

# GETTING TO NET-ZERO EMISSIONS

Lessons from  
Latin America and  
the Caribbean

IDB and DDPLAC





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# Foreword

In 2019, the Inter-American Development Bank Group celebrates its 60th anniversary. Over the last six decades, it has played a transformative role in Latin America and the Caribbean to promote development. As we reflect upon many of these positive advances and look ahead, what will our contribution to the region be over the next decades?

This deliberation must consider that we face simultaneous and overlapping ecological and climate emergencies. The United Nations says that as many as 1 million species are now at risk of extinction due to human activity and that transformative action is required now, and sustained through 2050, to ensure that the world limits global heating to 1.5 degrees Celsius.

As the world's most biodiverse region and one of the most vulnerable to climate change impacts, the Region's future hinges on our ability to fundamentally transform its development pathway. A failure to do so could roll back years of progress and make it near impossible to achieve sustainable and inclusive growth. Our responses must put citizens first to ensure that we continue to simultaneously help solve development challenges while avoiding exacerbating existing ones or inadvertently creating new problems.

While climate change presents considerable risks, countries across our region are demonstrating that efforts

to confront it could help to launch new engines for sustainable development. Thinking about climate action as a development choice is paramount as thus far global efforts to arrest climate change have fallen short. To a large extent, we have been looking at the climate problem through the wrong lens by talking about the reduction of greenhouse gas emissions as a cost rather than an economic opportunity. This has resulted in incremental steps, which moves us forward some of the way, but not nearly far enough to where we need to get to.

In a bold and intellectually stimulating step, various Latin American and Caribbean countries are leading the way, with long-term decarbonization strategies that represent transformative tools to steer economic development towards a more sustainable, resilient, inclusive and competitive future.

These initiatives in the region show that climate action is not just about reducing emissions but choosing a new development path. The transition is about what jobs we want in the future, not just about how many jobs. It is about developing the green industries of the future. And it is about reducing air pollution and congestion in our cities and saving money – rather than imposing incremental costs. I am proud to say that the IDB is supporting countries with this innovative work to deliver on the objectives of the Paris Agreement and the Sustainable Development Goals.

Getting to Net-Zero Emissions chronicles the inspiring work underway by LAC governments to design and implement long-term decarbonization strategies and plans. There is no question that transforming our economies towards net-zero emissions will be tough. However, the evidence is growing that it is both technically possible and, with the right approach, can bring economic benefits to the region. Achieving net-zero emissions is essential to confront the climate crisis and implement the goals of the Paris Agreement.

As we conclude this decade and look ahead to the 2020s and beyond, I am confident that the design and careful implementation of these long-term strategies is not only necessary to achieve the Paris Agreement goals but can also harness technological advances needed to boost sustained and inclusive growth. Governments are the protagonists to facilitate this transition from today towards decarbonization by removing regulatory barriers, enabling and encouraging new business models and ensuring an inclusive transition.

The IDB will continue to support our LAC partners to implement their commitments under the Paris Agreement and achieve a more sustainable and inclusive development, which can improve the lives of all. A paradigm shift is required, and this publication shows the way forward: getting to net-zero emissions is necessary, it can positively contribute to development and it can be done.



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# Key messages

**1** Limiting global warming to between 1.5°C and 2°C above pre-industrial levels requires achieving net-zero emissions of CO<sub>2</sub> by around midcentury and substantial reductions by 2030.

**2** The transition to net-zero emissions is technically possible by producing zero carbon electricity; electrifying industry, transport, heating, and cooking; increasing the provision of public and non-motorized transportation; managing and regenerating natural carbon sinks; and, by improving resource use efficiency, reducing waste, and minimizing carbon intensity in construction and diets.

**3** The transition to net-zero emissions brings substantial economic and development opportunities for Latin America and the Caribbean (LAC). The cost of renewable electricity and electric mobility is dropping fast. Solar and wind are already the cheapest options in many LAC countries. Done right, the transition can bring one million net jobs in the region by 2030 and generate benefits worth several percentage points of GDP through avoiding the current loss of productivity in congestion and health impacts from pollution.

**4** The implementation of current Nationally Determined Contributions (NDCs) is insufficient to meet the temperature goal envisaged in the Paris Agreement and may lock in high-emission pathways by creating technical and economic barriers to decarbonization, including future asset stranding. Updated NDCs could save the region \$90bn in avoided stranded assets and \$100bn in reduced investments costs just in the power sector.

**5** Long-term strategies can guide the design of more ambitious NDCs, help governments to anticipate costs, manage trade-offs, and ensure a just transition to net-zero emissions, while identifying the immediate policy reforms and investment priorities necessary to unlock the transformation.

**6** Latin America and the Caribbean is producing compelling evidence on how to work with stakeholders from government, civil society, academia and the private sector to design long-term strategies that integrate economic, social and decarbonization goals.





# Overview

## // Achieving net-zero emissions by around 2050 is necessary, possible and beneficial to development

The Inter-governmental Panel on Climate Change (IPCC) indicates that meeting the Paris Agreement's goal of limiting the global temperature rise from pre-industrial levels to between 1.5 and 2 degrees Celsius requires **reaching net-zero emissions of carbon dioxide (CO<sub>2</sub>) between 2050 and 2070, as well as deep reductions in the emissions of other greenhouse gases (GHGs).**

**Getting to net-zero emissions of CO<sub>2</sub> is technically possible.** Governments, academics, think tanks, and international agencies agree that it can be done through actions around four central pillars: (i) producing zero carbon electricity (e.g. through a large-scale rollout of energy from renewable sources); (ii) undertaking massive electrification (e.g. deployment of electric vehicles and electric cooking stoves) and switching to other carbon-free fuels; (iii) increasing the share of public and non-motorized transportation; (iv) halting deforestation and protecting and regenerating natural carbon-rich ecosystems. In addition, countries will need to improve efficiency and reduce waste across all sectors, particularly from energy and food consumption, and switch to less carbon-intensive industrial processes, building materials and diets.

**The costs of zero carbon technologies are dropping rapidly whereas business as usual is becoming more expensive and exposed to transition risks including asset stranding.** Renewable energy is now the cheapest form of electricity in many countries, following a fivefold reduction in costs over the last decade. The cost of batteries for electric vehicles has also seen a six-fold reduction in just eight years, which is expected to continue.

**The transformation to net-zero emissions can bring economic opportunities and contribute to delivering on the Sustainable Development Goals.** The OECD suggests that decisive action taken now towards decarbonization, if accompanied by structural policies, could increase GDP in 2050 by up to 2.8% on average across G20 countries. The ILO also says that one million net jobs could be created in Latin America and the Caribbean (LAC) by 2030 in the process. Actions to decarbonize can also help overcome development gaps. For example, transport systems relying more on public transport and electric vehicles can improve the quality of life for citizens of LAC countries and bring several percentage points of GDP worth of benefits through reducing time lost in congested roads and minimizing the health impacts of air pollution.

## // Several challenges need to be carefully addressed

**The current round of emissions reduction pledges outlined in the Nationally Determined Contributions (NDCs) are insufficiently ambitious to achieve the Paris Agreement goals.** IPCC scenarios compatible with the global temperature objectives imply substantial reductions of CO<sub>2</sub> emissions by 2030, which go far beyond existing collective targets put forward by countries in the context of the UN Climate Change Conference in Paris in 2015. Furthermore, policies, laws, and

investments for implementing existing NDCs could lock in high-emission pathways and create new technical and economic barriers to decarbonization. A significant risk is that long-lived assets, such as energy and transport systems, built in compliance with NDCs could become “stranded” (i.e. abandoned with consequent significant economic losses), when climate ambition is eventually increased. If the goals of the Paris Agreement are to be met, it is crucial that the updated NDCs, to be submitted in 2020, are consistent with country-specific pathways towards net-zero emissions.

In LAC, implementing current NDCs and correcting course in 2030 to reach carbon neutrality by 2050, would create USD 90 billion worth of stranded assets in the power sector. Doing so would also require USD 100 billion more in power plant investments than a transition starting from more ambitious NDC targets.

**The transition towards net-zero emissions potentially creates winners and losers, with negative social impacts if not carefully addressed.** The potential negative impacts on consumers, workers, communities and businesses include those related to phasing out or downsizing economic activities that are inconsistent with net-zero emissions, e.g. the production of fossil fuels or cattle. The short-term impact of removing energy subsidies or introducing environmental taxes that increase the cost of food and basic services are also important issues. These impacts need to be anticipated, minimized, and compensated by targeted policies and complementary measures. Furthermore, international evidence suggests that the social acceptability of reforms requires the consultation of stakeholders and communication campaigns before implementing reforms.

**Deep decarbonization will also affect sectors that contribute towards a country's fiscal revenues.** Fiscal sustainability is essential to the political feasibility of the reforms needed for transformational

approaches. For instance, the adoption of electric vehicles would typically reduce revenues from gasoline and diesel taxes, which can represent more than 10% of fiscal revenues in countries such as Costa Rica or Uruguay. It is necessary to anticipate these changes to allow for alternative fiscal measures to be planned and implemented. At the same time, the revenues that governments in LAC derive from oil production and exports, a key source of government funding in countries such as Ecuador and Venezuela, could be reduced by USD 4 trillion over the 2020–2035 period because of the global transition towards net-zero emissions. Ministries of Finance of oil-exporting LAC countries need to be aware of this transition risk and take measures to mitigate it.

