2023[3]).

Recommendation

- Improve regulatory frameworks for GHG and SLCPs emissions, with particular attention to methane and f-gases, setting sectoral, national and local targets.
- Aim for co-benefits of reducing air pollution with regulating climate mitigation by aligning environmental and health policies and diseases associated with environmental risks.

Methane emissions in LAC are generated by agriculture, coal and gas production and distribution, and waste management.

Methane emissions are an important contributor to global warming, with the largest source of anthropogenic methane emissions being agriculture, responsible for around a quarter of the total emissions, closely followed by the energy sector, which includes emissions from coal, oil, natural gas and biofuels (IEA, 2020[36]). LAC generates approximately 15% of global methane emissions, the main source of emissions are agriculture, at approximately 50%; coal, oil and gas production and distribution, at 40%; and waste management, at 10%. Brazil and Venezuela represent more than half of this figure (UNEP and CCAC, 2018[29]). Reducing SLCPs, such as methane and black carbon, which have a relatively short lifespan in the atmosphere, but potent climate change impacts, can bring immediate co-

benefits to the environment, air quality, and public health (UNEP and CCAC, 2018[29]). The IPCC Sixth Assessment Report (AR6) has emphasised that air pollution controls, relying on existing technologies, lead to more rapid improvements in air quality than climate change mitigation, which requires systemic changes. However, reductions in methane and black carbon would significantly improve air quality and reduce adverse effects on human health (Calvin et al., 2023[37]).

Among the most cost-effective and impactful actions that governments can take to achieve climate goals is the reduction of methane emissions from oil and gas operations. Controlling leaks, particularly methane emissions from oil and gas operations, is a crucial aspect of reducing GHG and SLCP emissions. Leaks in the natural gas supply chain can result in significant emissions of methane. It is essential for countries in the region to implement regulations that require regular monitoring of possible leaks in the natural gas distribution system. This could involve conducting regular inspections of pipelines, equipment, and storage facilities, as well as mandatory repairs for any detected leaks. Leak detection and repair (LDAR) programmes, designed to identify and address fugitive leaks, can be implemented. Policies may address equipment standards, inspection frequency, leak thresholds triggering repair requirements, and repair timelines. In 2018, Mexico approved the Guidelines for the prevention and comprehensive control of methane emissions from the hydrocarbons sector. Under the regulation, facilities must develop a Programme for Prevention and Integrated Control of Methane Emissions (PPCIEM) (IEA, 2021[38]), although the country has been regulating this since 2002 (Government of Mexico, 2022[39]). Colombia has implemented regulations that focus on monitoring and repairing leaks in the natural gas system, particularly in hydrocarbon exploration and exploitation (CCAC, 2022[40]). Another approach is to incentivise the use of technologies and practices that can help reduce leaks, such as advanced leak detection systems, remote monitoring technologies, and pipeline integrity management. Satellite, drone, and other aerial measurement methods can aid in locating significant emitting sources (IEA, 2022[41]).

Regulatory instruments should be designed to control and promote the adoption of methane control technologies. Biodigesters are natural systems that utilize organic waste from agricultural activities, mainly animal manure, to produce biogas and organic fertilisers through anaerobic digestion (Dafermos et al., 2014[42]). They can be used to treat waste from landfills, livestock operations, and other sources of organic matter, reducing the amount of methane that is released into the atmosphere. Methane can be used as fuel to generate electricity; capturing and using methane, instead of allowing it to be released into the atmosphere for electricity generation, can help reduce GHG emissions. These solutions are not mutually exclusive and can be used together to address methane emissions. Biodigesters, electricity generation and monitoring technologies can be combined as an integrated solution for controlling methane emissions. For example, methane produced by biodigesters can be used to generate electricity, and monitoring technologies can be used to ensure that the system is operating efficiently.

In LAC, several countries, including Brazil, Chile, Colombia, Cuba, Mexico, and Paraguay, have established regulations regarding biogas. In the case of Cuba, the country still needs to develop policies for biogas production, despite having regulations in place to facilitate the expansion of biogas plants. Argentina, on the other hand, lacks specific national regulations for biogas. Countries should consider the various scales of biodigesters suitable for their territories when developing regulatory frameworks for biodigestion. For example, in Chile, the existing Decree does not mention specific regulations for domestic biodigesters, which operate on a scale of up to 180 kW of nominal power. This imposes excessive requirements on systems designed for household use, impeding family enterprise projects, and demonstration and educational initiatives. Finally, it must be noted that these regulations are often not enforced in the region. In many cases, biogas waste is buried, burned, or sent to landfills, rather than being used to its full potential for energy and materials, such as biofertilisers (IICA & RedBioLAC, 2013[43]).

Fluorinated greenhouse gases(F-gas): three main emitters in LAC

F-gases have a significant impact on climate due to their high global warming potentials, even at small concentrations. They are commonly used as coolants or propellants in air conditioning units, refrigerators, fire protection systems and extinguishers, solvents and aerosols, foams, and insulation materials (International Climate Initiative (IKI), 2020[44]). Argentina, Brazil and Mexico are responsible for nearly 80% of regional total HFCs emissions, with residential applications accounting for 60% of these contributions, followed by 25% from transport and specific industrial uses (UNEP and CCAC, 2018[29]).

Enhanced international co-operation is necessary to phase out F-gases. The *2016 Kigali Amendment to the Montreal Protocol* aims gradually to reduce the production and consumption of HFCs[7] and achieve an 80% reduction in HFCs consumption by 2047. While this amendment is an important step in the right direction, additional actions are still required. Currently, 23 countries in LAC have accepted the Amendment. Mexico has ratified the Kigali Amendment and developed a national strategy to phase out HFCs in sectors such as refrigeration and air conditioning (Ministry of Environment Mexico, 2019[45]). Argentina has also modified its regulations and incorporated the requirement for import and export licenses for HFC substances (Ministry of Environment and Sustainable Development Argentina, 2020[46]).

LAC governments could develop and implement transition policies to accelerate the phase-out of F-gases in key sectors such as tourism, transport, construction, and food supply. These policies may include setting phase-out targets with compliance deadlines, implementing and enforcing regulations that limit the use of F-gases (e.g., building codes prohibiting their use in new constructions) (EIA, 2011[47]), and providing financial incentives for companies and individuals to invest in F-gases alternatives, such as refrigeration systems that use natural coolants like carbon dioxide or ammonia gas, as well as insulation materials with low global warming potential (International Climate Initiative (IKI), 2020[44]). Promoting best practices for food storage and transport, such as insulated or mini containers, can support emissions reduction in the food supply sector. The use of renewable energy can also help reduce the reliance on HFCs in this sector (Syam et al., 2022[48]). The decarbonisation in hard-to-abate sectors will require investments in technologies such as green hydrogen and other low-carbon alternative fuels, including sustainable biofuels (OECD et al., 2022[4]). Countries could also consider phasing down HFCs and products containing them, scaling-up action against their illegal trade, and introducing good practices in refrigerant and end-of-life management (Yamaguchi, 2023[49]); (UNEP and CCAC, 2018[29]).

Sectoral policies

Energy sector: The LAC region is still heavily reliant on fossil fuels.

Fossil fuel dependency in LAC

Fossil fuels still dominate the energy supply at 69% as of 2020 in LAC, despite the significant hydropower and biofuels energy sources and its cleaner primary energy supply compared to the global average. Countries such as Chile, Colombia, the Dominican Republic, and Guatemala still heavily rely on fossil fuels (OECD, 2023[3]). Most Caribbean countries depend on fossil fuel imports, with Trinidad and Tobago, Suriname, and Guyana being the only Caribbean countries with significant domestic energy resources (OECD et al., 2022[4]).

Many LAC countries have made significant progress in developing renewable energy markets and diversifying their energy mix to reduce reliance on fossil fuels and enhance climate resilience, particularly in their hydropower systems. In 2020, renewable energy accounted for 69% of regional electricity generation (OECD, 2023[3]). This is more than double of OECD average of 30%, with 78% coming from hydroelectricity and 22% from solar, wind, biomass, and geothermal sources (OECD, 2023[3]).

In the last two decades, Central America has increased its electricity supply matrix of renewable energy sources from 65% to 77%, followed by the Caribbean with a 3 percentage point increase, due to an increase in the diversification of renewable sources of power; shifting from mainly hydropower to growing shares of thermal, wind, and solar energy. However, there are notable differences across the region, with countries like Paraguay and Brazil generating 100% and 84% of their electricity from hydropower, respectively, while Jamaica relies heavily on fossil fuels, with 87% of its electric power coming from imported oil derivatives (OECD et al., 2022[4]).

There are some positive developments and efforts in LAC to move away from fossil fuel dependency. For instance, Belize banned all petroleum operations in its maritime zone in 2017 through the adoption of the Petroleum Operations (Maritime Zone Moratorium) Act (Government of Belize, 2017[50]). At COP26, the governments of Costa Rica and Denmark led the creation of the *Beyond Oil & Gas Alliance* (BOGA), an international alliance with the objective of achieving the managed phase-out of oil and gas production, although Costa Rica has reduced its leadership role in this area (BOGA, 2021[51]); (Rodriguez, 2022[52]). In 2020, Chile published its *Plan of Phase-out and/or Reconversion of Coal Units*, aiming to eliminate all coal-fired power plants before 2040, with an initial phase established by 2024 (IEA, 2021[53]). In June 2023, during the World Economic Forum, Colombia announced that it would not approve any new oil and gas exploration projects (The Guardian, 2022[54]).

LAC countries could develop and implement energy plans that prioritise the deployment and utilisation of renewable energy sources. Transforming the region's energy mix is crucial to promote well-being and build more resilient societies. To achieve a successful transition to net-zero emissions, a systemic decarbonisation through electrification across all sectors is necessary. These plans should consider various approaches to accelerate the transition to net-zero energy systems. By investing in renewable technologies, some LAC countries can reduce their reliance on imported fossil fuel products, provide lower-cost power, and decrease GHG emissions (OECD et al., 2022[4]).

At the same time, some LAC countries could develop policies aimed at expanding the access to electricity in the region. This objective will improve livelihoods, foster inclusive local economic growth, increase well-being, and contribute to a sustainable, inclusive, and just transition that addresses historical social inequalities. As of 2019, access to electricity reached 95.5%, representing a 15.7% increase over the past two decades (OECD et al., 2022[4]).

Phase-out plans for fossil fuel exploration and production infrastructure could be established. The latest UNEP Production Gap Report highlights that the extraction of coal, oil, and gas is not aligned with agreed climate limits and national net-zero emission targets worldwide. Governments are currently planning to produce more than double the amount of fossil fuels in 2030 than would be consistent with limiting global warming to 1.5°C, and 45% more than consistent with limiting warming to 2°C. Moreover, there are no plans to wind down the production of fossil fuels (UNEP, 2021[55]). Plans aimed at phasing out fossil fuels should include a timeline to cease granting new permits for fossil fuel exploration, production, and infrastructure, as well as a phase-out of all subsidies to fossil fuels (Equitable Climate Action, 2021[56]), and the re-direction of public funding toward the development of low-carbon alternatives alongside improvements in energy security and energy efficiency (OECD, 2022[57]). The energy transition must be fair and inclusive, and it is important to establish effective policies that ensure developing economies, like those in LAC, receive financial assistance and technological know-how for phasing out fossil fuels. Governments should consider implementing support policies for fossil fuel industry workers and communities by promoting training and facilitating new job opportunities (IEA, 2021[58]).

