



## Perspective

# Opportunities for the global climate development agenda with Net Zero in the horizon: A perspective from Central America

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## ABSTRACT

Net Zero pledges have become the most prominent expression of political and business commitment to climate action in the 2020s. The article examines the relevance of this policy framework within the diverse context of Central American countries, which exemplify the varied experiences of middle-income economies outside the G20. The countries in the region have crafted long-term strategies and short-term policies amid rising climate ambition under significant capability gaps and the unfulfilled promises of climate development finance. This Perspective calls on the earth system governance community to draw on evidence from a larger and more diverse set of local circumstances to define expectations of climate target setting and the integration of carbon removal into climate policy. The article highlights the continued relevance of issues like capacity gap, for instance, to complete GHG inventories or to establish a carbon removal policy. But also the importance of past failures of the climate regime, notably the unfulfilled promises of finance under the Kyoto Protocol, which continue to influence policy debates in Central America.

## 1. Introduction

Climate change burdens developing countries, coastal societies, and island states with disproportionate burdens. Central American countries, as small and mostly open economies, have actively considered the developmental opportunities of climate mitigation but face significant challenges in dealing with the costs of climate change adaptation, the unfulfilled promises in climate finance, and community and human rights violations from large scale project in the region. The commitments to emission reduction under the Paris Agreement in the region totalled three hundred million tons, highlighting the concrete commitment of local actors to transition towards low-carbon economies.

Countries in the region are considering Net Zero paths, including the potential role of carbon dioxide removal (CDR).<sup>2</sup> This Perspective revisits the state of carbon neutrality debates in Central America, considering plans to achieve a balance of emissions “based on equity, and in the context of sustainable development and efforts to eradicate

poverty,” to quote the Paris Agreement (Article 4.1). By discussing current debates in Costa Rica, El Salvador, Honduras, Guatemala, Nicaragua, and Panama, we seek to follow current academic and policy debates in the region. By excluding Belize from this analysis, we acknowledge the distinct governance framework as a constitutional monarchy, which shapes its approach to formulating and implementing strategies and policies.

“Net Zero” refers to a state in which the greenhouse gases entering the atmosphere are balanced by removal from the atmosphere (Valenzuela and Lezaun, 2024). Net Zero targets have become the most visible form of political and business commitment to climate action in the 2020s. As highlighted by Khosla and co-authors (2023), current applications and expectations of net zero frameworks should address key concerns, including acknowledging historical responsibilities, establishing mechanisms for redistributing benefits from net-zero transitions, and understanding the specific risks and opportunities associated with the activities adopted for net zero pledges, such as carbon dioxide

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<sup>2</sup> CDR is not a new subject, but the expansion of items included within a category that has long existed in the form of carbon sinks, or “enhanced” sinks (Carton et al., 2020). Distinguishing between natural sinks and human-enhanced sinks has its challenges, but the State of CDR Report considers there are about 2GtCO<sub>2</sub> of removals, and 99.9% are still from land-based Approaches, like reforestation, afforestation, and ecosystem restoration. Land ecosystem-based CDR approaches are nature conservation and productive approaches that simultaneously achieve the sequestration of CO<sub>2</sub> and other socially relevant outcomes (Smith et al., 2023).

removal in particular locations.

Central American countries actively participate in international climate change policy, formulating strategies and goals under the UNFCCC. International support could enhance institutional capacities, such as improving national inventories and developing local policies and programs related to carbon removal and net-zero targets. However, the climate development finance promised since the Kyoto Protocol has not fully materialized. Future funding schemes from private markets and the Paris Agreement should explicitly address socio-environmental priorities in Central American countries.

Given the strong domestic interest, countries in the region should expand the scope of available climate actions, including exploring agricultural practices that promote soil carbon sequestration and ecosystem restoration. This expansion could be facilitated through increased south-south cooperation aimed at developing technical skills and programs across Central America and Latin America. This Perspective analyses the net-zero climate policies of six Central American countries, focusing on the legal frameworks introduced to promote carbon removal activities. It explores the role of international institutions in providing guidance, establishing rules, and facilitating knowledge exchange. The analysis encompasses discussions on the importance of funding, cooperation, sectoral needs, and mitigation potentials.