**Current regulations can undermine the implementation of low-carbon options by the private sector.** The prevailing market organization of entire sectors may be intrinsically linked to incumbent technologies, practices, and business models. For instance, the LAC public transport sector tends to rely on small-scale operators that may struggle to bear the higher upfront cost of electric buses, even if these vehicles make greater financial sense over their lifetime. Governments will need to change the rules of the game and let new business models emerge.

**Current prices may send the wrong signal.** The IMF estimates that, at the global level, varied forms of energy subsidies stood at USD 5.2 trillion (6.5% of GDP) in 2017, with LAC accounting for 5% of global energy subsidies. On the other hand, the abrupt increase of prices, due to subsidy removal or environmental taxation, could hurt poor and vulnerable consumers, disrupt business models, create stranded assets, and lead to business closures and jobs losses. Any significant price change needs to be phased-in and accompanied by measures to help the most affected groups manage the transition.





## // Long-term strategies can help governments plan for net-zero emissions, anticipate and manage trade-offs, update NDCs, and design policy and investment roadmaps needed to enable the transition

As part of the Paris Agreement (Art 4.19), by 2020 Parties are expected to formulate and communicate long-term development strategies to reduce greenhouse gas emissions. **Long-term strategies (LTSS) should establish a country's vision of specific development outcomes associated with deep decarbonization**

by mid-century, and identify the sectoral pathways to get there, so as to guide the design of more ambitious NDCs.

Many countries in LAC have established processes for developing national decarbonization plans. Costa Rica published its national decarbonization plan in February 2019. This plan is one of the first to map out a comprehensive transition to net-zero emissions by 2050, including setting out a sequenced policy package. In 2019, twenty-one countries in LAC have announced that they are working towards achieving net-zero emissions by 2050.

**Several key principles have emerged in recent years to guide the elaboration of long-term strategies.** These include the integration of all development goals, beyond decarbonization, as well as the participation of multiple stakeholders from civil society, the private sector and

government from inception through to implementation. Back-casting from a 2050 vision to the present day helps identify the public policy, planning and investment choices needed to achieve this vision, particularly for long-lived infrastructure, as well as an appropriate sequence of policy actions for a just and inclusive transition.

These principles have guided the design of the **Deep Decarbonization Pathways in Latin America and the Caribbean (DDPLAC)** project led by the IDB, in partnership with the 2050 Pathways Platform and the Agence Française de Développement (AFD), and drawing on the experience of the Institute for Sustainable Development and International Relations (IDDRI). Under this project, domestic universities and think tanks from six LAC countries (Argentina, Colombia, Costa Rica, Ecuador, Mexico, and Peru) are investigating national decarbonization pathways. The teams are using models describing the energy, agriculture and land-use systems built in partnership with international experts, creating a regional peer-to-peer exchange platform, and discussing decarbonization scenarios with policymakers, civil society, and other stakeholders in their countries.

**The pathways confirm that decarbonization can be achieved alongside economic growth.** In all six countries analyzed in the DDPLAC project modelling teams have developed scenarios where GDP per capita increases steadily by 2050 while emissions are reduced by 55-100%. In the case of Costa Rica, decarbonizing the transport sector will bring total net benefits of nearly USD 20 billion by 2050 as a result of the reduced negative impacts of air pollution on health, time saved from reduced congestion, fewer accidents, and lower operating costs. These benefits more than compensate for the initially higher upfront costs of switching to electric vehicles.

**Long-term strategies can help inform the re-orientation of infrastructure choices and the design of investment plans**

**to deliver the transition.** Examples of investments in the transport sector planned for 2019-2022 in Costa Rica's National Decarbonization Plan include dedicated bus lanes, intermodal stations, a network of fast charging stations, and an electric passenger train project. With priorities on investments defined, governments can identify financing gaps and possible approaches to catalyze investments.

**Long-term strategies can help build policy roadmaps to address regulatory barriers to decarbonization.** Starting from a clear vision of what they are trying to achieve, governments can focus reforms on enabling the transition to net-zero emissions. For instance, Chile has created new business models in the public transport sector to enable the introduction of electric buses, and Costa Rica is thinking about the design of a new payment for ecosystem services to incentivize reforestation and the preservation of biodiversity by private farmers.

**A long-term vision can help manage fiscal impacts.** Countries that tax gasoline consumption can progressively adjust the rate of taxes on gasoline, electricity and vehicle ownership and operation based on the targets in their decarbonization plan. For oil exporting countries, a long-term view gives time to plan the diversification of their economy and the targeting of government funding to reduce their vulnerability to changes in global fossil fuel demand.

**Long-term strategies can also help governments manage the social impacts of decarbonization and ensure a just and inclusive transition.** Chile is transforming its power sector through the progressive retirement of coal powered generation. This is being supported by a dialogue between the government and coal power plant owners, workers' unions, affected municipalities, academia, and civil society. This process has allowed for consideration of the timing of coal phase out and the potential use of compensatory policies to support the most affected communities.



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# Long-term strategies can help achieve net-zero emissions by around mid-century and guide the design of more ambitious NDCs

**//The Paris Agreement established the need to reach carbon neutrality by around 2050**

**Achieving the goals of the Paris Agreement will require systemic transformations to achieve net-zero emissions by around 2050.** The agreement aims to limit the global average temperature increase from pre-industrial levels to well below 2°C, pursuing efforts to limit it to 1.5°C, boost the ability to adapt to the adverse impacts of climate change, and make finance flows consistent with a low greenhouse gas emissions and climate-resilient development pathway.

Both the 1.5°C and 2°C targets will require reaching net-zero emissions of carbon dioxide (CO<sub>2</sub>) between 2050 and 2070, and deeply reducing emissions of other greenhouse gases (GHGs) before the end of the century. Net-zero emissions means that anthropogenic CO<sub>2</sub> emissions are balanced globally by anthropogenic CO<sub>2</sub> removals through activities such as afforestation (IPCC, 2018). To achieve net-zero emissions, the IPCC indicates that a systemic transformation is needed in the sectors of energy, cities and transport systems, and land-use and agriculture.

**Meeting either target will require a massive reduction of net GHG emissions within the next decade.** Drawing on models of emission trajectories that lead to no, or only limited, temperature overshoot, the IPCC notes that global net anthropogenic CO<sub>2</sub> emissions would need to decline by 45% from 2010 levels by 2030 to limit warming to 1.5°C, or by around 25% by 2030 for 2°C (IPCC, 2018).

**A net-zero carbon economy is technically possible.** Academics, think tanks, governments and international agencies have studied this question for years and concur that action on four fronts is needed (Clarke et al., 2014, Fay et al., 2015):

- 1** Produce zero carbon electricity (e.g. massive rollout of renewable energy combined with grid flexibility)
- 2** Undertake massive electrification (e.g. using electric vehicles, motors, heat pumps and boilers and cooking stoves), and where not possible, switch to other carbon-free fuels (e.g. hydrogen or sustainably-produced biofuels)
- 3** Increase the share of public transportation (e.g. bus or train) and non-motorized transportation (e.g. walking and cycling) in total mobility and reduce demand for transport
- 4** Preserve and regenerate natural carbon sinks (e.g. by reducing deforestation, and promoting reforestation) and the restoration of other carbon-rich ecosystems

In addition, countries will need to improve efficiency and reduce waste across all sectors, particularly from energy and food consumption, and switch to less carbon-intensive industrial processes, building materials and diets. Research confirms that action on these same pillars of decarbonization is required at the regional level for LAC (Calderón et al., 2016; Lucena et al., 2016; Vergara et al. 2015; Veysey et al., 2016).



To decarbonize on time, countries need to move on the four pillars of decarbonization in parallel. For instance, it makes sense to promote electromobility even in countries where the marginal power generation is through coal power plants, as long as the country is also advancing on decarbonizing power generation (Audoly et al., 2018).

**The transformation to achieve net-zero emissions by 2050 can create immediate and sustained economic opportunities.** For instance, the OECD (2017) suggests that decisive action taken now towards decarbonization, if accompanied by structural policies, could increase GDP in 2050 by up to 2.8% on average across G20 countries. The International Renewable Energy Agency (IRENA, 2019) also says that a large-scale shift to electricity from renewable energy would boost gross domestic product (GDP) by 2.5% and total employment by 0.2% globally in 2050. Research found that efforts to reduce emissions could result in the net creation of 24 million jobs globally by 2030, including one million net jobs in LAC (ILO, 2018; ECLAC/ILO, 2018).

**Implementing long-term emission-reduction actions will however necessitate addressing social and fiscal challenges and lifting market and regulatory barriers.** Some assets and jobs will be affected by phasing down the use of fossil-fuels, and the removal of fossil fuel subsidies could affect vulnerable consumers. Business models in the transport, agriculture or energy sectors could be disrupted by carbon prices or the removal of subsidies. Also, decarbonization will affect sectors that contribute towards a country's fiscal revenues, be it through gasoline and diesel taxes, or through oil royalties.

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**“** *The transformation to achieve net-zero emissions by 2050 can create immediate and sustained economic opportunities.*

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## // Early action is key to avoid carbon lock-in and stranded assets

**Infrastructure and equipment that produce emissions often have lengthy lifespans, making long-term decarbonization targets relevant to investment decisions today.** For instance, cars can be used for more than 15 years, and power plants for more than 40 years, while transport systems and human settlements can last even longer (Davis et al., 2010; Tong et al., 2019). This means that deploying carbon intensive infrastructure or equipment today may lock in emissions for 2030, 2050, and beyond.