Enhanced international co-operation on managing fossil fuel production is necessary to achieve the Paris Agreement goals. In 2017, the governments from Canada and the UK launched the *Power Past Coal Alliance (PPCA)* to advance the transition from coal power across the world. From LAC, Costa Rica, El Salvador, and Uruguay are part of the PPCA and are coal free, while Peru has committed to phase out coal before 2025 and Chile and Mexico after 2025 (PPCA, 2017[59]). In 2022, the Governments of Vanuatu

and Tuvalu launched the proposal for a *Fossil Fuel Non-Proliferation Treaty (FFNPT)*, which is structured around three pillars: i) enable a global just transition; ii) prevent the proliferation of coal, oil and gas by ending all new exploration and production; and iii) phase out existing production of fossil fuels in line with the 1.5ºC goal in a fair and equitable manner. The FFNPT has the objective of complementing the demand-side of the Paris Agreement, by addressing the supply- side of fossil fuels and promoting international co-operation in active support (The Fossil Fuel Non-Proliferation Treaty, 2022[60]). Currently, this proposal has been endorsed by LAC cities from Belize, Brazil, Costa Rica, Haiti, and Peru (The Fossil Fuel Non-Proliferation Treaty, 2022[61]).

Recommendation

- Develop and implement energy plans that prioritise the deployment and utilisation of renewable energy sources, while considering expanding affordable and reliable access to electricity.
- Establish and implement phase-out plans for fossil fuel exploration and production infrastructure, including policies aiming to re-direct public funding towards developing low-carbon alternatives.

Renewable energy in LAC

LAC countries need to accelerate their efforts to achieve the 2050 net-zero emissions goals by promoting renewables. In 2020, renewables account for 33% of the total energy supply in the region, compared to the global average of 13%. The primary sources of renewables in LAC include hydroelectric power (9%), biofuels such as firewood and bagasse (18.8%), solar and wind (5.1%), and geothermal (0.9%). Natural gas is the second largest energy source at 31%, slightly surpassing oil at 30%, possibly due to the effects of the COVID-19 pandemic. Coal accounts for 5% and nuclear energy for 1% (OECD et al., 2022[4]).

Ensuring access to energy in LAC is crucial for a green and just transition. In LAC, 17 million people still lack access to electricity, with rural areas facing significant challenges. The COVID-19 pandemic has exacerbated social challenges, leading to increased levels of poverty and inequality, particularly affecting food prices (OECD et al., 2022[4]). Electricity demand in LAC is expected to recover to pre-pandemic levels between 2022 and 2024, with an average annual growth of 3.9% for the rest of the decade (López et al., 2022[62]). The renewable power capacity of Latin America is projected to increase by 45% between 2022 and 2070, with Brazil accounting for over 55% of this growth (IEA, 2022[41]).

To ensure access to electricity in isolated and underdeveloped areas, the use of distributed wind and solar photovoltaic generation is key. Several LAC countries have implemented programmes to promote clean energy access in these areas, such as Peru's National Photovoltaic Household Electrification Programme, Nicaragua's National Programme for Sustainable Electrification and Renewable Energy, Guyana's Hinterland Renewable Energy project, Mexico's Isolated Communities Electrification project, and Brazil's Light for All programme (Grottera, 2022[63]). Additionally, Ecuador's has made significant improvements in off-grid electrification efforts through solar PV in local communities, providing an electromobility solution to improve transport along the Tupungayo River. The project resulted in replacing gasoline outboard engines with electric ones, leading to improved regularity of boat services, reduced emissions, and mitigated noise and water pollution risks. This marked a paradigm shift in providing basic services (energy, water, and mobility) for local communities (OECD et al., 2022[4]).

Several countries in the LAC region have made commitments to increase their use of non-hydro renewable energy, improve energy efficiency, and protect forests or coastal ecosystems through NbS, which can help absorb carbon dioxide from the atmosphere. For example, the Central American

Integration System (SICA), consisting of Belize, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, and Panama, established in its 2030 Energy Strategy the goal to diversify the energy matrix by promoting investment in energy infrastructure and clean technologies, as well as the aim to increase the use of other energy sources, particularly geothermal, solar, wind, and modern biomass. The strategy also emphasises the rational and efficient use of energy and aims to accelerate improvements in energy efficiency (UN ECLAC and SICA, 2022[64]). Additionally, SICA has conducted High-Level Dialogues to enhance financial allocations and prioritise NbS to respond to adverse processes and foster resilience in an area with over 60 million inhabitants (El Pais Costa Rica, 2021[65]).

The use of renewable energy in the productive, service, and residential sectors should be promoted in LAC. Green energy plans should prioritise the massive deployment and use of renewable energy in these sectors. It is important to establish achievable targets and projects that aim to transition to renewable energy sources and explore low-cost sustainable technologies for clean energy in electricity production, water heating, cold chains, air conditioning, and heating. The region must boost the demand and supply of renewable energies, especially considering, as mentioned above, that LAC will have an average annual growth of electricity demand of 3.9% throughout the decade. Long-term planning and regional integration must be improved to maximise the use of renewable energy while ensuring energy security (Martínez, 2022[66]). It is important to mention, that renewable energy sources tend to require higher upfront investment than fossil fuelled plans, which is balanced with lower Operation and Maintenance (O&M) costs, leading to a decreased lifetime overall cost (Grottera, 2022[63]).

Digitalisation has transformed the way electricity is produced, transmitted, and consumed due to the shift in consumer behaviour and the transformation of electricity generation through decentralisation. It is crucial that regulators in the region prepare institutions and frameworks for a rapid transformation, with the possibility to re-design network services, and establish tariffs that ensure cost recovery and affordability under changing circumstances. Regulatory frameworks could integrate the benefits of digitalisation in other services, such as electric mobility, and promote access to finance and reduce risk exposure (Grottera, 2022[63]).

Governments should encourage public and private investment in renewable energy projects by implementing mechanisms including subsidies, tax cuts, and policies aimed at phasing out fossil fuel subsidies. Economic instruments to promote renewable energy can be categorised in four groups: i) price regulation, a direct government intervention to set the price of energy; ii) quantity-based instruments, which are market regulations that make a specific outcome mandatory, such as the quantity of renewable energy generated; iii) fiscal instruments, understood as direct budgetary transfers and various forms of taxes like value-added or carbon taxes; and iv) financial instruments that include green bonds and policies that provide financial support to renewable energy projects, directly de-risking investments. Incentives should be extended to productive enterprises, institutions, and households, along with the dissemination of information and training on energy efficiency and renewables (Frédéric Gagnon-Lebrun et al., 2018[67]).

While many countries in LAC have implemented fiscal exemptions for renewable energy products and services, the adoption of carbon taxes remains limited. Most countries in the region have established funds or special credit lines to finance renewable energy, but there is still a need to incorporate policies that address technical aspects like grid access and the integration of renewable energy in other sectors, such as social housing. It is important that countries establish legally binding obligations or enforcement mechanisms, similar to those instituted in Chile, the only country in Latin America to have legally binding targets with clear penalties for non-compliance and a monitoring and enforcement mechanism (Grottera, 2022[63]).

Auction processes have proven to be effective for introducing renewable energy in LAC. By 2017, at least 10 LAC countries had implemented renewable auction policies. These auctions typically involve long-term contracts (15 to 30 years), technology-specific competitions, and a significant focus on solar and wind energy. Net metering policies have also been successful in encouraging small consumers to adopt

renewable energy systems. These policies allow consumers to offset their electricity consumption by inputting self-generated surplus electricity into the grid, generating credits that can be utilised later. As of 2018, 17 countries in LAC had implemented net electricity metering policies to promote their adoption, by small consumers such as households and small businesses (Hallack and Tolmasquim, 2020[68]).[8]

Regional and international co-operation needs to be enhanced to accelerate the deployment of renewable energy. In 2019, 16 countries in LAC launched the *Renewables in Latin America and the Caribbean initiative (RELAC)* with the aim of achieving at least a 70% renewable share in the region's electricity matrix by 2030. Moreover, countries seek to develop a specific climate action platform to monitor climate goals for the energy sector (RELAC, 2019[69]). Under RELAC, each member country contributes to the regional target, based on its own NDCs and national conditions. The Inter-American Development Bank (IDB) and the International Renewable Energy Agency (IRENA) provide support to member countries in developing their energy transition strategies, identifying gaps, and prioritising investments to overcome institutional, legal, planning, financial, technical, and regulatory barriers. Moreover, RELAC contributes to the expansion and integration of the regional power sector by establishing the common objective of accelerating the carbon-neutrality of electricity systems in LAC, developing common regulatory and institutional frameworks and enhancing co-ordination between agencies by identifying technical assistance needs, disseminating best practices and channelling climate finance resources (IRENA, 2022[70]); (RELAC, 2019[69]).

Recommendation

- Adopt low-cost sustainable technologies for clean energy used in electricity production, water heating, cold chains, air conditioning and heating.

Expanding Energy efficiency in LAC.

Energy efficiency is the most cost-effective and scalable way to address energy security and climate change targets, including the reduction of GHG emissions. In LAC, economic growth is closely linked to energy consumption, as better access to energy improves the quality of life for many people. However, energy efficiency has not been a priority in the region due to the abundance of renewable resources (such as hydro and geothermal in Central America, as well as wind and solar) and hydrocarbons in some countries (IEA and UN ECLAC, 2015[71]); (Enerdata, 2023[72]). The share of the household budget dedicated to energy ranges between 7% and 9% of income, and for the poorest households, it can exceed 24%, often focused on electricity and gas expenses. While securing energy supplies is important, it is equally important to analyse the role of more efficient and flexible demand in ensuring affordable and reliable energy. Affordable energy is essential to ensure access to basic energy services, including lighting, clean cooking, space cooling, heating, and transport. At the same time, reducing energy bills supports the maintenance of access to these services. Energy efficiency and other demand management measures, such as load shifting and conservation, can provide short and long-term benefits to the energy system and consumers by reducing demand, costs, and emissions, and avoiding the need for more expensive supply-side solutions (IEA, 2023[73]).

Latin America has intensified the implementation of energy efficiency measures and investments. *The Energy Efficiency Information Base*, developed in 2011 by the UN Economic Commission for Latin America and the Caribbean (UN ECLAC) and the French Agency for Ecological Transition (ADEME), monitors energy efficiency trends in Latin American countries and has noted a 70% increase in energy efficiency measures since 2010 and a 30% increase since 2019. Moreover, 30% of the measures are horizontal, meaning they are not sector specific. Among sector-specific measures, households account for 33%, followed by transport at 25%, services at 23%, and industry at 19% (Enerdata, 2023[72]). Energy

efficiency translates into budget savings, as most countries in LAC subsidise energy prices. LAC governments should develop energy savings programmes, such as appliance replacement schemes, to lift families out of energy poverty while generating public budgetary savings (IEA, 2023[73]).