Our research shows an overall shortfall of net zero policy across all cases. This institutional diagnosis allows us to highlight three main findings. Firstly, carbon removal by other names is already part of the agenda given the importance countries in the region put on ecosystem conservation and restoration, but there is a lack of understanding regarding carbon removal and sequestration technologies. Secondly, international collaboration can support the development of appropriate legal and policy frameworks, but these must attend to local priorities, rather than focus on the replication of high-income countries experiences. Local priorities, like fighting land degradation, should be the driving motivation for considering approaches to carbon removal. Finally, both public and private international financial institutions must acknowledge that the climate finance under the Kyoto Protocol left a sense of unmet commitments towards sustainable development. Projects carried out under the Kyoto Protocol, particularly in areas with minimal territorial development and lacking local development policies, intensified the overexploitation of natural resources and led to significant alterations in physical landscapes (Molina-Rodríguez, 2019). The past political commitment and success as well as failures should not be forgotten in the adoption of the new policy framework of net zero.

## 2. Climate engagement and carbon neutrality as a goal

Central American countries plan to adapt their legal frameworks. A common objective across the region is to promote adaptation and mitigation strategies, as well as the comprehensive management of risk within all national policies and plans, ensuring the protection of the population in the region. As part of the mitigation strategies, governments are considering increasing carbon absorption through forest coverage and landscape conservation, with each country including specific goals tailored to its circumstances. A comparison of the legal frameworks across six countries has allowed us to diagnose the challenges and barriers, identifying both commonalities and differences.

International climate change policy, guided by the UNFCCC system, has influenced national measures to mitigate climate change. A global mitigation vision could become tangible for these parties if it translates into roadmaps toward reducing emissions (Rayner et al., 2021). However, these roadmaps differ across countries. In Central America, these roadmaps are not clearly defined, except for Costa Rica. While elements necessary to establish roadmaps for climate change mitigation roadmaps exist –such as non-binding regional agreements, national climate policy documents, and priority sectors for reducing greenhouse gas emissions—some countries lack a dedicated legal framework at the national

level that currently exists to regulate these activities.

In Central American countries, non-legally binding regional agreements such as the Regional Convention on Climate Change (1993); the Regional Climate Change Strategy (2010); the Climate-Resilient Sustainable Agriculture Strategy for the SICA Region 2018–2030 (2017), and the Regional Environmental Framework Strategy 2021–2025 (2021) emphasize mitigation activities. These agreements also highlight the importance of technology transfer and financial flows for regional emission reduction projects. Therefore, international cooperation will be essential for advancing these efforts. With the support of regional funding schemes such as ICCO América Latina, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Costa Rica, and Plan Vivo Foundation, Central American countries have undertaken mitigation activities focused on forest and landscape conservation, as well as agriculture, forestry, and other land use (AFOLU) sectors, along with renewable energy projects.

The AFOLU sector in Central America plays a crucial role in mitigating GHG emissions and sequestering carbon, driven by three main factors. Firstly, land-use alterations and the loss of forests are significant contributors to climate change. In 2020, the AFOLU sector accounted for 193.3 million tons of CO<sub>2</sub> equivalent, representing 21.74% of the region's total emissions (FAOSTAT, 2023). Secondly, deforestation—defined as a permanent human-induced conversion from forest to another land use—is estimated at 350,000 ha per year (CCAD, 2019). Lastly, forest cover loss including the reduction of trees in natural forests, tree plantations, and crops due to human or natural causes, has decreased at a rate averaging 27,000 ha from 1990 to 2016 (CEPALSTAT, 2020).

At the national level, Central American countries face diverse challenges related to their development agenda. The economic growth model with high capital concentration and inequality has led to the formation of subsistence economies that still exist today. This has resulted in disorderly urban expansion, affecting agricultural production and making the inhabitants dependent on these activities more vulnerable. This condition has been exacerbated by extreme changes in the climate system (Molina and Paniagua, 2021). In this context, despite having commitments to reduce their emissions, the government's efforts have mainly focused on economic growth.

