



NDC ASPECTS

Country Report

Transition pathways for Ecuador

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Key messages

- The 2024 National Climate Change Mitigation Plan of Ecuador (PLANMICC) is the first long-term integrated strategy to guide the mitigation actions up to 2070 in energy, agriculture, LULUCF, residues and industrial processes. It seeks to achieve the ambitious target to reduce 70% of annual GHG emissions by 2070, in comparison to the BAU scenario.
- A national implementation strategy is needed to achieve the goals of PLANMICC. This is only possible if all institutions, policy makers, entrepreneurs and society as a whole embrace it. Thus, education at all levels and communication strategies are required.
- The second NDC should propose initiatives aligned with the long-term goals and sectoral decarbonization pathways, with concrete interim targets in 2030 and 2035.
- One of the main barriers to advance in decarbonization targets is financing. Thus, the public and private sectors need to agree on the boundary conditions for participation in this endeavor. Capacity building is required in governmental institutions for the application and utilization of international green funds.

Introduction and overview

Ecuador, with a population of approximately 16.9 million as of 2022 and a GDP of over \$109 billion (USD) in 2021 (around 6450 USD per capita), is located in northwestern South America. It has a significant reliance on oil exports, which constitutes a major part of national revenue. Ecuador is actively implementing its first Nationally Determined Contributions (NDCs) under the Paris Agreement, targeting a 9% reduction in greenhouse gas (GHG) emissions in its unconditional NDC or respectively a reduction of 22.5% with international support (unconditional + conditional NDCs) by 2025. This target refers to a baseline scenario (starting in 2010) for the energy, agricultural, industrial processes and uses, and waste sectors. However, the aimed reduction would still lead to an absolute increase of GHG emissions for those sectors. Land Use, Land Use Change, and Forestry (LULUCF) had a different metric and methodology in the first NDC, proposing a reduction of 4% in the unconditional NDC and a reduction of 20% adding the conditional NDC by 2025, in comparison with an emissions reference level from the period 2000-2008 [1].

Development in recent years

Since 2012, Ecuador has experienced significant demographic and economic changes. The population has grown by approximately 10% between 2012 and 2022, and the Gross Domestic Product (GDP) has increased by about 30% during the same period. This economic and population growth has driven a rise in primary energy demand by around 12% and a corresponding increase in energy-related emissions by about 10%.

Ecuador's energy landscape is characterized by a significant reliance on oil for its primary energy production, with 65% of this energy being exported in 2022 [2]. When it comes to final energy demand, electricity makes up only 17.5% of the total demand in 2022. The power sector in Ecuador has undergone substantial development, with a marked increase in electrical capacity by around 62% since 2012. Since the introduction of the NDC in 2019, there has been no significant increase in gross electrical capacity until now, which currently stands at 8.9 GW (including

National Interconnected System and isolated systems). However, it shall be noted, that there is ongoing development of power plants considered in the NDC which aims at an implementation until 2025. The country's power generation structure is dominated by hydropower, which accounts for 58% of the installed capacity, with thermal plants and a minor share of other renewable energy sources making up the rest. Ecuador's electricity supply is therefore highly renewable, with around 75% derived from renewable sources in 2023. Hydropower is the predominant contributor, making up almost 75% of the electrical energy supply.

The transport sector is the most energy-intensive, accounting for about 50% of the final energy demand, followed by the industrial sector at approximately 18%, and the residential sector at around 13%. It is notable that there is barely any electrification in the transport sector, indicating a heavy reliance on fossil liquid fuels and leading to the transport sector being the main contributor regarding energy-related emissions with around 50%, followed by the industry sector with around 12% and the residential sector with more than 8%.

In addition to energy-related emissions, emissions due to LULUCF represent a significant component of overall net GHG emissions in Ecuador which add up to 16.28 MtCO₂e per year in 2018. LULUCF accounts for more than 21% of the total net emissions. The increase in mitigation efforts like the implementation of the REDD+ Action Plan or the implementation of the Climate Smart Livestock Project led to GHG emissions reduction in both the agricultural sector and the LULUCF sector, due to a reduced expansion of agricultural frontiers. One major reason for LULUCF GHG emissions is deforestation, which leads to a loss in tree cover of more than 500 kha, equivalent to more than 2.5% of the tree cover in Ecuador since 2012 [3] despite ongoing mitigation efforts like reforestation or the support of sustainable land management practices.