One of the main challenges the region will face is adapting to hydropower disruptions driven by climate change. Hydropower accounts for 45% of the electricity supply across the region. Argentina, Chile, Costa Rica, Guatemala, Mexico, and Panama are likely to experience a steady decrease in their hydropower capacity factors due to changing rainfall patterns. Brazil, Paraguay, Uruguay and Venezuela will also experience a mild decrease in their hydropower capacity factors. On the other hand, Colombia, Ecuador, and Peru are expected to have a slight increase in hydropower capacity factors due to increasing precipitation and runoff volume on average (IEA, 2021[74]). To address this issue, countries in the region should enhance the resilience of their hydropower plants and adapt to changing climate conditions. While there is no one-size-fits-all solution, a tailored combination of resilience measures based on a comprehensive assessment of climate risk and impact will help increase their resilience. These measures may include strategic, operational, and physical arrangements categorised as “soft”, which consist of strategies, policies, and actions related to the planning, operational management, and recovery of the hydropower system, and “hard”, which are associated with the physical enhancement of assets, such as technical and structural improvements to hydropower plants (IEA, 2021[74]).

It is important that LAC countries develop targeted policies, programmes and institutional frameworks to deliver energy savings, overcome barriers to energy efficiency and drive the market for energy efficient products and services. The countries with the biggest historical energy efficiency improvements, such as Mexico, Brazil and Chile, have developed specific institutional frameworks to develop, track and improve energy efficiency policies and programmes. The LAC governments need establish regular data collection and develop indicators as well as awareness campaigns and educational programmes on energy efficiency. Countries in the region may also apply standards and labelling programmes to deliver energy savings in products such as air conditioning and electric motors. Argentina, Colombia, Mexico, Panama, Uruguay and countries in the SICA have all introduced standards and labelling frameworks for appliances and electric motors (IEA, 2023[73]).

Energy efficiency can be as an important source of local jobs. The latest *World Energy Employment report* noted that worldwide energy efficiency accounted for 10.9 million full-time-equivalent jobs in 2019. In Latin America, direct energy efficiency jobs accounted for about 8% of energy sector jobs. In Central and South America, 33% of energy efficiency jobs are in the construction sector, and around 25% in manufacturing (IEA, 2022[75]). At the same time, the ILO has highlighted that decarbonisation has the potential to create 15 million new jobs in LAC by 2030 (Saget, Vogt-Schilb and Luu, 2020[76]).

Recommendation

- Intensify targeted policies, programmes and institutional frameworks to improve energy efficiency. Apply standards and labelling programmes to deliver energy efficient products such as air conditioning and electric motors.

Biofuels is an opportunity in LAC.

Biofuels play a crucial role in decarbonising transport by offering a low-carbon solution for existing technologies, particularly light-duty vehicles in the short term and heavy-duty trucks, ships, and aircraft with limited alternative options in the long term. In 2021, biofuels represented 3.5% of the global transport energy demand, primarily in road transport (IEA, 2022[77]). In 2011, the main producers of bioethanol and biodiesel in LAC were Brazil, Argentina, and Colombia. In 2021, Brazil was the second-largest global producer of biofuels, while Argentina ranked eighth (UN ECLAC, 2011[78]); (Statista, 2022[79]).

According to IEA's renewables analysis and forecast to 2027, global biofuel demand was expected to be 6% higher in 2022 than in 2021, and the demand for ethanol increased in 4% in Brazil during 2021-2022, where rising prices of gasoline and diesel use accelerates demand for biofuels. Moreover, Brazil, along with the USA, Canada, Indonesia, and India make up 80% of global expansion in biofuel use (IEA, 2022[41]).

Biofuels produced from waste and residue resources are expected to meet 45% of total global biofuel demand by 2030. Central and South America produce approximately 28% of global liquid biofuels. Argentina, Brazil, Colombia, and Guatemala produce 24% of biodiesel and 29% of ethanol globally (IEA Bioenergy, 2023[80]). The production of biofuels primarily relies on conventional feedstocks like sugar cane, corn, and soybeans. To mitigate the impact on land use, food prices, and feed prices, it is important to transform biofuel production by advancing feedstocks. New technologies, such as cellulosic ethanol and biomass-based Fischer-Tropsch (bio-FT), can utilise non-food feedstocks to produce low-carbon biofuels for the transport sector. Scaling up technologies that convert woody feedstock into biofuels will be necessary (IEA, 2022[77]).

Biofuels have the potential to significantly reduce global road transport oil consumption. Collectively, biofuels avoided 4% of global road transport oil use (2 million barrels of oil), with nearly 60% of the biofuel demand coming from advanced economies (IEA, 2022[77]). In Brazil, biofuels account for 25% of its transport fuels, with bioethanol being the most important, representing 49% of the combined energy from gasoline and ethanol use. The use of biodiesel is also increasing, aiming to replace diesel in heavy-duty vehicles. As of 2019, biodiesel in Brazil accounted for 9.6% of the energy used in diesel. Brazil has a large fleet of flex-fuel vehicles that can run on either gasohol (a mixture of gasoline and anhydrous ethanol) or hydrous ethanol (IEA Bioenergy, 2021[81]); (OECD/FAO, 2019[82]).

Argentina, Bolivia, Brazil, Colombia, Ecuador, Paraguay, Peru and Uruguay are considered by the IEA as countries that have a robust and fully implemented biofuel programmes, with a blending mandate in place, a regular market of biofuels established and liquid fuel terminals operating normally. Costa Rica, Guatemala, and Mexico have approved legislation and regulation to promote the use of biofuels, some with schedules and programmes to adopt blending mandates. However, debates among consumers, fuel distributors, and biofuel producers persist regarding the convenience, risks, and advantages of biofuels. While Argentina, Brazil, and Colombia have fully implemented biofuel programmes, Guatemala is yet to adopt a national biofuel programme and plans to introduce a 10% ethanol blend in gasoline by 2024 (IEA Bioenergy, 2023[80]).

Sustainability frameworks should be developed and implemented in LAC to ensure that biofuels meet rigorous sustainability requirements verified through third-party certification of biofuel supply chains, including life cycle analysis of GHG emission reductions. Brazil, through its 2017 National Biofuels Policy (RenovaBio) Programme, establishes annual targets for decarbonisation, determined by the federal government, and allocates them among fuel distributors based on their market share. Ethanol, biodiesel, and biogas producers have their CO_2 emission mitigation certified by independent companies using the RenovaCalc model's life cycle analysis (LCA) to assess environmental efficiency. They receive grades that determine the issuance of mitigation credits (CIBIOs) corresponding to their production, which can be traded in the stock market. Fuel distributors need these credits to meet decarbonisation targets, or they may face legal actions. Since the programme's launch in 2020, 75 million CIBIOs have been issued (IEA Bioenergy, 2023[80]).

LAC governments must ensure robust sustainability governance is linked to biofuel policy support, establish mandates, GHG emission intensity reduction targets, and implement carbon pricing and financial incentives aligned with a net-zero trajectory. The expansion of waste and residue-based fuels, lower GHG emissions fuels, and technologies like carbon capture and storage should be prioritised. Additional measures may include loan guarantees and specific biofuel quotas for emerging fuels (IEA, 2022[77]).

International co-operation can facilitate the development of best practices, co-ordinate research, policy implementation, and deployment, as well as promote common sustainability standards to accelerate biofuel adoption. Key initiatives in this regard include *the Biofuture Platform Initiative*, launched in 2020, aiming to promote an advanced low-carbon bioeconomy that is sustainable, innovative, and scalable. This initiative fosters consensus on biomass sustainability, promotes best practices, enables financing, and encourages international co-operation. Argentina, Brazil, Chile, Costa Rica, Mexico, Panama, Paraguay, and Uruguay are part of this initiative (Biofuture Platform, 2020[83]). IEA's *Bioenergy Programme* also plays a significant role in improving co-operation and information exchange between countries with national bioenergy research, development, and deployment programmes. Brazil is currently the only LAC country participating in this initiative (IEA Bioenergy Programme, n.d.[84]). Moreover, the *Global Bioenergy Partnership,* launched in 2006, brings together public, private, and civil society stakeholders in a joint commitment to promote bioenergy for sustainable development. Argentina, Brazil, Colombia, Mexico, and Paraguay are partners of this initiative, while Chile, El Salvador, Panama, Peru, and Uruguay serve as observers (Global Bioenergy Partnership, 2006[85]).

Green and low-carbon hydrogen (GLCH) in LAC

The commercial viability of GLCH needs to be promoted in LAC.[9] While hydrogen is already in use and economically viable for various applications, its current production relies on fossil fuels. The LAC region has significant long-term potential to produce large volumes of competitive low-carbon hydrogen and export it to other global markets, making it a crucial region for a global net-zero emissions future. It is important to note, that despite hydrogen not emitting CO_2 at the end-use stage, current production processes are responsible for large volumes of emissions in the region. Notably, the region's industrial and oil refining sectors contribute about 5% to the worldwide demand for hydrogen, predominantly employed in the production of ammonia, methanol, steel, and refined oil products. The hydrogen production process in the region for 2019 consumed more natural gas than the entire supply in Chile, resulting in the release of more CO_2 into the atmosphere than the cumulative emissions from Colombia's road vehicles. Furthermore, close to 90% of the hydrogen demand in the LAC region in 2019 was concentrated in Argentina, Brazil, Chile, Colombia, Mexico and Trinidad and Tobago which accounted for over 40% of the total hydrogen demand (IEA, 2021[86]).

The region needs to generate a large-scale demand for GLCH, as a feedstock and alternative fuel, creating a virtuous circle between decarbonisation efforts and sustainable industrial development. The LAC region holds immense potential for green hydrogen production, both for domestic consumption and export, thanks to its abundant wind, solar, geothermal, and hydric resources. Additionally, the strategic geographical positioning of LAC provides access to markets in Europe, Asia, and North America. The utilisation of GLCH has the capacity to support countries in decarbonising hard-to-abate sectors such as industry and transport, which contribute to nearly 50% of global GHG emissions. These initiatives offer significant opportunities for an equitable energy transition that places communities at the core, expands energy access, generates new green employment, promotes participation from marginalised groups, advances gender equality, strengthens energy security, and buffers consumers against the volatility of fossil fuel prices (Christiaan Gischle et al., 2023[87]).

Green hydrogen deployment can reduce LAC countries' economic dependence on oil and gas exports, reduce energy price volatility, and provide grid stability by enabling energy storage and adding renewable energy to the grid, particularly in countries suffering intermittency issues associated with renewable energy sources. Countries like Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, and Peru, have a significant potential for developing a competitive green hydrogen industry. These countries have advantages in the hydrogen market due to their abundance of low-cost renewables and relatively clean electricity mix. Supporting private sector engagement and promoting a regional agenda could foster synergies to increase competitiveness and support industry development in the region (OECD et al., 2022[4]).