For instance, the first strategy outlined in the Regional Environmental Framework Strategy emphasizes the transition to sustainable production and consumption patterns. It highlights the need to generate innovative opportunities in production processes to enhance competitiveness and achieve environmental quality in the region, effectively integrating environmental concerns into the economic domain. Specifically, El Salvador identified its primary goal as diversifying energy generation sources and attracting foreign investment (Cáceres, 2018). In Guatemala, the General Electricity Law and the Renewable Energy Incentives Law stipulated that electricity generation would be undertaken by private investors (Molina-Rodríguez, 2019). These efforts have primarily focused on economic growth, which can be both an opportunity and a challenge for the development of mitigation activities and the establishment of robust regulatory frameworks and institutions in the region. However, balancing economic growth with environmental sustainability remains a challenge, as it requires comprehensive policies and strong institutions to ensure that economic activities do not undermine environmental goals.

It is challenging to assert that the region as a whole has made significant progress in their climate policy frameworks, giving countries uneven progress. A comparison of the legal frameworks of six Central American countries has allowed us to identify specific policy changes, highlighting both similarities and differences among them. These findings are summarized in Table 1.

Guatemala has developed the National Climate Policy Document and enacted the Framework Law on Climate Change, making it the only country in the region with such comprehensive legislation. These instruments aim to achieve sustainable low-emission development and

**Table 1**  
Overview of institutional transformation.

Country	Emission target (million TonCO <sub>2</sub> e)	Emission Reduction Target (2030)	National Climate Policy Document	Legal Framework	Priority Sectors
Costa Rica	106.53 (2021–2030)		Policy and National Plan for Adaptation to Climate Change, National Decarbonization Plan, Action Policy of the National Climate Change Strategy		Energy, Industrial, Processes and Product Use Sector (IPPU), Agriculture Forestry and Other Land Use (AFOLU) and Waste
El Salvador	640 (energy, 2019–2030) 50.86 (AFOLU, 2015–2040)	61% (energy)	National Climate Change Plan, National Environmental Policy, National Plan for Adaptation to Climate Change	Reform to Law on Environment.	Energy and AFOLU
Guatemala	65.00 (2016–2030)	11.2% or 22.6%	National Development Plan K'atun: Our Guatemala 2032, National Climate Change Action Plan. National Development Strategy with Low Greenhouse Gas Emissions. National Strategy for the Reduction of Deforestation and Forest Degradation	Climate Change Framework Law	Energy, Land Use, Land-Use Change, and Forestry (LULUCF), Agriculture, and Waste
Honduras	28.95	16%	The Law for the Establishment of a Vision for the Country and the Adoption of a National Plan for Honduras.	Climate Change Law	Energy, Agriculture, IPPU, and Waste
Nicaragua	71.00	8%	National Strategy on Climate Change, National Plan for Adaptation to Climate Change; Decree to Establish the National Policy for Mitigation and Adaptation to Climate Change and the Creation of the National Response System to Climate Change		Energy, Forest, and Land Use Change
Panama	60.00	24%	National Climate Change Strategy 2050		Energy and Land-use, Land-Use change, and forestry (LULUCF)

\* Emission reduction target by 2050.

\*\* 11.2% using its resources and 22.6% with international support.

Source: Authors, based on NDCs updates.

mitigate the threats associated with climate change (MARN, 2022). Additionally, the Guatemalan government is actively working on developing databases, indicators, and goals to enhance the monitoring, reporting, and verification of mitigation efforts.

**El Salvador** has also taken steps to address climate change and implement mitigation measures. Although there is no specific framework law on climate change, El Salvador enacted an Environmental Reform Law in 2012, which includes a dedicated chapter on adaptation. In this chapter, the government emphasizes the importance of researching, promoting, and developing mitigation technologies. In 2015, the government approved the National Climate Change Plan, which aims to build a society and economy resilient to climate change and promote low carbon emissions (MARN, 2015). The National Environmental Policy, issued in 2022, also focuses on managing climate risks and transitioning to a low-carbon economy.