**Globally, existing fossil-fuel energy infrastructure in 2018 is at odds with the 1.5°C target** (Tong et al., 2019). If operated as originally planned, existing fossil-fuel infrastructure, including power plants, industrial plants, and transport equipment, will cumulatively emit more than 650 GtCO<sub>2</sub> over their lifetimes. These so-called *committed emissions* are already greater than what the IPCC estimates can be emitted globally to stay below 1.5°C (420–580 GtCO<sub>2</sub>). To meet the global temperature targets, some of the existing infrastructure will need to be retired early or be retrofitted with carbon capture and storage technology, which is yet to become commercially viable.

In the case of Latin America and the Caribbean, IDB research puts committed emissions from the power sector at 6.9 GtCO<sub>2</sub> (González-Mahecha et al., 2019). This is more than the emissions for the LAC power sector consistent with limiting temperature increases to 2°C or 1.5°C CO<sub>2</sub> according to the average scenario reviewed by the IPCC (approximately 6.5 and 5.4 GtCO<sub>2</sub>, respectively). Worse, building all the planned or announced fossil fuel power plants in the region would bring committed emissions to 13.6 GtCO<sub>2</sub>, approximately doubling the current amount of committed emissions.

Many technology choices that marginally reduce emissions, such as using natural gas to replace coal power plants, or efficient gasoline cars to replace inefficient gasoline cars, would still lead to substantial committed emissions. In LAC, natural gas already represents 52% and 63% of committed emissions from existing and planned power plants, respectively. Replacing planned coal plants with natural gas plants would only reduce committed emissions by around 10% (González-Mahecha et al., 2019). To avoid carbon lock-in, therefore, governments need to act early on emission reductions by focusing now on options that are consistent with a rapid transition to net-zero emissions, such as electric vehicles or zero-carbon electricity.

**Future emissions from existing and planned power plants are not inevitable but avoiding them can prove politically difficult.** Closing existing power plants or reducing their utilization rate represent two ways to reduce committed emissions. Both options would mean creating stranded assets and concentrated costs for the owners of fossil fuel power plants and the workers and communities who depend on them, making the political economy of climate policies difficult to manage (Bertram et al., 2015; Vogt-Schilb and Hallegatte, 2017; Rozenberg et al., 2018).

## // Current Nationally Determined Contributions (NDCs) are insufficient

**The Paris Agreement establishes that via its NDC each country periodically communicates its efforts to reduce emissions and other actions towards the achievement of the agreement's goals.** The agreement is complemented by an ambition mechanism, which takes stock of progress every five years and expects countries to propose new and more ambitious NDCs towards the global goals.



**The current NDCs submitted around COP21 in 2015 are insufficient** since they would collectively fail to put economies on track to limiting global warming to well below 2°C (UNEP, 2018). The IPCC (2018) indicates that current NDCs will allow emissions of 52-58 Gt CO<sub>2</sub>e in 2030, in contrast to the 25-30Gt CO<sub>2</sub>e needed to reach the 1.5°C target. The creation of policies, laws and investments to support the implementation of existing and inadequate short-term targets could erect technical and economic obstacles to achieving the long-term Paris Agreement goals.

**A rapid and disorderly transition to correct the situation after 2030 would imply grave costs for economies and societies and would likely still not be able to reach the 1.5°C target.** At the global level, a pathway immediately aligned with the global goal to reach net-zero emissions by 2050 or 2070 would require 84% fewer premature retirements of power generation capacity and 56% fewer new capacity additions after 2030 to reach the 2°C target, compared with a pathway based on the current NDCs (Iyer et al., 2015). The IPCC (2018) did not find any pathway that achieves current NDCs and then decarbonizes on time to stay below 1.5°C.

Similarly, IDB research shows that, in Latin America and the Caribbean, NDCs fail to put the region on a low emission and economically prudent pathway to achieve the objectives of the Paris Agreement (Binsted et al., 2019). Implementing NDCs as they stand and correcting course in 2030 to reach carbon neutrality before 2050 would create USD 90 billion worth of stranded assets in the power sector. This trajectory would also require USD 100 billion more in investment compared with a smoother transition enabled by more ambitious NDCs.

“ *A rapid and disorderly transition to correct the situation after 2030 would imply grave costs for economies and societies and would likely still not be able to reach the 1.5°C target.* ”

## // NDCs need to be updated with an eye on the end goal

**If the goals of the Paris Agreement are to be met, the next round of NDCs to be submitted in 2020 need to reflect the need for long-term carbon neutrality, short-term actions to minimize the risk of stranded assets and substantial transformation by 2030.** The first round of NDCs rarely contemplate concrete outcomes to be achieved decades into the future, and focus instead on incremental improvement from ‘business as usual’ scenarios. These commitments now appear insufficient or even misleading.

Countries are invited by the Paris Agreement (Art. 4.19) to formulate and communicate long-term low greenhouse gas emission development strategies. This invitation to submit long-term strategies (LTSS) is an opportunity to prepare and present by 2020 national pathways leading to net-zero global emissions between now and around 2050.

**Countries in LAC are already making concrete progress and are going through, or have already gone through, the process of establishing such long-term strategies.**

As of November 2019, Mexico remains the only country in LAC, and one of only a few developing countries, that has

communicated an LTS to the UNFCCC. It aims at halving emissions by 2050 and explores possible pathways to do so. Chile has announced a target to reach net-zero emissions in 2050, a goal that could be enshrined into a new climate change law. Costa Rica revealed its national decarbonization plan in 2019, which is one of the first in the world to map a transition to net-zero emissions by 2050, including a comprehensive policy roadmap (Gobierno de Costa Rica, 2019). During the UN Climate Action Summit in September 2019, 21 LAC countries, alongside others from around the world, announced that they are working towards achieving net-zero emissions by 2050. These include Antigua and Barbuda, Argentina, The Bahamas, Barbados, Belize, Chile, Colombia, Costa

Rica, Dominica, the Dominican Republic, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, and Uruguay (Kosolapova, 2019).

“ *Countries in LAC are already making concrete progress and are going through, or have already gone through, the process of establishing such long-term strategies.* ”





## // Key principles for the successful development of long-term strategies

Lessons learned from past experiences and analysis provide advice for the design and implementation of LTSs and their relevance for guiding an increase in the ambition of the NDCs (Fay et al., 2015; Bataille et al., 2016; Williams and Waisman, 2017; Levin et al., 2018; Climate Analytics, 2019; Cox et al., 2019). Key recommendations stemming from these initiatives are summarized below.

**The design of LTSs should integrate all development goals, beyond the goal of decarbonization, and all relevant stakeholders should be involved in their elaboration.** If they make the need to protect vulnerable populations and sectors during the transition integral to their analysis, LTSs can describe what is required to achieve a net-zero emission economy while addressing the economic, financial, social, environmental and institutional dimensions of sustainable development (IDB and IDB Invest, 2018).

The complexities and political sensitivities of designing LTSs, and the transformations they entail, demand extensive consultation and dialogue from the outset through to implementation. Key stakeholders include government entities responsible for the design and execution of the LTSs, and those who will be most affected by them, such as sector associations, firms, energy utilities, unions, researchers, indigenous communities and civil society groups.

LTSs should build on academic and analytical work to investigate the technical, economic and social dimensions of decarbonization scenarios, using sectoral and macro-economic modelling tools. Any analytical simulation should be developed in a way that produces inputs for the policy discussions and can be understood

and accepted by a working majority of stakeholders.

**The details of the physical transformations should be explicitly described.** LTSs should aim to translate emission reduction efforts and socio-economic goals into a description of the technical and socio-economic transformation required to support them, such as the share of mobility needs satisfied by electric buses in 2030, or reforestation rates in 2040 (Waisman et al., 2019). The analysis should start from a description of current conditions and develop economy-wide and sectoral indicators that help stakeholders develop an understanding of what the transition to a decarbonized future requires in terms of a timeline for behavioral changes (e.g. concerning diets or preferred mobility modes), infrastructure stocks (e.g. power plant mix and composition of the vehicle fleet), technology deployment (e.g. market share of electric cars), and investments needed.



**The end goal of an LTS is to create a roadmap for the policy reforms and investment steps needed to reach a decarbonized economy by around 2050.** The long-term effects of infrastructure and equipment choices, and the social and economic impacts of transformation policies, need to be carefully anticipated.

## // Building an informed process and creating space for dialogue to design long-term strategies

**The Deep Decarbonization Pathways in Latin America and the Caribbean (DDPLAC) project supports academia and think tanks in six LAC countries to implement the above principles.** This ongoing project is led by the Inter-American Development Bank (IDB), in partnership with the 2050 Pathways Platform and the Agence Française de Développement (AFD). The Institute for Sustainable Development and International Relations (IDDRI), meanwhile, provides technical coordination, building on the experience of the previous Deep Decarbonization Pathways Project (DDPP). The original DDPP was an international research collaboration designed to inform the negotiations that led to the Paris Agreement. It explored how 16 countries representing 74% of global CO<sub>2</sub> emissions could transition to a low-carbon economy consistent with limiting warming to less than 2°C while achieving other socio-economic objectives (Bataille et al., 2016; Waisman et al., 2019).