Scaling up the production, consumption and export of GLCH can accelerate the energy transition in LAC. Hydrogen has the potential to serve as a feedstock and low-carbon or zero-carbon fuel, facilitating the shift away from fossil fuels, especially in heavy duty vehicles and machinery. Also, as a feedstock, hydrogen can play a role in the production of synthetic fuels, enhancing or improving the combustion processes of biofuels, for example. Hydrogen can also play a crucial role in LAC's energy transition by providing a more sustainable energy solution, enabling food production, and accelerating the decarbonisation of the economy. Moreover, hydrogen and ammonia can act as a substitute for fossil fuels in the power generation sector, as well as in heavy-duty, aviation and maritime transport and fertiliser manufacturing While there were only three hydrogen pilot projects in Latin America in 2019, located in Argentina, Chile, and Costa Rica, the region has now developed a pipeline of over 60 projects as of October 2021, with the aim of exporting hydrogen to Europe and Asia, although most of them are still at an early stage (Oxford Business Group (OGB), 2022[88]); (IEA, 2022[89]). In June 2022, the Argentine province of Tierra del Fuego outlined plans to develop a hydrogen and ammonium industry. The province is trying to use the region's vast wind resources to attract USD 6 billion in investment in technologies to produce the fuel, including investing in wind farms to generate electricity to produce hydrogen. Once established, some of the hydrogen from the project will be used to produce ammonia, which in addition to being used to create fertiliser, can also serve as a carrier fuel to transport hydrogen through branch pipelines to markets (Oxford Business Group (OGB), 2022[88]).

As of 2021, only 33% or 11 countries in LAC had either published or were in the process of developing national hydrogen strategies and roadmaps. These strategic frameworks play a pivotal role in directing hydrogen development towards sectors and applications that align with each country's specific context. They help identify opportunities in the short, medium, and long term while outlining the requisite regulatory, infrastructure, and skill prerequisites. LAC countries could also establish supportive policies that facilitate the initial deployment of critical technologies, offer financial mechanisms for early-stage projects, and implement risk management strategies tailored to different project phases. These efforts should extend beyond emissions reduction, with a strong focus on Research and Development (R&D) (IEA, 2021[86]). Chile launched a *Green Hydrogen Strategy* in 2020 with the goal of establishing 5 GW of electrolyser capacity by 2025 and 25 GW by 2030. It aims to produce the world's cheapest hydrogen by 2030 and become one of the world's top three hydrogen exporters by 2040. Colombia's *National Hydrogen Strategy and Roadmap* aims to facilitate the development of a green hydrogen industry, delivering cost-competitive green hydrogen by 2030. The strategy also considers the production of blue hydrogen using carbon capture, utilisation, and storage (CCUS) to capture emissions. Additionally, Argentina, Bolivia, Brazil, Costa Rica, El Salvador, Panama, Paraguay, Trinidad and Tobago, and Uruguay are in the process of preparing national hydrogen plans (OECD et al., 2022[4]).

LAC countries may integrate hydrogen into policy, institutional, and legal frameworks. It is key that countries understand the value chain and individual potential within each country to develop green hydrogen. Thorough analysis of business cases, economic factors, benefits, and risks is essential, with special attention to cost drivers. This scrutiny enables the creation of robust business models and validation of suitable applications at the country level. Lastly, identifying appropriate policies to bridge viability gaps and cultivate favourable market conditions and financing mechanisms is essential to nurturing green hydrogen development (Cordonnier and Saygin, 2022[90]).

Governments in LAC could develop policies aiming to transform existing industrial and petrochemical hubs where currently grey hydrogen is being consumed to begin the deployment and production of green hydrogen. Petrochemical hubs could use GLCH to produce ammonia, which can be used as feedstock for fertilisers or as fuel for new applications such as shipping. It can also be used to produced methanol, synthetic fuels, or even as a reducing agent to replace coal in iron production (IRENA, 2022[91]). Moreover, refineries use hydrogen to lower the sulphur content of diesel fuel, as well as in the de-sulphurisation of crude oil to make petrol, diesel, and other chemicals (ITM Power, 2020[92]).

The LAC region has the potential to become a green hydrogen industrial hub, considering the growing global demand for hydrogen in line with the expanding global population, industrialisation, and urbanisation. Existing oil and gas infrastructure can be repurposed to accommodate CCU, and storage projects. LAC countries with established natural gas industries may be well-placed to produce and export blue hydrogen, while those with substantial solar and wind resources can make the conversion to green hydrogen. LAC countries that are fossil fuel producers may have an opportunity to offset significant capital expenditures required to develop a hydrogen industry by re-purposing existing oil and gas infrastructure (OECD et al., 2022[4]).

GLCH can be utilised to decarbonise hard-to-abate sectors such as chemicals, steel, road freight, aviation, and shipping, where viable alternatives to fossil fuels are currently lacking. Hydrogen could support the decarbonisation of heavy transport, by replacing diesel mining trucks in countries such as Chile, Colombia, and Peru (OECD et al., 2022[4]). Green hydrogen and its derived products can enable the alignment of these sectors with the net-zero emissions goal. In net-zero scenarios, the use of hydrogen is generally prioritised for hard-to-abate industry sectors with high process heat requirements that cannot be met by other low-carbon alternatives (Cordonnier and Saygin, 2022[90]).

In the maritime sector, the adoption of hydrogen, hydrogen-based fuels such as ammonia, and related technologies offers a tangible pathway for achieving decarbonisation and reducing air pollution from global fleets. To facilitate this transition, robust co-operation is essential among all relevant stakeholders, including shipowners, shipbuilders, fuel producers, and port authorities. Developing a coherent and enduring policy framework, alongside legislation mandating fuel use and infrastructure obligations beyond a certain threshold, will be crucial. The success of maritime decarbonisation hinges significantly on the timely establishment of green hydrogen storage capacities at ports, supported by specific targets for hydrogen and hydrogen-based fuels in the sector's total fuel demand. Furthermore, the integration of the maritime sector into Emission Trading Systems (ETS) could prove instrumental in curbing CO_2 emissions, limiting carbon leakage, and accelerating the shift towards cleaner fuel source (Hydrogen Europe, 2021[93]). Some countries at advanced stages of variable renewable energy (VRE) deployment are also considering its use to enhance electricity system flexibility, since green hydrogen provides a medium for long-term seasonal storage, for instance through the production of synthetic fuels (Cordonnier and Saygin, 2022[90]).

The development of a hydrogen industry in LAC will require government-sponsored demonstration or first- mover projects, as well as collaboration with the industry at the national and regional levels to create market demand, a key factor in raising finance for hydrogen projects. At the same time, it is vital that countries evaluate the potential environmental impacts, risks, impacts, and mitigation measures of activities related to green hydrogen production, storage and transport. Regional co-operation on hydrogen infrastructure development, cross-border regulation, and free trade agreements are essential to support demand creation to increase the commercial viability of regional hydrogen industries (IEA, 2021[86]); (OECD et al., 2022[4]). Regional dialogue, involving a broad spectrum of stakeholders, but especially energy regulators, is key to enable Latin America to exploit synergies in future hydrogen production and demand patterns (Mariano Berkenwald & Jose M Bermudez, 2020[94]).

There are several risks related to the use of hydrogen for both humans and the environment. The production of green hydrogen requires a significant amount of water and could exacerbate existing water shortages, in some areas where water is scarce. While the use of deionised water produced by desalination plants may reduce freshwater demand, it generates a need to discharge a stream of brine into the water sources and soils. The production of ammonia and methanol generates waste and often involves the use of catalysts and other chemicals that can be toxic or harmful to the environment, potentially contaminating water sources and soils during production and transport. Furthermore, the production of renewable energy, needed to power electrolysis, often requires large amounts of land, which could lead to the conversion of natural habitats or agricultural land and pose negative impacts on biodiversity and food security. Land use changes driven by large-scale green hydrogen projects and related large-scale renewable farms may lead

to the loss of natural areas, resulting in an increase in vulnerability, community safety and health-related risks and impacts (Signoria and Barlettani, 2023[95]). Finally, hydrogen is a highly flammable gas, and can also present a significant risk to workers' safety during production, transport, and storage.

Recommendation

- Implement policies to create and scale up the necessary demand for green and low-carbon hydrogen as feedstock and alternative fuel, creating a virtuous circle between decarbonisation efforts and sustainable industrial development.

Sustainable mining for a just and green transition

Reaching net-zero emissions by 2050 means quadrupling minerals supply for clean energy specifically by 2040 (IEA, 2022[96]). LAC has the potential to become a significant player supplying key minerals for the energy transition. Minerals pose a growing concern because these are non-renewable, and their deposits are generally geographically clustered, making security of supply a potential risk. The dependence on politically stable emerging markets for mineral sourcing has intensified with the decline of economically competitive deposits in developed nations, and this mounting demand from emerging markets, coupled with the necessity for rare minerals in emerging technologies, coupled with limited substitution options in various applications, and low recycling rates, has accentuated the vulnerability of economies to potential supply disruptions (Coulomb et al., 2015[97]).

In 2017, the region held 61% of global lithium reserves, 39% of global copper reserves, and 32% of global nickel and silver reserves. Argentina, Chile, and Bolivia possess the world's largest reserves of lithium, and there are areas in the region where hydrogen can be produced at very low costs. Chile and Peru also have substantial copper reserves required for the manufacturing of electric vehicles (EVs) (OECD et al., 2022[4]). Historically, mining has accounted for between 13% and 19% of Latin America's incoming foreign direct investment. At present, LAC contributes 35% of the world's lithium supply, with Chile accounting for 26% and Argentina for 6%. The primary reserves of lithium in LAC are concentrated in Argentina (21%) and Chile (11%), while untapped lithium resources in Bolivia remain economically constrained due to infrastructure limitations. The LAC region also holds promise for production in graphite, nickel, manganese, and rare earth elements. Despite Brazil boasting approximately one-fifth of global reserves for each of these resources, its current production levels constitute just a small fraction — 0.2% for rare earth elements and 7% for graphite of the total mineral production (Bernal, Husar and Bracht, 2023[98]).

Mining operations in LAC have been linked to water, air and soil pollution, deforestation, and loss of biodiversity, as well as conflicts over water and land use or lack of community participation (Morales Munoz et al., 2023[99]). Land use change, water use, and waste generation are the three main challenges present throughout the mining value chain. Nonetheless, mining activities also entail other environmental impacts including air and noise pollution due to blasting and transporting activities (IEA, 2022[96]). It is important to strategically integrate environmental considerations at the early stages of project planning to ensure the adoption of sustainable practices and the acceptance of these practices by local communities. Mining projects in the region often face strong opposition from local communities, with approximately 45% of mining conflicts occurring in the LAC, where operations are frequently located in proximity to ecologically sensitive and biodiverse ecosystems that may also host vulnerable communities. The use of heavy machinery required for mining activities can increase the potential for conflicts and challenges. Moreover, taking into account the disparities in wealth within the LAC region, the perceived local benefits or lack thereof from mining projects can contribute to social unrest, leading to protests that halt ongoing mining operations or delay new developments (Bernal, Husar and Bracht, 2023[98]).