**Honduras** has made significant progress in establishing the foundation for a low-carbon development strategy with a long-term vision. The Law for the Establishment of a Vision for the Country and the Adoption of a National Plan for Honduras initiated a series of reforms to address environmental issues and meet international commitments (Molina-Rodríguez, 2019). The National Plan and the Vision for the Country aim to increase the share of renewable energy in the country's electricity generation to 80% and to restore one million hectares of forest land ecologically and productively, by accessing the international carbon credits market (Decreto N°286–2009). The government has prioritized emission mitigation efforts by reducing fuelwood consumption and implementing Rural Landscape Restoration initiatives. However, it has not included the Land Use, Land-Use Change, and Forestry (LULUCF) sector in the mitigation agenda, due to the absence of an updated National Inventory of GHG Emissions (Gobierno de la República de Honduras, 2021), which is essential for measuring and reporting emissions from different sectors.

**Nicaragua** has defined its goals according to the objectives of the Paris Agreement through the NDC. Yet, the government approved the National Strategy on Climate Change, which dates back to 2010 and includes measures for mitigation, adaptation, and risk management (Ministerio del ambiente y los Recursos Naturales (MARENA), 2020). In line with this strategy, Nicaragua's updated NDC emphasized the

importance of increasing renewable energy projects and forest conservation as key actions to reduce GHG emissions.

**Panama** has made strides in climate action, focusing on environmental management, the transition to a low-carbon economy, and the enhancement of climate resilience at the national, local, and sectoral levels. Panama included two sectors in its NDC: Energy and LULUCF (Ministerio de Ambiente, 2020) which have the greatest impact on national emission trends.

Finally, **Costa Rica** stands up for its ambitious goal of achieving net-zero economic growth. The National Policy on Climate Change Adaptation, the Action Policy of the National Climate Change Strategy, and the National Decarbonization Plan define measures to achieve economy-wide decarbonization by 2050, transforming the economic structure and implementing decarbonization, resilience, and adaptation activities rooted in nature-based solutions (Ministerio de Ambiente y Energía, 2020).

As shown in Table 1, at the national level, only Guatemala has a specific legal framework for climate change. The emission reduction targets vary in each country. Countries like Nicaragua aim to reduce emissions by 8% by 2030, while countries like El Salvador project reductions ranging from 35% to 61%. Guatemala has projected a reduction in emissions of 11.2% using its resources and 22.6% with international support. These goals consider the Business as Usual (BAU) scenario. Regarding national climate policies, except for Honduras, all countries have developed national policies and strategies on climate change. However, only Guatemala and El Salvador have legal frameworks that regulate mitigation activities. The priority sectors for promoting mitigation activities include AFOLU (Agriculture, Forestry, and Other Land Use), LULUCF (Land Use, Land-Use Change, and Forestry), Agriculture, Forests, Waste, and Energy. This prioritization is primarily driven by including the REDD + mechanism in the Paris Agreement and the region's commitment to the Bonn Challenge.

### 3. Finance development and not just removals

The failure of past efforts to curb global GHG emissions has drastically reduced the remaining carbon budget compatible with the 1.5 °C temperature target. As a result, CDR activities have become increasingly

significant in global and national emissions trajectory models and policy discussions.

Several countries that have adopted net-zero pledges have also communicated plans to use CDR activities to offset residual emissions. Similarly, many companies have outlined their vision for CDR project deployment or financing to compensate for emissions within their value chains. Private governance and standard mechanisms are emerging to guide the accounting of these removals. As a result, CDR has become part of business, national, and international climate action efforts, though its integration into specific policies remains undefined.

The Economic Commission for Latin America and the Caribbean (ECLAC) has emphasized the challenge of land degradation, and the opportunity to pursue conservation and address productive land degradation through a CDR agenda based on ecosystem (including soil) restoration (Samaniego et al., 2023). These activities should be pursued regardless of their climate benefit, but framing them as CDR might allow the government, landowners, local communities, or companies to benefit from additional financial or technical resources. However, this reframing depends on capabilities and local infrastructures to monitor and govern carbon removal effectively to avoid global corporations or government greenwashing.