The objective of the DDPLAC project is to equip in-country teams with tools and methodologies for the development of decarbonization pathways. Through DDPLAC, different scenarios of decarbonization were investigated based on numerical models by national academia or think tanks, benefitting from the support of international expertise.

DPLAC also facilitated a dialogue between researchers and national decision-makers, to ensure that researchers understand the needs of policymakers, and that the results of their long-term analysis can be considered by governments wishing to design long-term strategies or update their NDCs. The project also worked as a forum for exchanges of experiences among the country teams, and among academic and institutional actors across the region.

In 2018 and 2019, six teams comprising national academics and international research expertise working in Argentina, Colombia, Costa Rica, Ecuador, Peru and Mexico, participated in the ongoing DDPLAC project (Box 1). Country teams will publish more in depth and complete findings in 2020, but some of their initial insights are gathered here.

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# Box 1

## DDPLAC country teams and main lines of work

The Argentina team comprises the Bariloche Foundation (an associated unit of CONICET), and the CIRED, a France-based development research institution on environment and development. The analysis uses both a bottom-up energy model, LEAP, and a country-scale computable general equilibrium model, IMACLIM. Together, these models analyze energy system scenarios compatible with deep emission reductions and their macroeconomic implications. A historical socio-economic scenario was defined, alongside an aspirational decarbonization scenario reflecting changes in the productive structure, per capita income and development standards.

In Colombia, researchers from the Universidad de los Andes and the Universidad del Rosario have joined efforts with colleagues from the University of Maryland. They are furthering the development of the Global Change Assessment Model (GCAM), providing details for Colombia, so that the analysis of deep decarbonization pathways for the country can be done within global scenarios. All the emitting sectors are being modeled, and three CO<sub>2</sub> trajectories are being assessed: an NDC-extended scenario, and scenarios that reduce emissions by 30% and 90% by 2050, compared with 2015 levels.

In Costa Rica, the University of Costa Rica has partnered with the Swedish Royal Institute of Technology, to develop an open source energy model for the country using the Open Source energy Modelling System (OSeMOSYS) tool. The focus of the collaborative work is to inform policymakers of technical options to decarbonize energy production and uses, particularly for the transport sector, which, in 2012, when the last inventory was produced,

represented 44% of the gross emissions in Costa Rica. The project also analyzes the cost and benefits of decarbonizing the transport sector from the perspective of users, government and operators.

In Ecuador, the Escuela Politécnica Nacional, with the technical assistance of the Federal University of Rio de Janeiro, developed the Ecuador Land Use and Energy Network Analysis Model (ELENA), which is a long-term integrated energy and land use model based on the internationally established MESSAGE model. The ELENA model allows alternative approaches to decarbonizing the energy matrix to be assessed, looking with special interest into the transport sector, which consumes approximately half of the final energy in Ecuador. The model can also evaluate reforestation and deforestation scenarios.

In Mexico, Tempus Analítica, a think tank focusing on climate change policy, has partnered with Evolved Energy Research, a consulting firm founded to address the energy sector challenges that stand in the way of preventing climate change. The team is using EnergyPATHWAYS, a state-of-the-art analytical tool, to build a granular representation of Mexico's energy system, and RIO, an optimal capacity expansion model, to develop a range of scenarios, taking into consideration the interaction between power generation, transportation, industry, and the fossil fuel sector. Concrete milestones towards achievement of the Paris Agreement goals are being identified for these sectors, which provide insights into the short-term policy actions needed to achieve the desired long-term goals in respect to energy transition.

In Peru, the Universidad del Pacifico, partnering with the University of Tennessee, is developing the first integrated land-use model for Peru. The main objective is to assess GHG emission reductions through interventions in the forest and agricultural sectors. To complement this work, decarbonization strategies in the transportation and energy sectors are also being evaluated.

Together, the experience of LAC countries, specific experiences from the DDPLAC project, and various research studies commissioned by the IDB and other institutions, provide valuable insights from LAC on the elaboration of LTSS. These include detailed scenarios and analysis on the sectoral transformations required to achieve decarbonization in an economically beneficial and just manner, as well as policy packages to support these transformations. The following sections discuss these insights.





## 2

## Building long-term decarbonization strategies with economic and social goals at their heart

**//The participation of a broad set of stakeholders is crucial to designing and implementing strategies that are both relevant to the country context and socially acceptable**

Stakeholder engagement is essential when designing, assessing, and implementing decarbonization pathways to ensure that the perspectives of all the relevant actors are considered, to account for different development goals, and to understand what changes could be viable and what the barriers are to decarbonization in the specific country context. This early engagement can also strengthen ownership of LTSs amongst stakeholders and their support during implementation.

In Costa Rica, the decarbonization plan was designed through a participatory process. The government first distributed a concept note for the plan, laying out principles like those discussed above, setting the goal to decarbonize the economy by 2050, and taking stock of current emissions trends and their drivers. From there, the government convened sectoral workshops to gather feedback and comments. The inputs from the different stakeholders were then used to define a series of climate actions that would contribute to meeting the 2050 target. Those discussions were informed by results of the quantitative analyses of the energy and transport systems provided by the Costa Rican DDPLAC team.

In Colombia, the government has issued a roadmap for the construction of the Colombian long-term strategy, called Strategy 2050. The roadmap includes the design and implementation of a participatory structure that seeks to collect inputs from public and private actors in all relevant sectors, civil

society, territories, non-governmental organizations, and academia, in terms of both what the strategy should aim to achieve and related options. Additionally, a panel of experts has been convened to generate recommendations in the strategy construction process. The DDPLAC team is part of this process, to provide inputs to the construction of the Strategy 2050, with a focus on stakeholder engagement and uncertainty analysis (Lempert, 2018; Sato and Altamirano, 2019).

**//National development priorities and a broad socio-economic vision should underpin the design of the long-term strategies**

Deep decarbonization scenarios developed in the context of the DDPLAC project start from a socio-economic vision and are underpinned by priorities specific to the country. Storylines that frame the climate objective start from socio-economic objectives such as economic growth, income equality, poverty alleviation, access to services, air quality, or energy security. In Colombia, for instance, the deep decarbonization pathways that have been developed, envisage the income per capita reaching levels comparable with current values for Portugal by 2050. This increase in income sustains an improvement in standards of living and continued poverty alleviation. Energy security is reached by doubling the share of renewables in the primary energy mix, fostering bio-based fuels and using local fossil fuel resources coupled with carbon capture and sequestration technologies.

In Mexico, the DDP scenarios developed advance four social and economic development objectives. First, economic growth and job creation result from the additional investments required to implement the energy system transition.



Second, social inequality is reduced through better urban structure that increases access to services and work and education opportunities, as well as by improving quality of life and reducing journey times and energy needs for millions of workers. Third, public health benefits significantly from improvements in both exterior and interior air quality, due to the roll out of electric vehicles and electrification of cooking and heating that reduces the use of firewood. Fourth, energy sovereignty, which seeks to ensure citizens and businesses have adequate energy, will provide two sets of benefits since efficiency measures will reduce the energy intensity of GDP, and sourcing energy from abundant national renewable resources will shield the economy from international fuel price fluctuations.

In Peru, where 41% of the population of the Amazon region is poor, one of the objectives of the deep decarbonization scenario is to explore how decarbonization can reduce poverty. Options include the clear assignment of use rights for primary forest, improved participation of native communities in conservation and sustainable forest management, and increased economic attractiveness of forestry activities triggered by the sustainable management of forest concessions and commercial plantations. In Ecuador, more than 20% of the population suffers from chronic malnutrition. Its deep decarbonization scenario therefore seeks to achieve an increase in the food intake per capita of 30% between 2015 and 2050, while reducing GHG emissions from agriculture by almost 10% by 2050.

Argentina suffers from chronic macroeconomic difficulties, stemming notably from its exposure to commodity price variability and currency risks. There is little employment creation happening outside agro-exporting sectors. The decarbonization scenarios explored by the DDPLAC project therefore took into consideration options to reduce such exposure, including diversification of

exports, development of new industries and services, and global value chain improvements in niche segments.

In Costa Rica, the national decarbonization plan explicitly integrates the socio-economic issues that the country needs to address. These include the current relative disconnect between growth (driven by the service industry in this case) and employment generation, insufficient investment in infrastructure (leading to an inefficient transportation model), as well as public debt. Furthermore, the implementation of the plan itself is integrated within the economic planning and investment tools and the sectoral institutions responsible (see below).

## //Decarbonization brings economic and development opportunities

Analysis of decarbonization options in LAC shows that reducing carbon emissions does not necessarily mean limiting growth or prosperity. On the contrary, many options to reduce emissions come with immediate development benefits.

**Decarbonizing the transport sector brings opportunities to improve mobility, reduce local air pollution, and improve the quality of life.** Many cities in LAC are above the World Health Organization thresholds for the concentration of airborne pollutants. Every year, 50,000 people die prematurely in the region due to air pollution caused mainly by transport (Galarza and López, 2016). Time lost in congestion and the cost of accidents is also an expensive problem. In Costa Rica, it is estimated that time lost due to congestion, accidents, and the health impacts of local air pollution cost the country 3.8% of GDP annually (EN, 2018). LAC's transport sector is also the largest and fastest-growing source of carbon emissions in the region with a



rapidly growing car fleet, set to triple in size over the next 25 years (GlobalData Energy, 2017).