To accomplish its full potential, governments in LAC could strengthen the compliance of mining activities to high environmental, social and governance (ESG) standards and promote ways to generate tangible benefits for local communities (Bernal, Husar and Bracht, 2023[98]). The LAC region has the opportunity to expand its production of critical materials like rare earth elements, essential for EV motors and wind turbines, and nickel, a key battery component. The creation of frameworks that attract increased investments in mining and processing activities will be central to success. This requires the development of clear regulations and incentives while ensuring strict adherence to ESG standards. By doing so, the region can effectively prevent and mitigate adverse impacts on both the environment and local communities. Additionally, upgrading national geological surveys to encompass energy-related critical minerals could greatly support future exploration campaigns. For instance, Chile offers comprehensive open-source geological data via its service SERNAGEOMIN, featuring regional and mineral-specific focal points. In Brazil, the geology department (DIPEME) has established a dedicated division focusing on critical minerals, issuing regulations aimed at streamlining administrative processes for strategic mining projects, particularly centered around lithium, rare earth elements, graphite, copper, and cobalt. Colombia, on the other hand, recently developed a strategic roadmap, the Copper Route, designed to amplify the domestic copper industry (Bernal, Husar and Bracht, 2023[98]).

The mining sector needs to undergo a transformation to safeguard the environment while simultaneously boosting mineral recycling rates and the substitutability of minerals. Governments play a crucial role in fostering the adoption of innovative technologies and practices within the mining industry. On a global scale, mining contributes to roughly 11% of total energy consumption. To address this, companies can incorporate renewable energy sources into mineral processing, refining, and transport operations. They can also engage in innovative measures to minimise water usage, improve waste management and reduce their environmental impact. Furthermore, the industry should focus on innovations that curtail mineral demand by promoting recycling and implementing new, less resource-intensive technologies and industrial processes (Marchan, 2019[100]). Governments can promote the improvement of resource efficiency stimulate the transition to a circular economy in material use. Furthermore, they can provide significant support to the metal industry by removing support for primary extraction and processing to stimulate recycled and re-used metals (the secondary metals sector) (McCarthy and Börkey, 2018[101]).

Recommendation

- Ensure that the growing demand for critical minerals, used to develop low-carbon energy technologies, along with the region's strategic position, allows for an integral model of sustainable mining, with low environmental impacts, well-being for local communities, and linkage in regional value chains that enable their transformation and the production of high-value-added final goods.

Transport in LAC: several common challenges

LAC countries face several common challenges concerning the transport sector. Currently, transport accounts for 14.4% of total emissions in South America, 21.4% in Central America, and 11.1% in the Caribbean, representing 26% of the region's final energy consumption (OECD et al., 2022[4]). Furthermore, transport networks in LAC are inadequate and fail to keep pace with urbanisation rates. Public transport usage is declining in LAC, while private motorisation rates are continuously increasing. Overall, low-income households, and women, who rely more on public transport services are the most impacted (Rivas, Suárez-Alemán and Serebrisky, 2019[102]).

Electrifying the public transport sector while implementing policies that promote a transition to renewable power sources are crucial for cost-effective decarbonisation in LAC and for meeting climate change commitments. In 2015, the global average rate of car ownership was 172.8 per 1 000 people, compared to 196 in Latin America and 201 in the Caribbean. The growth of private cars and motorcycles is driven by greater affordability, rising incomes, and the availability and quality of public transport (SLOCAT, 2021[18]). In fact, the motorisation growth rate in this region is among the highest in the world. LAC countries contributed 7% to global new vehicle sales in 2020 (ICCT, 2022[103]). Trucks currently account for about 70% of cargo transport in the region, and this is expected to double between 2015 and 2050. Moreover, electric cars and buses are projected to become the most affordable alternatives by 2025 (Vergana, Fenhann and Santos da Silva, 2020[104]).

To promote clean public transport in LAC, it is crucial to first eliminate diesel subsidies and other pollutant incentives. Subsequently, implementing a tax on fossil fuels and offering financial incentives to public transport operators to transition to cleaner technologies is essential. Governments can promote this transition by establishing carbon-pricing schemes and a kilometre charge that varies depending on the type of vehicle. Research has shown that combining these tax schemes with increased bus electrification efforts could lead to a 45% reduction in CO_2 emissions and a 30-50% decrease in harmful air pollutants, such as CO_2, Volatile Organic Compound (VOC) Gases, Nitrogen Oxides (NO_X), and $PM_{2.5}$, by 2050 (Tikoudis, Udsholt and Oueslati, 2022[105]). The consumption of fossil fuels carries significant environmental costs, with the majority of subsidies being implicit. Environmental costs are often not factored into fossil fuel prices, particularly for coal and diesel. In developing countries, these subsidies to fossil fuels are projected to increase as consumption levels approach those of advanced economies. Eliminating both explicit and implicit fossil fuel subsidies is estimated to prevent 1.6 million premature deaths annually, generate USD 4.4 trillion in additional government revenue, and align emissions with global warming targets. Phasing out these subsidies would also allow for income redistribution, as fuel subsidies disproportionately benefit wealthier households over lower-income ones. To effectively drive these reforms, governments must design, communicate, and implement them as part of a comprehensive policy package highlighting their benefits, and considering a portion of the increased revenues to be earmarked to compensate vulnerable households for potential rises in energy prices (Black, Parry and Vernon, 2023[106]).

Policies should focus on improving public transport infrastructure. Despite the current decline in public transport usage, 68% of all trips in LAC are still made through public transport, making it the region with the highest per capita bus usage in the world. LAC countries should implement policies aimed at expanding dedicated bus lanes, promoting alternative modes of transport, and encouraging the use of low-emission vehicles, technologies, and alternative fuels for public transport. These can include clean diesel (Euro VI equivalent), compressed natural gas (CNG), battery-electric (BEB), hybrid diesel-electric (Hybrid or HBD), biofuels, and hydrogen-powered buses (World Bank, 2019[107]). Additionally, countries could establish reduced fares for passengers using clean public transport to encourage adoption or implement clean vehicle procurement policies, requiring the purchase of public transport vehicles that meet specific standards or use alternative fuels.

Considering the high share of trips made through public transport, LAC region may consider expanding Bus Rapid Transit (BRT). Currently, over 45 cities in Latin America have invested in BRT, collectively representing 63.6% of BRT ridership worldwide (Rodriguez and Vergel Tovar, 2023[108]). With passenger demand expected to surge by 67% in LAC by 2050, it's crucial for countries to prepare for this growth in a sustainable manner. This includes initiatives such as creating and expanding BRT corridors, introducing light rail transit, and electrifying public transport fleets. To achieve this, countries should enhance options for active mobility through the development of better cycling and walking infrastructure and reallocating urban space accordingly. Additionally, integrated land-use planning and transit-oriented development are key to meeting the increased demand while simultaneously improving urban mobility access and sustainability (ITF, 2023[109]). Ensuring service regularity is crucial in encouraging the adoption

of these mobility modes. Offering rapid services on trunk routes alone is insufficient, and this presents a unique challenge for trunk and feeder systems and routes that operate in mixed traffic. Reliable service stands as one of the most critical factors in increasing ridership, necessitating innovative and holistic approaches (Institute for Transportation & Development Policy, 2018[110]). Moreover, it is vital for countries to integrate their public transport networks, connecting them with walking and cycling networks and developing dedicated spaces for public transport (Sustainable Mobility for all, 2022[111]).

Achieving transformation and decarbonisation in the transport sector requires a systemic approach that addresses the unsustainable aspects of car dependency and urban sprawl. Policies must be designed to achieve multiple desirable outcomes such as reducing traffic congestion, air pollution, and emissions, while promoting social equity and well-being. Governments can promote the use of active and shared modes of transport by reallocating public space and regulating parking prices. Car-free zones, non-motorised transport infrastructure, and events that restrict car access can encourage walking and cycling. To reduce car dependency and contain urban sprawl, improvements in land-use planning are necessary. Policies supporting shared mobility, telecommuting, and flexible work schedules can further reduce emissions and alleviate peak traffic hours (OECD, 2021[112]); (OECD et al., 2022[4]). Encouraging multimodal on-demand intelligent distribution of freight and passengers in land, river, and maritime transport systems; and expand non-motorised transport infrastructure such as bike lanes or pedestrian paths is vital.

Prioritising the development of zero-emission mobility infrastructure is essential. This includes building net-zero renewable fuel infrastructure in road networks and urban areas, such as biogas and EV stations, as well as improving the efficiency of the biofuel chain. The lack of cost-effective and efficient charging stations presents a barrier to boosting electrification in the transport sector. Therefore, governments should invest in or promote investment in the installation of public charging infrastructure in dense urban areas, highways, and high-performance charging stations for heavy vehicles (Vergana, Fenhann and Santos da Silva, 2020[104]). As vehicle fleets electrify, it is crucial to increase interoperability, ensuring compatibility among key system components such as vehicles, charging stations, charging networks, and the grid, as well as the software systems that support them, enabling seamless and effective operation (Electric Power Research Institute, 2019[113]). Governments can consider requiring the purchase of EVs for government fleets, implementing more rigorous CO_2 standards for heavy-duty vehicles, offering financial incentives such as tax cuts or emissions-based fees, and introducing non-monetary incentives like free parking, priority lanes, and toll exemptions (Vergana, Fenhann and Santos da Silva, 2020[104]). In recent years, there has been significant expansion of charging infrastructure, primarily driven by private stakeholders such as BMW and Enel X (BMW Group, 2020[114]); (Enel X, 2020[115]). Mexico currently has the highest number of public charging stations in the region, while Barbados has the largest coverage of recharge infrastructure based on population density and number of registered EVs (Vergana, Fenhann and Santos da Silva, 2020[104]).

To achieve full adoption of EVs in LAC, it is essential to strengthen the application of policy instruments to acquire the industrial capacity needed to promote net zero emissions modes of transport for 2050, including solutions such as biofuels and EVs. The goal should be to develop the necessary industrial capacity to replace all internal combustion vehicles with zero-emission alternatives in 2050**.** The adoption of electric passenger cars in the region is still at a very early stage, with only 0.6% of sales in Costa Rica and Colombia, and 0.5% in Chile (ICCT, 2022[103]). In 2018, Costa Rica implemented a law on fiscal incentives for the promotion of EVs (Government of Costa Rica, 2018[116]). Additionally, in 2019, Ecuador's Organic Law on Energy Efficiency mandated that all vehicles incorporated into the public transport system from 2025 must be electric. The law also introduced differentiated or preferential fees for public and private vehicles and mandated local governments to incentivise the use and circulation of EVs (Government of Ecuador, 2019[117]).