Ecuador's current political situation is marked by instability and economic challenges, influencing its climate ambitions and energy transition efforts. The country has experienced frequent changes in leadership and political unrest, which complicate the consistent implementation of long-term policies. Economic difficulties, exacerbated by the COVID-19 pandemic and fluctuating oil prices, have strained government finances, limiting investments in renewable energy and sustainable infrastructure.

The current policies that are in action in the context of a sustainable transformation of the economy lack, above all, sustained finance mechanisms. For innovation, there is an insufficient policy framework and availability of public funds to enhance public research, development, and demonstration (RD&D), to employ market instruments or to ensure transparency and information. The current policy framework does not address appropriately a demand reduction, international coherence or socio-economic implications. However, there is a partial existence of regulatory environment policies.

Key decarbonization pathways & related transformations

As Ecuador signed the Paris Agreement and committed to reducing emissions to stay well below 2°C, in August 2024 the Ministry of Environment, Water and Transition (MAATE) launched a long-term strategy for decarbonization. This is the National Climate Change Mitigation Plan (PLANMICC) [4], and it defines strategies that Ecuador wants to follow up to 2070. PLANMICC's "2070 Climate Commitment" scenario enacts a 70% reduction in annual national GHG emissions by 2070, compared to the business as usual (BAU) scenario (see Figure 1). It is a plan that arises from integrated modeling using OSeMOSYS tool (energy, agriculture, LULUCF, residues and industrial processes) and was formulated in a participatory and consensual way with sectoral actors during the



period 2022-2024. This scenario is currently considered feasible from technical, economic, environmental, social and political points of view. The energy sector would reach a peak in emissions around 2030. Thereafter, climate protection measures will be gradually increased. The goals for the energy sector are to reduce annual emissions by 30 % by 2050 and by 50 % by 2070 compared to the BAU scenario (see Figure 2).

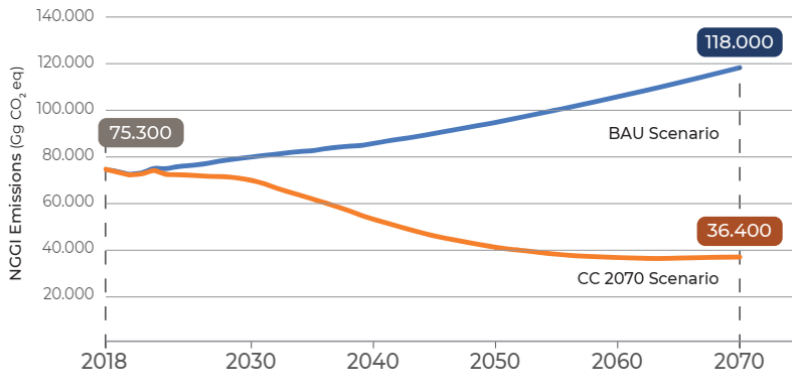


Figure 1: Annual CO₂e emissions at national level in the 2070 Climate Commitment scenario from the PLANMICC [4]

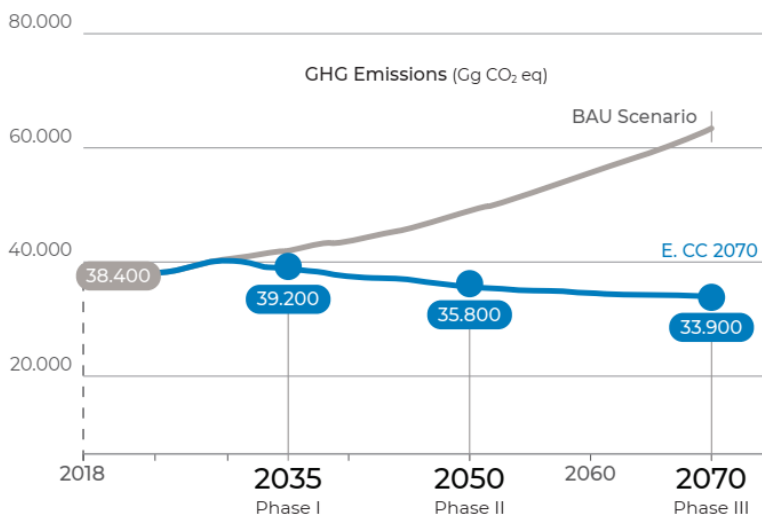


Figure 2: Annual CO₂e emissions in the energy sector in the 2070 Climate Commitment scenario from the PLANMICC [4]