Moving to efficient public transport systems and to electric vehicles could be one of the greatest opportunities to support the transition to net-zero emissions while bringing substantial benefits to the economy and society. An effective urban transport system based on electric buses can cut congestion, accidents and local pollution while taking advantage of clean electricity and saving money. If the current fleet of buses and taxis in Latin America's biggest 22 cities went electric, the region could save USD 64 billion in fuel costs and prevent 300 million tons of carbon dioxide equivalent from entering the air by 2030 (UN Environment, 2018). In Costa Rica, the DDPLAC team found that decarbonizing

the transport sector will bring net benefits of about USD 20 billion to the country by 2050, with lower operational costs, time saved in congestion, reduced health impacts and reduced accidents compensating the initially higher costs of electric vehicles (Presidencia de la República de Costa Rica, 2019).

Complementing these benefits, the cost of electric transportation is decreasing

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“ Analysis of decarbonization options in LAC shows that reducing carbon emissions does not necessarily mean limiting growth or prosperity. On the contrary, many options to reduce emissions come with immediate development benefits.

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rapidly. Lithium-ion batteries became five times cheaper between 2010 and 2017, and are expected to become even cheaper, making electric vehicles more affordable than internal combustion engine vehicles in the near future (Bloomberg New Energy Finance, 2019).

**The region is ideally suited to embrace the transition to a power grid with 100% renewable energy.** Overall, the region already possesses some of the cleanest power grids in the world due to the extensive use of hydropower. While solar and wind-based electricity generation currently plays a marginal role, the region faces no shortage of potential: the solar and wind potential in the region are sufficient to cover current electricity needs 37 and 16 times over respectively (Paredes, 2017). LAC could therefore get to 80% renewable electricity by 2030 in an affordable way, making use of abundant

wind and solar resources as their cost continues to decrease, and using thermal power and large hydropower facilities – provided hydrological conditions remain favorable – as a means to balance the system. If LAC countries strongly backed renewable energy, the region would save USD 7 billion compared to the current trajectory (Paredes, 2017). The International Energy Agency confirms that technical and operational solutions exist to integrate variable renewable electricity into the grid, using fossil fuel power plants, interconnections, and pumped hydro to provide flexibility; with battery (and perhaps hydrogen) storage and demand-side management supported by digitalization probably playing an increasing role in the next decades (IEA, 2018).

The falling costs of solar and wind energy technology and production make the economic case for decarbonizing energy supply. Between 2010 and 2017, the global average cost of generating electricity with new plants has dropped from USD 360 to USD 10 per megawatt-hour for photovoltaic and from USD 80 to USD 60 for onshore wind (IRENA, 2018). In the region, auctions have awarded contracts at USD 30 per MWh for PV solar in Mexico, Peru and Chile, and for wind in Mexico, which are among some of the lowest costs globally (IRENA, 2018). Costs are also expected to continue to fall, with new renewable power in LAC expected to be USD 10-30 per MWh cheaper than existing fossil-fueled power by 2025 (Vergara et al., 2015).

Announcements of foreign direct investments in renewable energy in LAC already outpace those for coal, oil and gas (ECLAC 2019). LAC represents an estimated USD 1 trillion of clean energy investment opportunities by 2040, of which USD 600 billion is expected to materialize by 2030 (Bronder and Grossmann, 2016). Those investments come with jobs: Brazil presently has close to 15,600 jobs in solar PV, mostly

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**“** *The falling costs of solar and wind energy technology and production make the economic case for decarbonizing energy supply.*

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in construction and installation (IRENA 2019a). A further 15,000 new jobs are to be created as Brazil installs 1 GW of solar capacity in 2019.

**The forestry and agricultural sectors can benefit from nature-based solutions** (Bronson et al., 2016). The region is home to around 22 percent of the world's forest area and is described as a “biodiversity superpower” accounting for key environmental services and containing an astonishing number of species (Bovarnick et al., 2010). Of the world's seventeen megadiverse countries,

six (Brazil, Colombia, Ecuador, Mexico, Peru, and Venezuela) are in the region. It has an estimated 31 percent of the earth's freshwater resources (UNEP, 2010), a quarter of the world's medium to high potential farmland and is already the world's largest net food exporting region (Truitt Nakata and Zeigler, 2014).

This unique source of natural capital generates important life-supporting benefits for people, referred to as ecosystem services (IPCC, 2019). The OECD (2019) estimates that global ecosystem services delivered by biodiversity, such as crop pollination, water purification, flood protection and carbon sequestration, are worth an estimated USD 125-140 trillion per year. Conversely the “cost of inaction” on biodiversity globally is very high, up to USD 31 trillion per year owing to land-cover change and land degradation. Latin America still loses the most tree cover every year with the expansion of the agricultural frontier. This is driven by the demand for agricultural commodities related to international trade, such as livestock, feed and food crops (FAO 2016; Rocha et al., 2019). Global Forest Watch data shows that four of the top ten countries for tropical tree cover loss in 2017 were in Latin America.

Payments for ecosystem services can promote reforestation, reignite economic activity in rural areas and improve forest management and economic practices. The securing of land rights for indigenous communities can make a major contribution to sustainable economic development while slowing deforestation. Tenure-secure indigenous forestlands exhibit low deforestation rates in Bolivia, Brazil, and Colombia. These areas provide benefits including regulation of local climate dynamics and water cycling, hydrological services, pollination, nutrient retention, existence values, and recreation and tourism values. These benefits are estimated to range between USD 679 and USD 1,530 billion for the next 20 years (Ding et al., 2016).





## //The costs and social impacts of transition to decarbonization need to be addressed

**While decarbonization comes with opportunities, the benefits of the transformation may be unevenly distributed socially or geographically, and social impacts must be carefully managed.** The potential effects include the impacts on workers and communities of transforming entire sectors of the economy (for instance phasing out fossil fuel extraction and closing down fossil fuel power plants), and the impact on consumers of energy or food price rises due to the introduction of policies, such as environmental taxes or removal of fossil fuel subsidies, that governments may put in place to incentivize the transition to a decarbonized economy.

Unmanaged impacts on specific communities and groups could jeopardize political support for emission-reduction policies (Vogt-Schilb and Hallegatte, 2017). Balancing potential winners and losers, and ensuring an inclusive and just transition, is a necessity for both ethical and political reasons (Trebilcock, 2014).

**Social dialogue is key to minimizing and addressing the social impacts of the phasing out of carbon-intensive industries.** The Chilean government is discussing options to progressively retire or transform coal power generation. To inform this discussion, the government convened a working group that has commissioned studies on technological, financial, economic, and social aspects of the coal phase out plan, to be discussed between coal power plant operators, workers unions, municipalities hosting coal power plants, academia, government, and civil society. IDB research has found that phasing out coal could result in the net creation of between two and eight

thousand jobs in Chile by 2030, especially in the power sector (Viteri Andrade, 2019; Vogt-Schilb and Feng, 2019). While the macroeconomic impact is positive, four thousand jobs could disappear in the communes with coal-fired power plants by 2030 or 2050, depending on the scenario. In the most affected municipalities, up to 7% of the population works in a coal power plant. Social dialogue gives time to anticipate this impact and manage it.

Even if they have a positive impact overall, decarbonization strategies may need to be accompanied by policies at the local and national levels to help negatively affected communities and workers cope with job losses (ILO, 2018). Options include (i) access to general-purpose social protection and workforce benefits; (ii) adjusting the timing of the phasing down to take advantage of the natural retirement of workers, thus smoothing the impact on local job markets; (iii) implanting renewable power plants or the industry that supplies the parts for these in the same communities where coal is being phased down; or (iv) retraining to meet the additional demand on jobs in the renewable and manufacturing sectors induced by switching from coal to renewables (Altenburg et al., 2017; Green, 2018; ILO, 2018).

**Some climate policies can come with negative distributional impacts that also need to be managed.** Environmental tax reforms (including carbon pricing) and the removal of fossil fuel subsidies are often advocated as powerful measures to incentivize the transition to net-zero emissions (Stiglitz and Stern, 2017; Coady et al., 2019, IMF, 2019). These policies, however, could aggravate poverty by increasing the cost of gasoline and diesel, food, electricity, and public transport.

The good news is that those impacts can be managed. One option to compensate affected consumers is to use existing cash transfer programs. Cash transfer is one of the most efficient ways for delivering social

assistance, and most countries in LAC are already experienced with cash transfer programs (Bastagli et al., 2016; Ibararán et al., 2017). IDB research shows that cash transfers are much more cost-effective than energy subsidies: in the region, it costs typically about ten dollars to transfer one dollar to a poor household using energy subsidies, while it only costs two dollars to do the same using a cash transfer program (Feng et al., 2018; Schaffitzel et al., 2019). Using 30% of revenues from a carbon tax to expand the number of beneficiaries or the amounts disbursed with existing cash transfer programs would typically be enough to compensate poor and vulnerable households – leaving more than 70% of carbon tax receipts to fund other priorities (Vogt-Schilb et al., 2019).

Another option is to use in-kind transfers. Most of the impact on households of

carbon taxes and the removal of energy subsidies comes from the impact on the cost of food, public transport, natural gas and LPG, and electricity in the countries where it comes from fossil fuels (Feng et al., 2018; Dorband et al., 2019; Vogt-Schilb et al., 2019). To shield vulnerable households, governments can focus on providing those items at affordable prices for poor households, for instance using reforms of public transport tariffs, free school meals, food and LPG vouchers for poor households, or electricity lifelines (Rentschler and Bazilian, 2017; Schaffitzel et al., 2019).