Eight years after the Paris Agreement, developing countries face gaps in the continuity of the mitigation support mechanisms established under the equal but differentiated responsibilities principles—like the Clean Development Mechanism. These challenges are particularly evident in financing efforts to enhance carbon sink projects and programs. Central American countries, in particular, struggle to establish the necessary institutional frameworks and acquire the technology needed to achieve their domestic climate goals and fulfill international climate commitments. The experience with the Clean Development Mechanism serves as a cautionary example of unmet expectations regarding international support. Therefore, the increasing importance of CDR requires a critical assessment of past and present deficiencies within international and national climate policies.

#### 4. Acting upon knowledge gaps through south-south and triangular cooperation

In Central American countries, the net-zero agenda includes mitigation actions such as “Remoción de carbono” or “secuestro de carbono,” the Spanish term for carbon removal and sequestration. These mechanisms form part of the policy from forest and land ecosystems. However, “novel” CDR approaches identified in the State of CDR Report (Smith et al., 2023)—such as direct air carbon capture, biomass electricity generation with carbon capture and sequestration, and biochar production for carbon removal—are not yet included in policy discussions, and without them, Costa Rica has already adopted a carbon neutrality goal by 2050, aligning with a 1.5 °C climate scenario. This involves the expansion of forest area contribution to emissions balancing from −2.05 million metric tons of carbon dioxide in 2012 to −5.5 MtCO<sub>2</sub> in 2050 and other activities such as agricultural soil conservation to offset remaining emissions by that year (Gobierno de Costa Rica, 2019:25). This is a critical insight, as countries in the region might strive to contribute beyond the net zero and into net-negative if appropriately supported. Removals through forest ecosystems, coastal ecosystems, and agricultural soils appear to be the most relevant. The impact could be relevant, Central America’s total land area is 0.52 million km<sup>2</sup> or twice the land area of the isle of Great Britain at 0.21 million km<sup>2</sup>.

The ECLAC research reveals that NDCs in the Latin American region do not prioritize carbon removal as a standalone strategy. Instead, they focus on specific conservation efforts that could also contribute to carbon removal. The research has identified significant ecological, and social challenges, in the region, including deforestation and land degradation (Samaniego et al., 2023).

Another important issue is the impact on community groups and indigenous communities as populations adjacent to the carbon removal

projects. Decisions regarding carbon removal activities should be made in alignment with the provisions of the International Labor Organization Convention 169 on Indigenous and Tribal Peoples. This ensures that all affected communities are adequately consulted and informed, as their rights and input are essential for achieving equitable and effective outcomes in climate action initiatives within the region. Moreover, regional governments must recognize the integral role that local and indigenous communities play in the stewardship of carbon-rich ecosystems, as their traditional knowledge and practices are vital for sustainable environmental management and the success of any carbon sequestration initiatives (Rights & Resources, 2018). For instance, in Guatemala, where 56% of the land area is degraded due to deforestation and declining productivity (Samaniego et al., 2023: 22), indigenous communities are opposing these activities because there is no specific mechanism for public consultation among the general population as required by law, leading to conflicts.

At a regional level, carbon removal and carbon sink-enhancing activities have faced challenges due to delays in aligning national legislation with international requirements. One example is the Reducing Emissions from Deforestation and Degradation (REDD+) approach. There are often tensions between REDD+ goals for carbon and biodiversity conservation. In many cases, the synergies between carbon mitigation and climate adaptation go unrealized in the context of REDD+ projects, and the achievement of social co-benefits has been marginal, despite some benefits for forest carbon mitigation. Indeed, the development of equitable and effective benefit distribution strategies has been particularly challenging at project levels, owing to limited state and civil society capacity, corruption, and political resistance. Additionally, REDD+ project implementation has shown that interventions targeting small-holders and stakeholders often fail to address the most significant drivers of deforestation and are difficult to ‘scale up’ without enabling policy frameworks at the national and sub-national levels (von Hedemann et al., 2020).