mainly from the national grid, and thus reducing the self-consumption of hydrocarbons for electricity generation in oil producing blocks. The development of a hydrogen industry is expected in the long term, playing a rather modest role. Finally, energy efficiency is also an important pillar in all sectors. In the case of passenger transport, this is reflected in the preference for local public transport and micro-mobility to the detriment of the individual use of private vehicles.

While the current NDC only addresses the target year 2025, the MAATE is currently developing the second NDC with targets for 2030 and 2035. In addition, there is the National Plan for Adaptation to Climate Change (PLANACC), which was published in 2023 and contains goals for 2027.

In 2016 the former “Ministry of Electricity and Renewable Energy” developed the “Ecuador’s National Energy Efficiency Plan” (PLANEE), a public policy instrument to improve energy consumption habits. The PLANEE

In summary, the transition of the energy sector in the “2070 Climate Commitment” scenario is based on the following strategies. Final consumption sectors reduce the use of fossil fuels thanks to the promotion of electrification, this is fundamentally special in the transport sector, and with less impact this measure is basic for all other consumption sectors. This increase in electricity consumption requires an expansion in the installed capacity for additional electricity generation, which must be mainly based on conventional and non-conventional renewable sources. Hydroelectric, solar photovoltaic, geothermal, wind and biomass must achieve higher shares in electricity generation. On the other hand, this high proportion of renewable energies also requires a minimum of fossil thermal capacity, which acts as a backup to bridge years of low water potential and ensure flexibility for a reliable operation of the power system. In addition, the efficiency of oil and natural gas extraction and conversion is increased by using electricity

specifically addresses energy efficiency in sectors related to energy supply and use, and sets sectoral targets up to 2035. In August 2024, the Ministry of Energy and Mines launched the updated Electricity Master Plan (PME) 2023 – 2032, showing the mid-term strategy to invest in generation, transmission and distribution. Although the largest expansion in electricity generation is based on renewable energy, a significant investment is also planned in fossil thermal plants (1,290 MW) until 2029 to replace and repower old power stations at the end of their service life. From 2030, the expansion is to be achieved mainly by hydropower, which will be generated in mega projects in the southern Amazon basin.

There are only few national ambitious decarbonization pathways assessed in current literature, mainly developed in the context of the project “Deep Decarbonisation Pathways in Latin America and the Caribbean” (DDPLAC) using an Integrated Assessment Model [5,6] (Figure 3 [7]). In line with current sectoral shares of GHG emissions, all ambitious scenarios outlined in this study, aiming at 2°C and 1.5°C compatible pathways, highlight the necessity of additional electrification of the demand sectors. This implies the requirement of a significant expansion of sustainable electricity generation capacities. In addition to a further expansion of hydropower plants, the introduction of larger solar photovoltaics (PV), wind and thermal biomass generation capacities, which are not yet a relevant part of Ecuador’s electricity matrix, plays a crucial role.

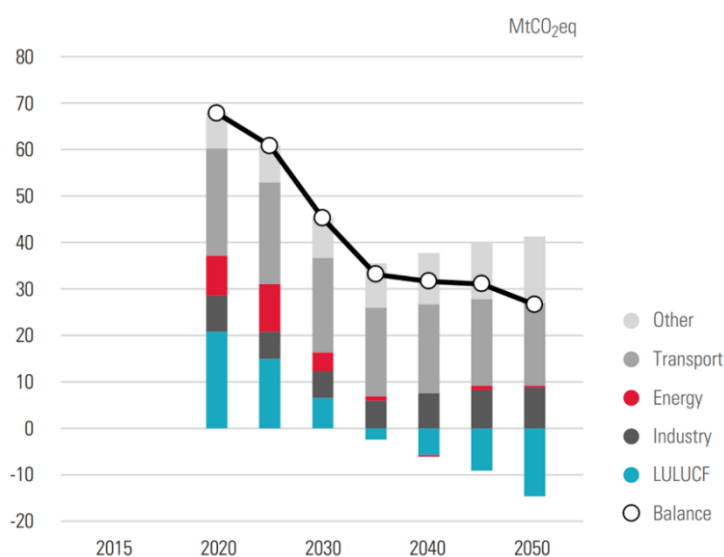


Figure 3: Annual CO₂ emissions of a possible ambitious decarbonization pathway from the DDPLAC project [7]