Whatever the compensation mechanisms chosen, experience shows that communicating the purpose or the reform and co-constructing compensation mechanisms with key stakeholders before the reforms are paramount steps to





enhancing the social acceptability of price increases (Rentschler and Bazilian, 2017; Whitley et al., 2018; Coady et al., 2019).

Another issue with tax reforms and subsidy removals is that they may precipitate stranded assets (Jenkins and Karplus, 2017; Rozenberg, Vogt-Schilb, and Hallegatte, 2017; Waisman et al., 2019). By making the use of polluting equipment more expensive, carbon taxes and energy subsidy removals discourage its use and may even encourage its owners to discard it. To avoid this issue, governments can select policy instruments that minimize abrupt disruption, such as performance or energy efficiency standards and feebates schemes that redirect investment toward zero-carbon capital without affecting directly those responsible for today's emissions.

**Deep decarbonization, both domestically and at global level, affects sectors that contribute towards a country's fiscal revenues.**

For example, since the adoption of electric vehicles will reduce revenues from gasoline and diesel taxes, which can represent more than 10% of fiscal revenues in countries such as Costa Rica or Uruguay, it is necessary to anticipate these changes to allow for alternative fiscal measures to be phased in. Solutions include the gradual increase of gasoline taxes to compensate for an eroding base, taxing electricity instead of gasoline, taxing vehicle ownership rather than fuels, and where possible, using distance and location-based charges that capture the external cost of driving on congestion, accidents and road damage (IEA, 2019). On the other hand, countries such as Colombia, Ecuador, Mexico, Trinidad and Tobago, and Venezuela depend on fossil fuel production and exports to fund the government (OECD et al., 2019). The proven and possible reserves of oil, gas, and coal worldwide already contain more than twice the amount of carbon than can be released into the atmosphere in scenarios aligned with the 2°C target (McGalde and Ekins, 2015), however, and

existing and sanctioned oil extraction projects worldwide would already extract more oil than is consistent with the 1.5°C target (CTI, 2019). In the region, 66% to 80% of proven, probable, and possible oil reserves will stay unexploited by 2035 if global oil demand follows what the IPCC projects would be consistent with global temperature targets. In that case, the revenues that governments in LAC will derive from oil between 2020 and 2035 could be reduced by USD 4 trillion (Baltazar Solano-Rodriguez et al., 2019). Anticipating the transition is key to plan a diversification of the fiscal base and export revenues.

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### 3

## Long-term strategies can help identify transformational pathways to achieve decarbonization and development goals





## // Short-term transformations are required in transport, power generation and land-use

Latin America and the Caribbean was responsible for 4 billion tonnes of CO<sub>2</sub>eq emissions in 2014, approximately 8% of the world's total, making the region's per capita emissions almost identical to the global average (WRI-CAIT, 2019). When looking at all greenhouse gases (GHGs), the composition of LAC's emissions is unique in so far as agriculture (23%) and land-use change and forestry (19%) account for nearly half of its total emissions versus an average of 11% and 7% respectively for the world. Many of the emissions from agriculture are in the form of methane or nitrous oxide. Those are important GHGs, and governments need to act to reduce them as much as possible. Nonetheless, according to the IPCC (2018), carbon dioxide has a special role to play in that global emissions of CO<sub>2</sub> need to get to net-zero by 2050.

As in the rest of the world, energy generation and transport are the main sources of CO<sub>2</sub> emissions in the region. Moreover, CO<sub>2</sub> emissions from fossil fuel combustion is the most important driver of an upward trend in total GHG emissions. Between 1990 and 2014, CO<sub>2</sub> emissions from fuel combustion grew by 87%. The carbon intensity of energy use increased in LAC by 5% from 1990 to 2014 due to a declining share of biomass and hydropower in the energy mix and higher use of coal and natural gas. Total emissions have grown faster than GDP in many LAC countries, which have struggled to decouple the economic model from a high-carbon path (OECD et al., 2019).

**The DDPLAC teams have explored technical pathways that their countries could follow to reduce emissions while continuing economic growth and**

**achieving other development goals.** Their scenarios find technical means to reduce net CO<sub>2</sub> emissions from energy supply and demand to 0-2 tCO<sub>2</sub> per capita by 2050, down from 1.8-4.6 tCO<sub>2</sub> per capita today. These country-level transformations largely follow the characteristics of the transformations the IPCC says are needed at the global level (Clarke et al., 2014). They rely on using clean electricity, adoption of electric vehicles, sustainably produced biofuels, and other clean energy carriers, as well as strong improvements in energy efficiency and carbon sinks (forests, vegetation and soils).

**Current NDCs in the DDPLAC countries are not aligned with deep decarbonization pathways.** The DDPLAC project invited the teams to compare the NDC scenarios to deep decarbonization scenarios, in order to assess the adequacy of the NDCs and how they could be aligned with the long-term decarbonization goal. Altogether, emissions from fossil fuel combustion for all the DDPLAC countries except for Peru (which only addressed land-use emissions at this stage) would be 700 MtCO<sub>2</sub> in 2030 in the NDC scenarios, and 600 MtCO<sub>2</sub> under the deep decarbonization scenarios, showing a 100 MtCO<sub>2</sub> gap. One exception is Costa Rica: its NDC is deemed to be consistent with the 2°C target. Costa Rica, however, now has the ambition to reduce emissions at a pace consistent with the 1.5°C target. To do that, it will need to update its NDC to align it with the 2030 targets of its national decarbonization plan.

**Current NDCs are not consistent with the necessary transformations.** In Colombia, the DDPLAC team finds that the NDC scenario might lead to 30% of fossil fuel power in the power matrix by 2030, while the deep decarbonization scenarios can accommodate only 10-17% of fossil fuel power. In Mexico, the NDC aims at reaching 43% carbon-free electricity by 2030, while the ir Deep Decarbonization Pathway (DDP) finds that 65% of electricity generation should be carbon-free by 2030. The analysis

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**“** *The DDPLAC teams have explored technical pathways that their countries could follow to reduce emissions while continuing economic growth and achieving other development goals.*

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also shows that the optimal trajectory for natural gas power depends the overall national decarbonization pathway, with electrification of transport playing a crucial role. The rapid electrification needed in the deep decarbonization pathway scenario increases power demand faster than in the NDC pathway, hence there may be a need to allow some gas assets to keep running even as renewable capacity is being built, provided that the rapid uptake of electric vehicles is well underway by 2025.

**Ongoing analysis from the six DDPLAC countries shows that three sectors are particularly important in LAC: transport, land use and electricity.** Without climate action, transport sector emissions would grow by between 28% and 327% across the six countries by 2050; while under the deep decarbonization scenarios they fall by between 78% and 99% from current levels. In 2015, deforestation represented between 1% and 83% of national emissions, while agricultural methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) represented between 7% and 43%. Reforestation and the restoration of other carbon-rich ecosystems, however, absorb large amounts of CO<sub>2</sub>, equal to between 3% and 66% of emissions. The DDP Agriculture and Land-Use Change and Forestry pathways identify that strong efforts to reduce deforestation, increase reforestation and afforestation, and limit methane and nitrous oxide can lead to dramatic changes in GHG fluxes in some countries (e.g. from -78 to -393%, i.e. into the deep net negatives). Finally, while the region currently benefits from a large share of hydropower, the deep decarbonization scenarios see large (+210-560%) increases in clean generation (e.g. wind, solar, fossil

fuel with carbon capture and storage) as being essential to allow other sectors (e.g. construction, services and industry) to decarbonize by electrifying.

## // Expanding public transport and planning transport electrification

Today, the passenger transportation sector represents between 7% and 50% of CO<sub>2</sub> emissions from fossil fuel combustion in DDPLAC countries. In the absence of policies to curb emissions, the rapid development of motorized mobility would cause emissions to grow by between 28% and 327% by 2050. Scenarios for deep decarbonization imply a significant transformation of the transport sector, necessitating far-reaching spatial planning measures, infrastructure deployment, institutional reforms and behavioral changes.

**Electrification of the fleet is key to reducing emissions.** In Mexico, the deep decarbonization simulations find that rapid electrification of the transport sector will be necessary to decarbonize, with an early emphasis on urban passenger transport. For private vehicles, at least 30% of new vehicle sales in 2030 are electric, and over 90% by 2040, implying deep changes in the industry in respect to stocking, servicing and charging these vehicles, as well as in terms of consumer choices. Achieving this presents various challenges which must be resolved simultaneously. Electricity demand will exceed the reference scenario value by 45% in 2030, and 90% in 2050, principally due to vehicle electrification, with clear implications for generation capacity roll-out.

In Costa Rica, the decarbonization plan sets the goal to reach 30% of buses being zero emission by 2035, as a first step towards 85% in 2050; while the targets for private cars are 30% and 95%, respectively. In Ecuador, the deep decarbonization



scenario identifies that an increase in electric public transportation, via the deployment of electric buses, attaining approximately 35% of total mobility by 2050, is key to decarbonize. In Colombia, the deep decarbonization scenario finds that by 2050, almost two thirds of bus services should be provided by electric buses.