Introducing stringent emissions standards and targets for public transport vehicles can reduce GHG emissions and air pollution in the LAC region. So far only Colombia and Costa Rica have

established targets for phasing out GHG-emitting public transport in official policy documents. Costa Rica pledged that 30% of their public transport would be zero emissions by 2035 and aims to achieve 85% zero-emission fleet by 2050 (Government of Costa Rica, 2018[118]). Colombia, on the other hand, has committed to having fully electrified public transport by 2035 (Government of Colombia, 2019[119]); (ICCT, 2020[120]). In 2020, the LAC region had the second highest number of implemented Sustainable Urban Mobility Plans worldwide, and National Urban Mobility Plans are increasingly being used (SLOCAT, 2021[18]). It is important to mention that improving engine efficiency is a transition measure, considering the time needed to develop electric infrastructure, as well as complete shift towards EVs in LAC.

There is need to speed up the implementation of comprehensive net-zero solutions in LAC to reduce GHG emissions in aviation, maritime, and rail transport. To achieve this goal, it is essential to encourage the increased use of sustainable fuels and low-carbon synthetic fuels. LAC governments may also impose challenging deadlines to eliminate non-zero emission aircraft, ships, and trains from circulation, starting with those coming from the most profitable sectors, such as cruise ships in maritime transport.

Aviation contributes approximately 2% to 3% of global CO_2 emissions and accounts for 12% of emissions within the transport sector. Sustainable Aviation Fuels (SAFs), derived from biological or non-fossil feedstocks (commonly referred to as biojet), offer a promising solution to replace or complement conventional aviation fuels, significantly reducing GHG emissions throughout the product's lifecycle. Several countries have already taken steps to encourage the adoption of SAFs and low-carbon aviation fuels. Brazil, for instance, has implemented a National Biokerosene Programme, mandating federal agencies and institutions to support SAF-related projects through measures like tax incentives. In 2021, Colombia passed Law 2169, calling upon the Ministries of Energy and Transport to promote the development and utilisation of SAFs. The Ministry of Energy is also actively working on establishing a national standard for SAF promotion and use. While the LAC region has initiated various efforts related to alternative aviation biofuels, it currently lacks specific public policies or strategic frameworks on this subject. Counties in LAC should enhance institutional collaboration by establishing treaties, interinstitutional and intersectoral agreements, and by encouraging both public and private research. These efforts will help structure a productive aerial biofuels chain involving diverse stakeholders (Torroba et al., 2023[121]).

Emissions from international shipping account for 2-3% of global emissions annually. This is projected to grow overall and increase relative to other parts of the economy, which will be able to electrify and curtail emissions faster. In order to meet the Paris Agreement goals, a full-scale transition to scalable zero-emission technologies over the coming decades is needed. LAC finds itself facing several untapped opportunities connected to the global maritime ecosystem’s transition to scalable zero-emission fuels. For international shipping to fully decarbonise it will be necessary to accelerate the shift to scalable zero-emission fuels, in particular green hydrogen in the form of fuels including green ammonia and green methanol. As previously mentioned, the region can highly contribute to green hydrogen production, potentially creating opportunities to generate and transport hydrogen to demand centres with low production capacity like Europe and parts of North East Asia. To accelerate the transition countries could support green fuel production, green port development, or R&D projects focusing on domestic fleets (Global Maritime Forum, 2023[122]).

Box 3.1. Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

In 2016, the International Civil Aviation Organization (ICAO) approved the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), with the aim of reducing the net-climate impact of aviation, and imposed CO_2 offset requirements in its various phases. These requirements primarily involve airlines acquiring emission rights, with the option of using biofuels. CORSIA's implementation stands as a significant milestone for the international community, as it represents the world's first global mechanism directly addressing CO_2 emissions in a specific sector, achieved through consensus among governments, industry stakeholders, and international organisations. While CORSIA serves as a mechanism to encourage long-term production, it may prove insufficient to fully credit the complete life cycle benefits of SAFs. Therefore, it becomes crucial to consider specific SAF policies that not only promote production but also consumption. The correct formulation of public policies allows the development of the industry by promoting the constant, growing and widespread use of SAFs.

Source: (Torroba et al., 2023[121])

Recommendation

- Strengthen the application of policy instruments to acquire the industrial capacity needed to promote net-zero emissions modes of transport for 2050, including the local production and use of biofuels and low-carbon synthetic fuels and EVs.
- Implement policies aiming to decarbonise freight and passenger transport. Expand non-motorised transport infrastructure such as bike lanes and pedestrian paths.
- Introduce stringent emissions standards and targets for public transport vehicles. Promote clean fuels and common fuel standards that reduce sulphur levels to ultra-low levels. Establish complementary programmes to reduce emissions from older diesel vehicles, focusing on urban fleets.

Cities and Urban development in LAC

The urban population share in LAC is projected to be 89% by 2050 and the urbanisation rate in the Caribbean has increased from 36.3% in 1950 to 72.2% in 2020. To address climate change and work towards achieving carbon neutrality by 2050, it is crucial to develop and implement ambitious policies and measures in urban areas to transition towards sustainable and net-zero emission (OECD et al., 2022[4]); (UN ECLAC, 2018[123]). Cities account for approximately 75% of global energy consumption and 70% of global CO_2 emissions. At the same time, they also present a vital opportunity to drive progress towards climate goals, as they contribute to 80% of the global GDP. Taking sustainable actions in cities could potentially reduce urban emissions from buildings, transport, materials, and waste by around 90% by 2050 (IEA, 2021[124]).

The decarbonisation of buildings and infrastructure is crucial for achieving net-zero emissions, efficiency, and resilience in the buildings and construction sector. Globally, the buildings and construction sector accounted for 36% of final energy use and 37% of energy and process-related CO_2 emissions (UNEP, 2021[125]). In Latin America, the buildings sector accounted for 24% of final energy use and 21% of process-related CO_2 emissions, excluding emissions from manufacturing building materials

such as steel, cement, and glass. The Global Buildings Climate Tracker, which monitors progress towards the Paris Agreement goals, indicates that the buildings and construction sector is on track to achieve complete decarbonisation by 2050. However, the changes in building use during the pandemic are expected to have a negative impact on progress unless efforts to decarbonise the sector increase significantly (UNEP, 2021[125]); (IEA, 2020[126]).

There has been some progress towards sustainable urban mobility and public transport in LAC. As mentioned above, LAC has the second-highest number of Sustainable Urban Mobility Plans, and the use of National Urban Mobility Plans is increasing in the region. Brazil has played a leading role by making it mandatory for cities with over 200 000 residents to develop and implement these plans. Similar efforts are underway in countries such as Argentina, Bolivia, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, Guatemala, Mexico, Paraguay, Peru, and Uruguay (MobiliseYourCity, 2022[127]). Furthermore, other LAC countries have taken specific actions to promote sustainable public transport. For instance, Chile has acquired electric low-emission buses for its public transport system (UNEP, 2019[128]). Paraguay aims to power 33.4% of its public transport with green hydrogen by 2030 (Government of Paraguay, 2021[129]). Peru has implemented projects to enhance electric transport (LATAM Mobility, 2021[130]), and Uruguay has introduced legal incentives to switch to electric buses and promote investments in electro-mobility (Transport Decarbonisation Alliance, 2023[131]).

Green public procurement can be an essential tool to promote circular construction developments, encourage the use of circular business models, incorporate secondary materials, and encourage repair and reuse actions through public purchases (OECD et al., 2022[4])**.** Countries can also establish credible standards and policies that promote green buildings and sustainable construction practices. These practices should include the reuse and recycling of construction materials, reducing energy consumption, and minimising GHG emissions associated with the construction, use, and maintenance of buildings. Meeting the goals of the Paris Agreement requires a 30% reduction in energy consumption in buildings by 2030 in comparison with 2018 (GlobalABC, IEA and UNEP, 2020[132]). In LAC, the municipality of Mendoza (Argentina) uses its public procurement system to enable a triple-impact economy (economic, social and environmental) by allowing procuring agencies to prioritise goods and services from companies certified as B Corporations (i.e. complying with environmental, social and governance criteria) (OECD et al., 2022[4]).

In LAC, the implementation of urban public transport policies should be prioritised, aimed at reducing city commute times and transitioning towards more sustainable urban transport. Population in LAC often face longer waiting times and commutes compared to developed nations, even for shorter distances. On average, people in LAC spend 77 minutes on public transport weekly, surpassing the 64-minute average in advanced economies. Additionally, the waiting time at stops or stations in the region is higher at 21 minutes, compared to 14 minutes in advanced economies (Rivas, Suárez-Alemán and Serebrisky, 2019[102]). The reduction of commuting emissions significantly contributed to the decrease in GHG emissions in 2020, highlighting the importance of minimising commuter emissions for achieving a sustainable future and meeting international abatement targets. To this end, countries could consider promoting remote working to foster innovation and induce behavioural changes in the population, emphasising the benefits of work-life balance through remote work, raising awareness about the environmental impact of commuting, and encouraging the adoption of zero-carbon transport (Sutton-Parker, 2021[133]).

Cities can implement stricter energy efficiency standards in public buildings. Cities in LAC can leverage public buildings and procurement to promote energy efficiency and sustainability and attract private investments. Implementing stricter energy efficiency standards for public buildings and using public projects as catalysts for wider investment in energy efficiency can be effective strategies. Additionally, cities can drive innovation by launching pilot projects and using green finance to incentivise investments in building energy efficiency. Governments could encourage the development of innovative business

models that make energy efficiency measures more accessible and affordable, further promoting energy efficiency in the region (OECD, 2022[134]).

Many countries in LAC should strengthen the enforcement of regulatory frameworks for decarbonising buildings. The region should strengthen the enforcement of mandatory energy codes for buildings, provide a roadmap for stricter regulations and strategies, test functional regulations for existing buildings, and establish regulatory frameworks that facilitate integrated action. Many new constructions lack strong codes and mandatory minimum energy performance. Existing codes need to be strengthened to prioritise passive and affordable construction strategies, implement mandatory building energy codes, adopt passive designs, and reduce cooling needs. Regarding existing buildings, LAC countries must accelerate action on building retrofits and quality by developing and implementing affordable low energy decarbonisation strategies, increasing renovation rates for existing high-density development and low-income housing (GlobalABC, IEA and UNEP, 2020[132]).

Implementing efficient waste management policies, such as waste separation, proper collection and treatment infrastructure and recycling practices can substantially reduce methane emissions while improving the quality of life in cities. Improving regulatory frameworks for GHG and SLCP emissions in waste management is essential, with particular attention to methane emissions. Open dumps remain the most common form of final solid waste disposal in many LAC cities, generating substantial amounts of methane emissions. According to the Pan American Health Organization (PAHO), the region produces over 436 000 tonnes of solid waste per year, and 50% of this waste is disposed of in open dumps (PAHO, 2011[135]). Adopting a circular economy approach will contribute to the decarbonisation of built environment through minimised material use and maximised reuse (OECD, 2022[134]).