ECLAC proposed a phased approach for the development of CDR in this region. This includes implementing afforestation and reforestation initiatives now, with potential deployment of biochar as an approach to CDR by the 2040s. Furthermore, ECLAC suggested that approaches like Bioenergy with carbon capture and storage and Direct Air Carbon Capture and Storage could play a role in subsequent decades—beyond the 2030s—for countries like Brazil and Mexico which have larger industrial economies, unlike Central American nations which lack extensive fossil fuel industries typically associated with geological carbon sequestration.

A regional and subregional focus proves to be beneficial when compared to international assessments. A recent study by Fuhrman et al. (2023) examined the global impact of carbon removal approaches and modeled the potential of BECCS in Central America, indicating that it could contribute up to 20% of the region’s primary energy consumption by 2050. In Guatemala and El Salvador, there have been efforts to assess the potential for CO<sub>2</sub> geological sequestration. Guatemala has a significant share of biomass for electricity generation, while El Salvador has estimated carbon reservoirs in protected natural areas amount to 15.1 tons of carbon dioxide (MARN, 2018). But, in neighboring oil-producing Mexico, both CCS and large biomass thermal electricity were considered during the 2010s but have since been removed from energy and decarbonization plans due to a lack of coherence with developmental priorities. BECCS is simply too expensive for middle-income economies to pursue.

Central American countries have regional institutions for collaboration. Costa Rica has already set a favourable example, the development of its net-zero strategy, created by local researchers with support from experts in the region, and the multi-actor Deep Decarbonization Pathway Initiative (DDP). Collaboration in technological development can also be based on progress across Latin America, such as Brazil’s national soils atlas and carbon neutrality agriculture standards (Smith et al., 2023, see the Brazil case study) or Mexico’s advancement in hydro

char production using urban waste.

## 5. An invitation to regional explorations to contribute to global debates

In light of global scoreboards of carbon neutrality pledges and the dominance of perspectives of carbon removal that stress approaches like DACC, this Perspective calls for a robust discussion of regional approximations of the institutional conditions for the development of net-zero policies. Such discussions are vital to address the unique realities of different countries, highlight the shortcomings of international climate governance—especially regarding climate development finance—and underscore the importance of supporting collaboration among developing countries. Our contribution to this debate focuses on the experiences of Central American countries, which as a subset, are evocative (if not altogether representative) of middle-income economies with climate ambition and serious development challenges—many times obscured by the attention to BRICS and other G20 countries.

A recent information note: “Removal Activities under the Article 6.4 mechanism (version 04.0)”, under review in the UNFCCC process, states that engineered carbon removal “Activities do not contribute to sustainable development, are not suitable for implementation in the developing countries [ ...]” (UNFCCC, 2023: 18). This statement is controversial, but the evidence on either for or against this position should come from the concrete emerging experiences of countries like Costa Rica, El Salvador, Honduras, Nicaragua, Guatemala, Panama, reviewed in this perspective. New agendas must undergo testing to account for the variety of country conditions. Existing challenges such as national GHG inventories will continue to pose a barrier if left unaddressed, representing a pervasive issue for developing countries (Umeyama and White, 2024).

The Kyoto Protocol may have faded from discussions in developed countries, particularly in the United States, the UK, and Europe, with the Paris Agreement marking a new era in climate policy. However, for institutions that spent years working to benefit from the promised—yet unfulfilled—climate development finance, Kyoto’s legacy has now turned into both scepticism and caution optimism that new mechanisms will better address developmental concerns. The emergence of new mechanisms for climate finance as forms of compensation will benefit from understanding regional realities. Understanding regional realities will be crucial as new mechanisms for climate finance, particularly those involving private standards and carbon markets, seek to acquire compensatory removals from actions in developing countries, and as CDR gains traction within international cooperation agendas.

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### CRedit authorship contribution statement

**Cintya B. Molina-Rodríguez:** Investigation. **Jose Maria Valenzuela:** Validation.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

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