**Deep decarbonization scenarios imply modal shifts and reductions in distance travelled.** In the deep decarbonization pathways for Colombia, Costa Rica, Ecuador, and Mexico, public transport will represent 45% to 70% of motorized kilometers travelled by 2050 compared to often significantly lower figures (down to 30%) in scenarios without climate change policies. In Ecuador and Mexico, deep decarbonization scenarios consider how urban and infrastructure planning can reduce the distances between homes and other daily activities. These scenarios

show a reduction of kilometers travelled per capita of between 8% and 10% by 2050 compared to their baseline visions, and an absolute decrease of kilometers travelled per capita of about 10% by 2050 compared to 2010 in the case of Ecuador's deep decarbonization scenario. In Costa Rica, the decarbonization plan envisions that, by 2050, public transport should cater for most of the demand in metropolitan areas, and that non-motorized modes (including biking and cycling) should increase their contribution to 10% of mobility by 2050.

Reaching these goals will require adequate urban planning and improvements in the connectivity of the public transport system. For instance, the Costa Rican plan establishes the need for transit-oriented development, including planning urban and territorial development around multi-modal hubs, where bus and train lines intersect.

Triggering significant behavioral changes in mobility patterns will be challenging, since the trend in all countries in the last decades has seen the modal shift evolve towards personal vehicles. In Colombia for instance, the deep decarbonization scenario envisages an almost fourfold increase in public transport ridership between 2015 and 2050.

The good news is that LAC has been a pioneer in the implementation of Bus Rapid Transport Systems (BRTs) in its cities for the last two decades and is now experiencing increasing and rapid support for electric mobility. Since 2017, 14 cities, including Quito and Mexico City, have pledged to procure only zero-emission buses from 2025. In July 2019, Colombia established a goal that 100% of public vehicles purchased for mass transportation systems should be electric or zero emissions by 2035 (Congreso de Colombia, 2019). Chile is aiming at 100% electric public transport by 2040 and 40% electric private transport by 2050. Bogota, Colombia, is aiming to have nearly 600 electric buses in 2020. The Chilean capital, Santiago, now has around 400 electric buses in operation. Various other LAC cities including Guayaquil, Medellin, Panama City are also building up their own fleets of electric buses.

## // Supporting the expansion of clean electricity generation

**Decarbonization will entail a major increase in demand for electricity, while clean power becomes the norm.** The deep decarbonization scenarios envisage an increase in electricity generation of between 210% and 560% to allow electrification in the transport, buildings, services, and industry sectors, with almost all additions being solar, wind, hydropower or fossil fuels with carbon capture and storage. In these scenarios, the carbon

intensity of electricity production falls by more than 90% in all countries, to 21 grams CO<sub>2</sub>/kWh or less.

The technology mix used to decarbonize power generation varies by country, largely driven by the access to seasonally coordinated hydropower to balance wind and solar. Solar photovoltaic (PV) is the predominant energy source in the Mexican deep decarbonization scenario come 2050, and in one Argentinian deep decarbonization scenario a mixed system using nuclear, hydropower, solar and wind is modeled. Some natural gas is added for grid stability in some deep decarbonization pathways, but the amounts are minimal. In Colombia, hydro, wind, solar, biomass, and geothermal power plants will need to provide over 80% of the required power in 2050 in the deep decarbonization scenario. The remaining energy will be produced by fossil fuel power plants coupled with Carbon Capture and Sequestrations (CCS) or will require emissions to be offset through reforestation and afforestation.

Costa Rica already has a very low carbon power generation sector. The country has produced over 98% of its electricity using renewables over the last three years. The power sector needs to grow about 3.1% per year by 2050 to enable electrification of transport, however. Looking forward, the government will face trade-offs implied by various renewable options. Expanding run-of-river hydro implies increased vulnerability to climate change impacts, expanding geothermal production involves construction in national parks crucial for tourism and biodiversity conservation, whereas building conventional hydropower dams involves large emission penalties due to the land-use change. It appears that the least-cost solution for the country will revolve around deploying various technologies, which in turn will keep the electricity mix diversified and robust.

Planning will be needed to ensure enough zero carbon capacity and associated transmission lines are available rapidly and





at accessible prices, within a timescale that prevents locking in fossil fuel technologies. Extensive regional interconnections across LAC could contribute to mitigating the risks of exposure to drought periods faced by small hydropower plants by using the complementarities in rain patterns between different parts of the continent.

## // Factoring in new land-use options in economic planning

Close to half of LAC's total emissions come from agriculture, forestry and other land uses (AFOLU). Many of the largest emitters in the region have more than a quarter of their emissions originating from agriculture and deforestation, with several experiencing high levels of deforestation in recent years (FAO, 2018). Deforestation in the Amazon region plays a major role, accounting for 50% of the total emissions of Peru for example. Avoiding deforestation would provide the largest potential contribution to achieving net-zero emissions. With large-scale efforts in reforestation, restoration and measures in agriculture and animal husbandry, the total could add up to about 3 GtCO<sub>2</sub>e abated per year by mid-century. After accounting for the remaining emissions, the sector could be contributing net sinks of around 1.1 GtCO<sub>2</sub>e per year by 2050 (Vergara et al., 2015).

In the DDPLAC countries, agricultural emissions usually represent large positive flows (between 7% and 13% of national emissions) of methane and nitrous oxide from manure and fertilizer oxidation. Meanwhile afforestation, reforestation and restoration of high carbon systems equal to between -3% and -66% of national emissions, while deforestation accounts for between 1% and 83% of national emissions (most countries see some reforestation and deforestation happening simultaneously).

Stopping deforestation, enabling the intensification and transformation of farming and agricultural practices, and afforestation are at the core of the deep decarbonization scenarios analyzed in the DDPLAC project. Across these deep decarbonization scenarios, AFOLU emissions are reduced by between 78% and 393% by 2050, meaning that emissions can become net-negative.

In Peru, the AFOLU sector generated 66% of 2012 GHG emissions. The DDPLAC scenarios suggest that the sector can be decarbonized through interventions in all its subsectors. In forestry, the key policies are the assignment of right of use for primary forest, expansion of natural protected areas, provision of financial and skill-building support to native communities in respect to forest conservation, promotion of forest concessions under sustainable management, and commercial reforestation in degraded areas. In agriculture, policies with potential include the reconversion of rice to permanent crops, improvement of crop management and increase of intermittent dry systems in rice cultivation. In livestock, options include herding in natural and cultivated systems. The implementation of economic incentives and capacity building have the potential to involve native communities in the protection of more than 11 million hectares of primary forest.

Argentina's scenarios show that even radical decarbonization actions in the electricity and transport sector cannot compensate for emissions expected from agricultural and livestock production. To achieve NDC targets, the country envisages using carbon sequestration through afforestation of about 2 million hectares (from current levels of 1.2 million hectares). The Argentinian deep decarbonization scenario sees this afforestation



program gradually growing to capture 80 MtCO<sub>2</sub>/year, achieving 6 million of forested hectares by 2050. The management of agricultural and livestock quantities and qualities is also a key question; higher value-added production (such as organic, functional foods and other high-quality final food products) reduces carbon intensity, while diversification of industry and services is also found to reduce the exposure of exports to market uncertainties.

In Colombia, the deep decarbonization analyses show that intensification of livestock production is key to freeing up areas that can be used for crop production and reforestation. Moving from a current animal density of about 0.8 heads per hectare to 2 heads per hectare could free about 12 million hectares for other agricultural uses (allowing for more than doubling currently planted areas), helping also to end pressure on natural forests in some critical regions and to increase afforestation.



## 4

# Long-term strategies can help plan financing approaches, infrastructure investments and policy reforms

Once governments have a view on the gradual sectoral transformation required to deliver on decarbonization and development goals, they can use long-term strategies to plan for policy reforms, public investment, and financing approaches to promote mobilization of the multiple sources of investment required to deliver the transition, including the identification of ways to enhance private sector investment.

A long-term strategy can inform the definition of an approach to funding and financing the required investments. Sectoral targets can be translated into public and private investment and financing needs and compared to a map of available sources. This can provide clarity on investment priorities and financing options, including the desired role of public finance, private sector and financial intermediaries and international sources, considering the institutional mechanisms available.

## // Identifying and removing policy barriers to investments aligned with decarbonization objectives

Most of the investments required to decarbonize will be the responsibility of the private sector, including for instance the progressive adoption of electric cars or the deployment of energy efficient buildings for residential, commercial, and office purposes. In some LAC countries, the private sector is also in charge of providing services such as power generation, public transport, or waste management.

Current market organization can be an obstacle to decarbonization, calling for policy reforms to enable the transition. Public transport, for instance, is often provided by private bus companies in the region. Electric buses can be economical,

as they tend to have lower operating costs than diesel alternatives, but the current high cost of batteries (which can be more than half the cost of an electric bus) means higher upfront investment and longer amortization periods for bus owners. Operators also face uncertainties in respect to the long-term performance of batteries and the resale value of their investments in this new technology. Traditional small and medium enterprises, many of them composed of a single owner-driver operating on a single route, may lack technical expertise on batteries and can be too small to bear the financial risk of batteries failing.

In Chile, the solution was to reform bus concessions and develop new business models for electric public transport, separating fleet ownership and operation. Electric utilities were attributed a contract for fleet ownership, which they can manage at low cost given larger financial capacity, in-house expertise on battery technologies, and because used batteries are valuable to utilities, who can use them to provide grid services. Utilities then lease out electric buses to bus operators and drivers, who gain certainty on costs. In Santiago, 200 electric buses were introduced under this scheme in 2019, with 500 more to follow in 2020 and up to 80% of the fleet expected to be electrified by 2022.