One of the biggest challenges in achieving ambitious long-term goals is to overcome the current heavy dependence on fossil fuels, especially in the demand sectors. A shift from oil to sustainable biomass as main primary energy source could provide storable energy for the power sector and serve as raw material for sustainable liquid energy carriers. However, this would require a significant ramp-up of the biomass industry, both in sustainable cultivation and especially in biorefineries as a new industrial branch which is currently not existing in Ecuador.

As the energy demand of the transport sector is currently almost exclusively satisfied with liquid fuels based on fossil feedstocks and due to its high share on overall GHG emissions, this sector

provides a significant emission reduction potential, but also requires extensive transformation efforts. One key sector to achieve net-zero emissions is represented by LULUCF with the ability of serving as carbon sink in the long term. Increased afforestation and sustainable land use management combined with a reduction in deforestation can lead to net negative emissions and serve as measures to reduce the necessity of other negative emission technologies such as carbon capture and storage (CCS) in combination with biomass-based thermal power generation.

Finally, recent reports published by Interamerican Development Bank [8,9] and World Bank [10] also assess ambitious national decarbonization scenarios for Ecuador to get to net zero annual emissions by 2050. These studies compare decarbonization trajectories for countries in the same region developed under a common scenario design framework.

Sectoral system transformations

This section summarizes key challenges, targets and measures which may serve as enabler in the context of 1.5°C compatible pathways towards a GHG-neutral economy for the key sectors in Ecuador.

Industry

Ecuador faces a major challenge in transforming its energy sector and the related economy which is currently heavily relying on the use and export of crude oil as primary energy carrier. Although being net exporter of primary energy, Ecuador is highly dependent on imports of refined petroleum products, which resulted in fuel import costs exceeding the export revenues for the first time in 2023.

- The extensive but gradual transformation towards an economy without a pivotal role of the oil industry is necessary and will improve the sustainability of the economy and resilience to fluctuations in the global oil market.
- This transformation comes with significant impacts such as on related jobs or infrastructure. To enable a just transition, systemic support and targeted subsidies should be provided to dampen the negative impacts, considering local perspectives and creating alternative sustainable employment and income opportunities.

Energy

To satisfy the future increase in electricity demand of around 50% in 2030 and 150% in 2050, significant investment in sustainable electricity generation capacity is required. Despite the availability of additional hydropower potentials, an increase in extreme weather events, which exacerbated the critical situation that the power sector is facing (also due to neglected power plant maintenance, import limitations from Colombia and a delay in the expansion plan PME), led to a nationwide power outage in April 2024. In addition, the loss of glaciers would increase potential problems using hydropower as single backbone of the power sector on the long term.

- Further expansion of hydropower capacities is required to increase the availability of baseload electricity supply, considering social and environmental standards to strengthen the social acceptance.
- The diversification of the electricity matrix is key to a robust and resilient power sector in the long term, considering all available sustainable technologies, such as PV, wind, geothermal plants and thermal power plants using biomass.
- A rapid expansion of PV and wind onshore capacity is a no-regret option, especially in the Andean region and the south-west where comparatively high capacity factors can be achieved.
- The electricity transmission grid must be expanded in accordance with the increased share of fluctuating renewable generation capacities.
- Without reliable economic and geologic basis to assess the potential role of CCS in Ecuador, long-term strategies should avoid a reliance on CCS-based technologies.

Transportation

An ambitious reduction of GHG emissions in the passenger transport sector can mainly be built on two pillars, a modal shift, where possible, and electrification. Passenger transport is highly affected by individual habits and

subjective experiences (like e.g. traffic accidents, harassment or theft). A targeted transformation can therefore not only be achieved by legislative measures but also by an adjustment of the general conditions.