Digitalisation presents a significant opportunity for achieving zero emissions in LAC cities. By 2024, an estimated 83 billion connected devices and sensors worldwide will generate vast amounts of data on air quality, energy consumption, geospatial data, and traffic patterns, which can provide valuable insights for effective and sustainable urban planning and policies. To accelerate the transition to net-zero emissions and maximise the potential of cities, governments need to design inclusive policies and programmes that integrate equity and inclusion into urban digital and energy transitions. This requires investment in human resources, training programmes, partnerships, research and development, and innovation to enhance digitalisation and energy capabilities. Access to timely, robust, and transparent data, including energy use and transport patterns, is critical for digitalisation-based solutions and business models. Governments should also facilitate financing and promote financial innovation to overcome barriers, create new opportunities, and establish conditions for innovative financing schemes. The adoption of international standards and benchmarks is necessary to ensure interoperability and monitor progress towards net-zero emissions. Lastly, knowledge-sharing networks and the integration of urban environments into large-scale energy transition programmes will foster a successful transition (IEA, 2021[124]).

Sustainable Construction

Brazil and Mexico rank among the top 20 producers of cement globally regarding the construction sector, and the regional demand is expected to increase due to the need for infrastructure development and reconstruction in the face of climate change impacts. LAC has approximately 272 operational cement plants and experiences high consumption of bagged cement due to self-building and informal housing construction. It is crucial for policy approaches in this industry to consider the region's inequalities, as LAC faces a significant housing deficit, and any increase in construction prices could adversely impact poor households relying on self-construction schemes (Villagrán-Zaccardi et al., 2022[136]).

LAC countries should adopt comprehensive policy frameworks that focus on reducing industry emissions, including specific carbon prices and low-emission standards. It is essential for countries

to increase investment and financing in R&D of low-carbon technologies, such as carbon capture and storage (CCS) and alternative raw materials for clinker production (IEA, n.d.[137]). In order to achieve durability and resilience of infrastructure, the region should target long lifespan of construction which can provide a significant long-term reduction of emissions. Moreover, reducing the clinker factor by increasing emerging supplementary cementitious materials is one of the most straightforward strategies for reduction emissions. To achieve climate targets by 2050, technology will be needed, some of examples are the implementation of CCS, oxy-fuel, green hydrogen, intelligent plants to process reduce uncertainties related to the product performance, and Carbon Capture Utilisation (CCU) to convert CO_2 into materials with added value, for example, through mineral carbonation of industrial waste or natural minerals (Villagrán-Zaccardi et al., 2022[136]).

It is important to promote green building certifications. These certifications can go beyond mandatory regulations and assess factors such as energy efficiency, sustainable materials, water management, indoor air quality, and waste management, among other environmental and social aspects (OECD, 2022[134]). Several internationally recognised green certifications exist, including Leadership in Energy and Environmental Design (LEED), the Building Research Establishment Environmental Assessment Method (BREEAM), the WELL Building Standard, the Green Star, and the Living Building Challenge. However, there is a lack of regionally developed green certifications in LAC. Currently, multinational corporations that dominate the construction industry in the region typically rely on international certifications, and existing regulations are not stringent enough to encourage widespread adoption of green certifications. Therefore, the number of certified projects in the region remains low compared to other countries. In 2022, for instance, over 520 new projects were registered for LEED certification, with 317 projects successfully obtaining certification, bringing the regional total to more than 2 778 certified projects covering over 48.3 million square meters of space. The main countries for LEED certification in the region are Brazil, Mexico, Chile, and Colombia, representing 78% of the annual certified projects. Although the number of certified projects has been increasing in recent years, it still lags significantly behind the USA, which had 69 066 buildings accredited with the LEED certification by 2019 (GBCI, 2022[138]).

Recommendation

- Establish credible frameworks, standards and policies that promote sustainable buildings and construction practices in cities, thereby recycling materials and reducing greenhouse gas emissions associated with construction.

Industry and trade of industrial goods

Carbon footprint of products will become a factor for global markets in the future. The carbon footprint of products is becoming increasingly significant in global markets and is expected to continue shaping the future due to the rising demand for sustainable products, growing regulations and policies aimed at emissions reduction, supply chain management practices, and investor pressure on the private sector to be environmentally accountable. LAC, being the largest net-exporting region in the world, holds a vulnerable position in terms of transition risks and potential decreases in competitiveness, despite not fully realising its agricultural production potential (Zeigler and Ginya, 2014[139])). Certain countries in the region play a vital role as exporters of agricultural products. For example, Brazil, Argentina, and Paraguay are among the top five global exporters of soybeans, while Brazil and Colombia fall into the same category for coffee (Observatory of Economic Complexity, 2021[140]). Brazil and Argentina also hold significant global export shares for beef (Cook, 2023[141]).

LAC countries need to develop and implement policies that safeguard the exports of key national products. Mutual recognition of equivalent standards and agreements on trade in organic products can

be beneficial for the region. Chile, for instance, has been recognised as an equivalent third country for organic products since 2018, and Argentina and Costa Rica have initiated negotiations in this regard (OECD et al., 2022[4]).

To address the carbon footprint of key national products, LAC countries should consider implementing policies such as establishing carbon pricing schemes and emission standards for high carbon footprint products. Trade policies that take into account the footprint of products from countries and trading blocs, such as the European Union (EU), can significantly impact LAC exports. LAC is a crucial supplier of agribusiness products and raw materials to the EU. In 2021, the EU27 received 8.9% of total exports from LAC, with Brazil accounting for 34.4% of LAC exports, followed by Mexico (15.5%), Argentina (9.3%), Chile (7.3%), and Peru (6.3%). International green regulations like the Green Deal will impose demands for food chain traceability, transparency, compliance, and due diligence, as well as low-carbon, organic, and sustainable production, and reinforcement of the circular economy. These regulations also introduce additional controls on the use of antibiotics, hormones, biologically active substances, feed additives, and chemical residues. Consequently, EU policies such as the proposal for a regulation on deforestation-free products, the Fit for 55 Package, the New Circular Economy Action Plan, the Farm to Fork Strategy, and the Biodiversity Strategy for 2030 may have implications for LAC (OECD et al., 2022[4]). Governments will be compelled to adopt costly actions to align with new standards and requirements while adopting sustainable production practices, which may require investment in capacity building, infrastructure, or technology.

Agriculture, Forestry, and land-based sectors

There is a need to establish sustainable agriculture practices due to the increase in agricultural emissions and the growing challenges of hunger and food insecurity. Between 1990 and 2019, emissions from agriculture in LAC increased by approximately 32%, while agriculture, fisheries, and mining accounted for 6% of the final energy consumption (OECD et al., 2022[4])**.** In recent years, LAC has witnessed a rise in hunger and food insecurity levels, reaching their highest point in 15 years due to the COVID-19 pandemic. This resulted in 59.7 million people experiencing undernourishment and 237 million people facing moderate or severe food in security in 2020. Haiti, Venezuela, Nicaragua, Guatemala, Honduras, Bolivia, and Ecuador were among the countries with the highest prevalence of undernourishment. The region also grapples with adult obesity and childhood overweight, which have increased over the past two decades, leading to significant economic, social, and health impacts. These issues contribute to decreased productivity, increased disability, premature mortality, and higher treatment costs (FAO, 2021[142]).

LAC is the region with the largest producer of ecosystems services and has highest net food exports in the world, accounting for 16% of total global good and agricultural exports. The Food and Agriculture Organization (FAO) estimates that by 2024, net food exports from LAC countries will reach USD 60 billion, three times their value in 2000. The LAC region's share of world exports of commodities like bananas, sugar, and soybeans exceeds 50%, followed by lesser shares for coffee, beef, poultry, and corn, accounting for more than 25% of world exports of each commodity. Moreover, at the regional level, agriculture and livestock are responsible for 70% of habitat conversion, and deforestation rates are three times higher than the global average (FAO, 2016[143]). Beyond the loss of forests and habitats, agriculture accounts for over 70% of freshwater resource extractions in the region (FAO, 2016[143]); (Dávila, 2011[144]) and is among the leading causes of land and soil degradation and biodiversity loss (FAO, 2020[145]). LAC also hosts 57% of the world's remaining primary forests and a third of all plant species. Nearly half of the region's surface is covered by forests that store a large amount of carbon estimated at 104 gigatonnes (WMO, 2021[146]).

Forest loss is a prevailing trend in the LAC region, primarily due to the emergence of new uses of land for agriculture, forestry, and stockbreeding, as well as urban expansion and highway

construction to a lesser extent. Over the past two decades, Brazil has experienced the highest total forest area loss, reaching 544 690 km^2, with an annual deforestation rate of approximately 10%, and 11 088 km^2 of deforestation in 2020. Nicaragua and Paraguay have also faced significant forest loss rates, although on a smaller scale in the same period. In contrast, Chile and Costa Rica stand out as the only LAC countries that have managed to increase their forest cover by 15% and 6%, respectively from 2000 to 2020, thanks to robust governmental enforcement of laws, secure land tenure protecting property rights, and efforts to combat illegal deforestation and unsustainable agricultural and livestock practices (OECD et al., 2022[4]).

Brazil, for instance, has implemented different types of innovations to promote more sustainable agricultural and livestock sectors. The 2010 Sector Plan for Adaptation to Climate Change and Low Carbon Emissions in Agriculture, known as the ABC plan, sought to fortify innovation within tropical soils. From 2010 to 2020, the plan concentrated on the development of sustainable agricultural production technologies,[10] resulting in the mitigation of 170 million tonnes of CO_2e over two decades. Building on its success, the plan was updated for 2020-2030 (ABC +) to include encompassing new technologies such as bio inputs, sustainable irrigation systems, and intensified livestock farming. These innovations aim to expand across an additional 72 million hectares, potentially curbing more than 1 billion tonnes of CO_2e. Notably, the ABC+ strategy incorporates an Integrated Landscape Approach that holistically considers various components of rural landscapes, harmonising natural elements like carbon, water, soil, and biodiversity with agricultural production in a sustainable manner (OECD et al., 2022[4]).

Food and energy plans should be further integrated. The increasing demand for food, feed, fuel, and fibre offers substantial opportunities for the agriculture sector, yet effective government policies must address challenges such as boosting productivity growth, enhancing environmental sustainability, including the reduction of GHG emissions, and improving adaptation and resilience against climate change and unforeseen shocks. It is important that countries promote initiatives focused on avoiding and/or reducing deforestation and the degradation of vegetation resources, contributing to mitigation and adaptation to climate change (OECD, 2022[147]).

The interconnections among water, food, and energy lie at the core of sustainable development. Policy measures should emphasise the expansion of renewable energy sources and the establishment of integrated land, soil, and water systems that promote efficiency throughout the entire agrifood chain, aiming to conserve water, energy, and ecosystems (United Nations, 2021[148]). Biomass by-products from agri-food activities can be used to produce energy for processing, storage and cooking. Residues generated from crop production and livestock can be an important source of bioenergy while considering the competing end uses (e.g., as animal feed) (IRENA and FAO, 2021[149]).