Various countries have also introduced incentives for electric vehicles, such as exemptions or reductions in sales, environmental, and import taxes, revenue-neutral “feebates” that tax polluting cars and reward clean ones, exemptions from traffic permits and vehicle restrictions, and differentiated electricity tariffs (Edwards et al., 2018).

Sometimes, price incentives go against the adoption of low-carbon technologies. Economists have long emphasized that, in principle, a carbon price should be the preferred instrument to incentivize emission reductions at the lowest social cost (Stiglitz and Stern, 2017; IMF, 2019).



Instead of taxing carbon emissions, however, many governments subsidize fossil fuel energy (Coady et al., 2019). Removing energy subsidies would be an important first step at providing consumers and businesses with price incentives to decarbonize, as long as this is done with social consultation and compensating those negatively affected (see section 2 above).

In the power generation sector, Argentina, Brazil, Chile, Colombia, Mexico, and Peru have successfully used reverse auctions to procure renewable energy. Auctions have been found to reveal competitive prices, and they are also increasingly being used to ensure that projects are completed in a timely fashion and that intermittent renewable power is successfully integrated into the grid (IRENA, 2019b). For instance, Mexico's 2015 energy transition law established a minimum share of clean electricity generation of 25% by 2018, 30% by 2021, and 35% by 2024. To meet those goals, the government has required electricity retailers and large users to purchase clean energy certificates and has used direct procurement of renewable electricity capacity with public auctions.

Those examples are not an exhaustive list of reforms needed to enable decarbonization. The key is that clear sectoral targets for transitioning towards net-zero emissions enable the identification of the barriers that regulatory updates should remove at the sector and country level in order to unlock the transformations required.

In Costa Rica, the National Decarbonization Plan contains a list of regulatory updates and policy reforms required from the government to remove obstacles to decarbonization. It identifies more than 50 such actions for the current government to accomplish before 2022 to allow the eventual full implementation of the national decarbonization plan, including: updating business models for bus drivers to enable electrification of the fleet; analyzing

possible reforms of electricity tariffs to incentivize electrification of energy uses; introducing energy efficiency standards for residential and industrial appliances; improving the national payment for ecosystem services scheme to foster reforestation and the preservation and restoration of high-carbon ecosystems, and developing and scaling up low-carbon agriculture practices.

In Mexico, various possible short-term actions were identified by the DDPLAC team to help pave the way for the transition. These include increasing renewable energy generation targets from their current values to levels consistent with deep decarbonization – which they find to be at least 60% by 2030 and 90% by 2050, in line with other studies (Veysey et al., 2016); strengthening the focus of the Clean Energy Certificates (Certificados de Energías Limpias or CELs) mechanism to drive new investment; setting out a development process for investment in electrical transmission infrastructure so as to provide the future interconnections and enable the required expansion in renewable capacity across the country; updating the regulatory regime for urban infrastructure investment (with, for example, incentives for energy efficient housing) and introducing new enforcement mechanisms to ensure these are applied. Possible cross-cutting actions suggested also include a low-carbon fiscal reform to ensure that the tax system is aligned with decarbonization objectives, as well as ensuring that a long-term carbon price trajectory is agreed and communicated.

The DDPLAC exercise in Colombia identifies the need to create markets conditions enabling the deployment of wind and solar power and storage devices to cater for an average annual increase in electricity generation of 4.5% in the scenario aiming at carbon neutrality. Smart grids and massive demand response programs will be required, implying major changes in the current power sector structure.



On another front, the Colombian analysis recognizes that, while it is still a challenge in a peace-building context, the issuing of property rights, and their enforcement in areas where agriculture and natural forests interact, is key for stopping deforestation, as well as for intensifying agriculture given the need to invest in land infrastructure and plantings that imply long maturity periods. Likewise, for Peru, given that primary forests without usage rights experience the highest level of deforestation, regulating the rights of use appears to be a first step for a deep decarbonization strategy, acting as a foundation to expand the role of concessions for the sustainable management of primary forest and facilitating certification, traceability, and more efficient operations.

## // Identifying public investment plans to enable the transition to net-zero emissions, and an associated financing strategy

Many of the investments needed to implement long-term decarbonization strategies will be the responsibility of the public sector. In Ecuador, most of the power generation comes from the public utility. In that case, a power generation pathway developed under a long-term



strategy can simply be translated into a public power expansion plan. In Costa Rica, where the transport sector plays a key role in emissions, the national decarbonization plan contains a schedule of investments for the 2019-2022 period, including the establishment of dedicated bus lanes, the building of intermodal public transport stations, and the launch of a railway project. More generally, implementing decarbonization strategies will require public investments to be redirected.

One way to redirect public investments is to align sectoral investment plans with the long-term strategy. In Costa Rica, the decarbonization plan was drafted by the Ministry of Environment and Energy, but it assigns responsibilities to most of the other ministries. The government subsequently issued a national energy plan and a national electric transport plan,

among other sectoral plans, that each reiterate the decarbonization goals and associated sectoral targets. The Ministry of Planning is also designing a long-term national strategic development plan to 2050, that would likewise include the targets set by the decarbonization plan and provide a more comprehensive vision for the country's development. To make sure those plans are binding, governments can require that agencies in charge of implementing public investments justify within national public investment systems how the projects they execute are aligned with the decarbonization goals.

Coordinating the implementation of the policy reforms and investment needed may require institutional adjustments. The implementation of the Costa Rican decarbonization plan encompasses the creation of a team operating at the

Presidency level, to review, align, and prioritize public investment processes in coordination with the Ministries of Planning and Hacienda, specific teams to accelerate the implementation of key actions of the plan, provisions to ensure the monitoring of the plan, and coordination with all stakeholders of the climate change institutional system in Costa Rica (Presidential Environment Council, Climate Change Coordination of the Environment Sector Council, Directorate of Climate Change, Inter-ministerial Technical Committee, the Citizen Advisory Council on Climate Change and the Scientific Council on Climate Change).

Some of the public and private investments required to implement a long-term strategy might be funded externally using international funding, for instance from the Green Climate Fund or the Global Environmental Fund. International financial institutions may also finance some of the projects needed to decarbonize, especially if they are innovative in the country where they take place, or if concessional finance is able to de-risk financial plans for the private sector. Ultimately, however, domestic and international public funds represent a tiny fraction of the investment needed to decarbonize (Fay et al., 2015). The key for governments is to redirect both public and private investments, and a key role for international financial institutions can be to help reshape regulations and institutions towards that goal.

Altogether, developing a long-term strategy to support decarbonization is an essential step to develop investment

plans that can inform the mobilization of resources in the short, medium and long term. Since they set priorities in terms of infrastructure investments, policy reforms, and the institutional changes required to deliver them, long-term strategies can facilitate a rigorous conversation to identify the resources required and available for the different stages of implementation, as well as the specific financing gaps and barriers. This can then inform the desired role of public finance, private sector and financial intermediaries and possible approaches for the allocation of risk between these intermediaries to catalyze investment.

A long-term strategy can also enable countries to get to the level of granularity required to generate joint work between institutions leading the climate agenda – such as Ministries of Environment – and the financial agenda – such as Finance, Economy, and Planning Ministries. When paired with an investment plan it can further enable a conversation to define roles and responsibilities for delivery of a pipeline of viable projects in line with the decarbonization objectives. Clarifying governance and investment priorities can position countries to take greater advantage of international cooperation to bridge existing gaps within national finance landscape, and facilitate dialogue with donors, development agencies, and investors that seek long-term low carbon development consistency and sustainability of their support or investments.





To sum up, achieving net-zero emissions by around 2050 is technically possible and can bring economic and development benefits. Countries in LAC are committed to producing and implementing long-term decarbonization strategies. The growing body of international evidence shows that LTSs have a crucial role in guiding the transformation towards net-zero emissions. LTSs can be designed in an inclusive fashion and help to anticipate and manage trade-offs, set up immediate measures and sequences of policy reforms, and guide the design of more ambitious NDCs by 2020. The LTSs should be a priority for LAC countries in respect to achieving the objectives of the Paris Agreement and delivering sustainable and inclusive development.



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All the countries in Latin America and the Caribbean have ratified the Paris Agreement, which aims to limit global warming to between 1.5°C and 2°C above pre-industrial levels. Those goals require reaching net-zero carbon dioxide emissions by around 2050.

*Getting to Net-Zero Emissions* takes stock of the lessons learnt from IDB analysis and experience in Latin America and the Caribbean and proposes approaches to developing and delivering long-term pathways to net-zero emissions by 2050. By reading this report, we hope that decision makers and technicians will gain insights into how to deliver decarbonization successfully.

The report shows the essential role played by long-term strategies in terms of identifying and planning the deployment of the infrastructure and policy packages necessary to ensure a just transition towards a net-zero emission economy. Long-term strategies will help governments anticipate fiscal and financial costs, manage trade-offs, minimize social impacts, and define the sequence of policy reforms and investment priorities required to deliver a carbon-neutral future.

The design of long-term strategies by 2020 – in line with the timeline envisaged in the context of the Paris Agreement – can guide the establishment of more ambitious Nationally Determined Contributions (NDCs) and minimize stranded assets and associated costs.

Long-term strategies are an essential instrument, both to contribute to the redirection of public and private investments, and to guide the dialogue with development institutions seeking to support sustainable and inclusive development.