- For short distance travel, alternatives to motorized vehicles should be supported. Main measures can be improvements in road safety and pedestrian-friendly planning of urban areas.
- An increase of public transport capacity, especially using electric busses and trains, will reduce the specific energy demand per passenger and will result in an increased specific electrification.
- A reduction of the average weight of transport vehicles will reduce the energy demand. The introduction of light electric vehicles (LEV) for individual passenger transport in the urban context will reduce the specific energy demand, increase the electrification of passenger transport, and will result in reduced emissions and improvements in air quality.

A reduction of GHG emissions of freight transport can mainly be achieved by:

- Electrification of the truck fleet and a corresponding expansion of the charging infrastructure for battery-electric vehicles.
- Shifting road-bound freight transport to the rail using electric trains.
- The replacement of fossil liquid fuels with advanced liquid fuels based on biomass. To avoid a significant dependency on fuel imports, a large-scale bio-industry should be built up to satisfy national demand.

Agriculture and LULUCF

While the agricultural sector will be mainly relevant for replacing fossil liquid fuels, LULUCF can play a key role in generating negative emissions and thus achieving an overall target of close to net-zero GHG emissions. The main measures relevant here are:

- Gross deforestation as major GHG emitter in the LULUCF sector should be reduced.
- A support for sustainable farming and livestock practices, and effective water management can reduce the expansion of the agricultural frontier due to subsistence farming.
- Reforestation and afforestation of degraded land should be increased and go hand in hand with support for sustainable forest management. This should also consider sustainable community-based approaches, securing the access of local communities to raw materials they need for their livelihoods.
- The shift towards a large-scale bio-industry requires significant increase in cultivation, mainly with a focus on woody biomass. The arable land required for this should be developed in a sustainable and, in particular, socially acceptable manner. Conflicts with subsistence farming must be avoided, or socially acceptable alternatives must be provided for local communities, taking their way of life into account.

Buildings

- A conversion to clean fuels via electrification for cooking and water heating can reduce GHG emissions especially in the residential building sector.
- Improvements in energy efficiency standards and efficient technical building equipment according the PLANEE can reduce GHG emissions especially in both the residential and public building sector.

Global conditions

The transition away from the oil industry is a major economic challenge for Ecuador as currently oil-related activities represent around 10% of the national GDP and provide a relevant number of jobs for e.g. technicians and engineers. A corresponding global trend towards decarbonization could generate specific economic pressure here and accelerate efforts to establish new and renewable business areas.

Preferential market access and financial support for alternative economic activities and a facilitated access to climate funds which support the development of sustainable projects will support Ecuador in this transition.

Key messages for next NDCs

The current NDC issued in 2019 is not in line with global ambitious long-term net-zero pathways. Despite Ecuador being a non-Annex I country, the second NDC should consider initiatives that allow to cover an important part of the long-term mitigation goal presented in the PLANMICC up to 2070. Although different regulations were put into action to enforce a sustainable transition of the energy sector, the next NDC should be improved in clarity and guidance:

- The PLANMICC, a long-term strategic planning until 2070 covering all relevant sectors and their interdependencies should serve as the basis for the sectoral targets defined for the next NDC period until the year 2030 and 2035. The implementation of the long-term PLANMICC strategy will further improve the planning security for stakeholders and financing as it reduces the risk of lock-in effects and it increases the resilience of the long-term transformation process against political instability.
- The NDC should address the necessity of an economy-wide structured collaboration of the ministries and institutions defined and involved in the legislative processes.
- Specific GHG mitigation targets allocated to each individual sector in the PLANMICC, should be used to improve guidance and to clarify the responsibilities of the institutions and ministries involved.
- Although considering the transport sector as part of the energy system as done in the current NDC, the GHG national inventory and PLANMICC following the IPCC guidelines, addressing the transport sector as an individual sector in the NDC will highlight its relevance and improve the possibility for implementing a set of dedicated measures and mitigation targets.
- The current NDC lacks clarity on the international support of the conditional NDC targets. Improving clarity on the specific expectations and requirements regarding the international support could foster the engagement of international stakeholders.

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