LAC should prioritise the development of national bioeconomy strategies that recognise territorial specificities and establish or adapt educational programmes. The region needs policies that promote sustainable production models, ensuring the sustainability of natural resources that agriculture depends on, increasing the provision of ecosystem services, and enhancing climate resilience. Improved environmental management can bring significant national benefits beyond ecosystem protection, including the long-term sustainability of LAC's prominent position in global food markets. To achieve the best environmental outcome and political acceptability, measures should be implemented as close as possible to the point of emission, considering their impact. Often, a combination of policies such as "polluter pays" and "beneficiary pays," along with environmental regulations, will be necessary (OECD, 2018[150]).

Replacing traditional food production systems with better and scalable methods is essential. Agricultural strategies that prioritise ecosystem services can significantly enhance critical functions. The implementation of diversified farming systems, such as agroforestry and silvopasture, offers substantial benefits including increased biodiversity, improved soil quality, enhanced carbon sequestration, greater water-holding capacity in surface soils, heightened energy-use efficiency, and enhanced resistance and resilience to climate change (Kremen and Miles, 2012[151]). These techniques also contribute to biodiversity

preservation and habitat connectivity, effectively complementing protected areas and enhancing overall resilience to climate change (Kremen and Miles, 2012[151]).

Agri-food systems must become more efficient, resilient, inclusive, and sustainable to ensure access to sufficient, safe, and nutritious food. Strengthening the resilience of vulnerable and non-vulnerable populations in LAC is crucial, particularly in the face of extreme weather events. The ability to resume productive and economic activities is essential for recovery. LAC countries should have a clear understanding of the most exposed communities and geographical areas. Establishing climate risk repositories and maps that are shared with all relevant stakeholders is vital for informing climate change adaptation measures and prioritisation (OECD et al., 2022[4]).

The promotion of protected and precision agriculture is essential for efficient and sustainable food production. Smart villages, based on digital technologies and innovations, can enhance rural areas and communities, supporting quality of life, public services, and new opportunities for rural value chains (European Commission, 2018[152]). Sustainable biofactories are necessary for promoting the circular economy and sustainable water use in agriculture, treating wastewater and generating renewable energy while avoiding waste and environmental impact (UNFCCC, 2018[153]).

Recommendation

- Develop and implement integrated plans for sustainable energy, food security, and bioeconomy, considering the use of renewable energy sources and sustainable practices in agriculture, food waste minimisation, and the promotion of technological innovations with a resilience perspective.

Sustainable Tourism in LAC

As for other sectors, immediate action is necessary to address the existential crisis of climate change, reduce carbon emissions, pollution, and enhance energy and resource efficiency while preventing the depletion of biodiversity and ecosystems resulting from tourism activities. Tourism is both impacted by and highly dependent on the quality of the environment. This dependency requires adaptation to climate and other changes to be addressed alongside actions to mitigate and reduce the environmental impacts from tourism, while supporting the well-being of communities. It is vital that countries accelerate the transition to a greener tourism economy, translating commitments into tangible actions and outcomes, and integrating environmental objectives into tourism policies. This requires the implementation of active tourism policies and recovery measures aimed at driving the shift towards greener tourism business models and value chains. Such efforts can improve environmental outcomes for destinations while delivering benefits to local economies and communities, with a focus on considerations such as decarbonisation, climate change adaptation, ecosystem restoration, and inclusiveness (OECD, 2022[154]).

Tourism serves as a vital driver in LAC economies, contributing to foreign exchange, income, and employment. In 2019, the tourism industry accounted for 42% in the Caribbean and 10% in Latin America of total exports (goods and services). Additionally, it made up 26% of total GDP in the Caribbean and 10% in Latin America. Due to its labour-intensive nature, the tourism sector also provided 35% of employment in the Caribbean and 10% in Latin America (UN ECLAC, 2020[155]). Reliably estimating tourism's carbon footprint is challenging, but recent estimates range from 8% to 11% of global emissions. (OECD, 2022[154]). Potential negative environmental impacts associated with unplanned tourism growth include rapid urban growth, unorganised land use, resource depletion, destruction of fragile ecosystems, contamination of water bodies, and aesthetic deterioration of landscapes and urban environments (Altés, 2006[156]).

However, by implementing sustainable practices, the industry can reduce tourism's negative environmental impacts (OECD, 2018[157]) and attract environmentally conscious tourists. Moreover, tourism can also raise awareness of cultural and environmental values and help finance the protection and management of protected areas, and the preservation of biological diversity (OECD, 2021[158]).

Valuing landscapes and biodiversity should be fundamental principles of sustainable tourism in LAC to ensure long-term sustainability and enhance economic, environmental, and social benefits for local communities and visitors. The Latin America Development Bank (CAF) presented its new work proposal at FITUR 2023 to promote a model of living and regenerative tourism that contributes to mitigating the effects of climate change, preserving biodiversity, enhancing cultural heritage, and reactivating economies. The proposal aims to improve the well-being of rural communities, indigenous peoples, and Afro-descendants; protect and restore biodiversity and value ecosystem services; reduce vulnerability to natural disasters resulting from climate change through resilient infrastructure and monitoring systems; improve government planning processes; promote circular economy practices; and create new spaces to enhance creative and cultural economies, such as museums, galleries, theatres, or creative districts (CAF, 2023[159]).

Digitalisation of the tourism sector is an urgent priority to allow destinations to modernise, innovate, and generate more responsible travellers, who engage positively with host communities Countries need to take proactive measures to ensure that their tourism sectors can fully benefit from opportunities offered by the digital transition, addressing gaps in skills and infrastructure that many tourism businesses and destinations still face. There is an opportunity to develop policies that accelerate the dual transition towards greener and digital tourism, and this is true also for the LAC region. This includes exploiting the opportunities digitalisation opens up for marketing, product and destination development, as well as investing in human capital and skills to embrace digital solutions to promote greener tourism (OECD, 2022[154]). Governments should also actively promote collaboration among stakeholders within the tourism ecosystem. This collaborative approach can enhance the ability to respond to events, share valuable information and experiences, and gain a deeper understanding of both risks and opportunities. Lastly, countries should work on developing long-term integrated strategies with a sustainable tourism vision, clear goals, and targets, along with action plans and mechanisms for resource leverage and government co-ordination (OECD, 2022[154]).

Promoting sustainable tourism development and management presents an ongoing challenge, given the considerable variations in issues and impacts across different destinations (OECD, 2021[158]). To address this, there is a growing emphasis on the potential of certification schemes and similar tools to advance sustainable tourism practices. Countries can establish certification programmes for sustainable tourism activities, designed to minimise their environmental footprint and ensure equitable compensation for the ecosystem services they rely on, ultimately fostering a regenerative economy. Certification schemes represent just one approach to promote sustainable tourism, an area that has acquired increased attention for various reasons, both positive and negative. Concerns include the proliferation of schemes, their effectiveness in driving sustainable behaviours, and associated costs. In the tourism industry, third-party certification schemes have become common, while some countries are considering developing their own schemes tailored to specific objectives. These often concentrate on influencing the practices of businesses and destinations rather than the behaviours of travellers (OECD, 2021[158]).

The use or promotion of certification schemes could, under circumstances, promote ecotourism or certified tourism in protected natural areas that respect the ecosystem and have a minimal environmental footprint. These eco- or sustainability certifications serve as labels that assess the incorporation of sustainable practices and performance based on environmental, social, and economic criteria. These certifications validate an organisation's sustainability strategy by verifying claims and providing external validation on aspects such as responsible supply chain management, legal compliance, and environmental and social risk management practices. Moreover, certifications also exist for key

performance areas like energy management, emissions control, sustainable food practices, and accessible tourism. In many cases, these individual labels and programmes are locally managed and approved to address the region's specific and most significant impacts (GDSM, 2022[160]). At the same time, when introducing certification schemes, one should also consider the proliferation, veracity and success in promoting a shift to more sustainable behaviours, as well as the costs involved. Translating ambitions into relevant and meaningful actions to promote sustainable tourism development and management is an area of ongoing work, not least because the issues and impacts vary considerably between destinations. In this context, there is a growing focus on the potential for certification schemes and other tools to promote sustainable tourism activities.

Tourism can be a driver of positive change in global poverty reduction efforts. *The 2030 Agenda for Sustainable Development* highlights tourism as a driver of positive change in global poverty reduction efforts for both advanced and emerging economies. While tourism has the potential to contribute to all 17 SDGs, specific targets for inclusive and sustainable economic growth, sustainable consumption and production, and the sustainable use of oceans and marine resources are included in SDG 8, 12, and 14 respectively. Achieving these goals will require significant public intervention to create the necessary conditions for private sector growth, as well as co-ordination and dissemination of policy approaches and education and capacity building at the national and sub-national levels (OECD, 2018[157]).

Recommendation

- Develop comprehensive long-term strategies for sustainable tourism, supported by action plans. Promote the green tourism transition by leading through governmental example and ensure that all publicly funded or procured tourism infrastructure adheres to the highest environmental standards, contributing to climate-resilient development.
- Promote the certification of sustainable tourism businesses based on internationally agreed standards, as a tool to mainstream sustainable practices, reduce the negative impact on the environment, meet national sustainable development goals, and encourage more sustainable consumer choices and behaviour.

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Notes

[1] Countries that have not signed are Bahamas, Bolivia, Haiti, Nicaragua, Paraguay, St. Vincent & Grenadines, Suriname, Venezuela.

[2] Argentina, Belize, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Uruguay.

[3] Bahamas, Bolivia, Brazil, Dominica, El Salvador, Guatemala, Haiti, Mexico, Uruguay.

[4] High-income countries: Antigua and Barbuda, Bahamas, Barbados, Canada, Chile, Saint Kitts and Nevis, Trinidad and Tobago, United States of America, Uruguay.

[5] Low- and middle-income countries: Argentina, Belize, Bolivia (PlurinationalState of), Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Venezuela.

[6] The effect produced by the light and heat of the sun being reflected back from surfaces on Earth into the atmosphere.

[7] Hydrofluorocarbons (HFCs) are a group of synthetic gases primarily used for cooling and refrigeration. Many HFCs are very powerful, short-lived climate pollutants with an average atmospheric lifetime of 15 years.

[8] Panama (2008); Mexico, Uruguay, Barbados, Costa Rica (2010); Brazil, Chile, El Salvador (2012), Colombia, Honduras, Guatemala (2014); The Bahamas, Jamaica (2015); Suriname (2016); Nicaragua (2017); Argentina (2018).

[9] Low-carbon hydrogen includes green hydrogen (hydrogen from renewable electricity), blue hydrogen (hydrogen from fossil fuels with CO_2 emissions reduced by the use of Carbon Capture Use and Storage) and aqua hydrogen (hydrogen from fossil fuels via the new technology).

[10] Pastures recovery, crop livestock forestry and agroforestry systems, no tillage system, biological nitrogen fixation, planted forests and animal waste treatment.